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Business cycle surveys for the manufacturing industry

Ad Abrahamse and Thom Werkhoven

1. Introduction

The manufacturing industry has traditionally been central to the Dutch economy. Much importance is attached to monitoring manufacturing activity, although the sector's share in the total economy has declined in recent decades (to about 18%), while the share of the services sector has increased. In terms of economic dynamics, however, the manufacturing industry accounts for substantially more in the general business cycle in the Netherlands (yearly growth GDP), namely for over 50% and exports of manufactured products function as an economic booster, leading the rest of the economy.

Statistics Netherlands publishes monthly figures on the manufacturing industry, among other things the production index and producer prices. The first follows developments in the real production volume by the manufacturing industry, the second shows the price trends of the products. The significance of these statistics lies mainly in their topicality and their indicative value. Figures for the economy as a whole are only calculated on a yearly and quarterly basis in the National Accounts (NA). Producing the complete NA system every month would, however, involve prohibitively high costs, in terms of both money and response burden. Therefore the monthly statistics are limited to the economic variables deemed to be indicative or normative for general economic developments, indeed they are often called economic indicators. However, reporting monthly on the realised production and current prices is only part of the story. For a more comprehensive picture of ongoing economic developments we need more: which economic forces play a part, and in which direction are they moving? To get more insight into this, Statistics Netherlands also asks manufacturing companies what they think of their current situation and how they expect things to develop in the near future. These predictive surveys are not based on the expectations of Statistics Netherlands but on those of the companies themselves. The two surveys Statistics Netherlands conducts for this foresight are the monthly business sentiment survey and the half-yearly investment forecast. The sentiment survey focuses on short-term expectations and operational management in terms of orders, production, stocks, etc. The investment forecasts look further into the future, asking manufacturers to predict future investments and the reasons and factors behind them.
The importance of business cycle indicators is considerable, and particularly during periods of upturn or downturn and during economic crises the demand for topical information is greater than ever. Section 2 examines further the news value of business cycle indicators. The history and the international harmonisation of the indicators are discussed in Section 3. Section 4 looks at the business sentiment survey: how it is composed and how its results are interpreted. The investment forecasts are discussed in Section 5, and the role played by expectations in the economy in Section 6. Section 7 explains how Statistics Netherlands publishes the data and who uses them. Finally, Section 8 looks at the challenges of fulfilling users' and respondents' demands.

2. The news value of business cycle statistics

The media are always eager for the monthly results of the business sentiment surveys. Reports based on Statistics Netherlands press releases are published in the main national newspapers every month, even when things are relatively quiet on the economic front. For the media - newspapers, radio and television - these statistics are an important signal to the public. Based on the reports of Statistics Netherlands people can picture for themselves how the economy is doing. This information is not without consequence for economic activity. The outlook for the future plays an important role in decisions on the possible purchase of capital and financial assets, both by the business community and by private households.
Just a few seconds after the publication of Statistics Netherlands' press releases, at nine thirty a.m., the data are transmitted across the world through the main international press agencies such as Reuters, Datastream, AP Dow Jones, and ANP and FDA in the Netherlands. Agreements are made with these agencies about the format of the press releases, enabling them to enter the data in their own system in a few seconds. This is very important for the agencies, competitiveness in this branch is all about being the first one to publish the news. The time factor is very important, particularly in the financial world: a study by Dow Jones showed that the Dutch stock market shows an immediate response when press releases of Statistics Netherlands are published.
The newspapers also publish the releases, not as fast as the press agencies but still on the same day. Sometimes they publish only a short report of a few lines, but some releases also make front-page headlines. On the whole, Statistics Netherlands never releases more than two – in rare cases three – press releases on one day, as journalists tend to lose interest if there are too many Statistics Netherlands releases at the same time. Our policy is to make the information available to everyone at the same time. Business cycle data are not given to anyone beforehand, not even under embargo. Every December Statistics Netherlands publishes a calendar of press releases for the next twelve months. In addition, a weekly list of planned press releases is sent out on the Friday preceding the week concerned. The press in particular, need these prior announcements to plan their own reports, and to conduct any further research in time.
Given their news value, the quality of Statistics Netherlands press releases is important. The basic principles for the compilation of press releases are: a limited number of clear and appealing messages, a linguistically simple set up with short sentences and not too many figures. Naturally, these are also the guidelines for the business cycle press releases, but they must also be placed against the background of the general economic picture.

3. The history of business cycle statistics

The very first business sentiment survey was held around 1900 in Germany, when cereal farmers were asked to estimate their future crops. On a large scale, however, business cycle studies only began in the early fifties, at the German bureau of business cycle studies (IFO), the French Statistical Bureau (INSEE) and the Italian Chambers of Commerce (ISCO). In 1960 the European Commission (EC) took over the co-ordination and in 1962 it drew up the first harmonised programme for monthly business sentiment surveys in the manufacturing industry. The programme was subsequently harmonised and extended with surveys on consumers, the construction industry and retail trade. For the remaining services sectors, business sentiment surveys are still in their infancy, although consultations in this field between the Commission and its members are in full swing. Together with the members of the European Union business cycle surveys are now conducted in about 55 countries. With the help of the EC, countries in Eastern Europe are also participating in the business cycle programme to an increasing degree.

In 1960 the above-mentioned IFO, INSEE and ISCO also formed the basis for the Centre for International Research on Economic Tendency surveys (CIRET). This is a world-wide group with many well-known scientists and researchers from universities, private research institutes, trade organisations, central banks, government departments, statistical offices and international organisations such as the OECD and the European Commission. The aim of CIRET is to exchange theoretical and empirical research, specifically in the field of business cycle and opinion polls. Every two years the CIRET organises a congress.

The business cycle programme of the European Union consists of:

- business cycle surveys: monthly and quarterly opinion polls among manufacturers covering their assessment of the current situation and expectations for the near future;
- investment forecasts: half-yearly surveys on expected investments for the current and next year and on influencing factors and the motives behind the investment (since 1987);
- employment: five-yearly survey on employers' and employees' attitudes towards flexibilisation of the labour market (since 1995);
- internal market: a survey held in 1987 and 1989 among manufacturers on the expected effects of the realisation of the internal EU market on investment, employment and productivity.

Furthermore, the IFO carries out a three-monthly world-wide opinion poll, commissioned by the European Commission, among some 500 business cycle experts in more than 60 countries. Among other things the poll covers inflation, foreign trade, economic problems and the investment climate. In addition to the harmonisation of the survey questions, the United Nations and the European Commission have also developed international standards for the classification of economic activities. This makes it easier to compare the survey results from different countries. In the Netherlands this activity classification is the *Standaardbedrijfsindeling SBI 1993*, in European context it is the NACE, and at the UN it is the ISIC. In line with the above-mentioned predictive business cycle statistics, EU member countries have recently agreed a programme for short-term retrospective statistics, i.e. quantitative statistics on actually realised economic developments, as opposed to the qualitative future-oriented opinion polls.

4. Business sentiment survey for the manufacturing industry

Survey questions

Most of the questions in the business cycle survey are quality oriented: each question can be answered by '+', '=' or '–'. The survey is carried out monthly among a panel of about 1,550 manufacturing companies. The questions can be divided into three groups:

- about current developments in production and receipt of orders;
- their expectations for production and product prices in the subsequent three months.
- their judgement of order receipts, order books and their stocks of finished products.

Every three months, in the last month of the quarter, questions are added on the company's competitive position on the national and international market. Companies are also asked to predict staff numbers the next two quarters, and if they foresee a decrease or increase to express it as a percentage.
Furthermore they are asked to indicate the degree of capacity utilisation of the available production installation, and how the production capacity compares with expected demand: too high, sufficient or too low. The last quarterly question companies are asked is whether production is being held up in any way, and if so why: low demand, shortage of manpower, insufficient capacity of the production installation.

Processing

Qualitative information has to be processed differently than quantitative data, where the individual results can be added up to a total result relatively straightforwardly.
At Statistics Netherlands the qualitative information is processed as follows. On the basis of the industrial classification, Statistics Netherlands knows to which industry branch the participating companies belong, so we can compile homogeneous industry groups on the basis of activities. These data are recorded in the General Business Register, an internal databank at Statistics Netherlands, which contains meta-information about all individual companies. The next step is to assign a certain 'weight' to the companies. The reasoning behind this is that more importance should be attached to the answers from a company with a turnover of half a billion guilders, than those from a business with 'just' a few hundred thousand guilders turnover. The weight assigned is derived from other statistics; the amount of turnover is used to determine the importance of a company within a certain industry group. The assigned weight is the relative share that company has in its industry group. Subsequently the importance of the various industry groups within the whole manufacturing industry is determined on the basis of the gross value added according to the National Accounts. Once the framework has been determined thus, the percentages of the '+', '=' and '–' answers can be calculated. In line with international use, the difference between the '+' and the '–' answers to each question, the positive or negative balance, is also calculated. Lastly, these balances are corrected for seasonal effects, so the underlying trend of the economic indicators becomes clear.

Producer confidence

The enormous variety of answers makes the survey a rich source of information for research. The other side of this coin is that the wide array of opinions makes it more difficult to find out quickly what the state of the manufacturing industry as a whole is. To rectify this, the *producers' confidence* was introduced. This is one figure that reflects the overall sentiment of manufacturers, based on the seasonally adjusted balance results of the following indicators:

- the expected production in the next three months;
- manufacturers' judgement of their order books;
- their judgement of the volume of stocks of finished products.

Before these indicators can be combined into the producers' confidence they have to be adjusted because of systematic bias. Research has shown that companies who complete the questionnaires are not objective enough in their answers. Company directors – and not only in the Netherlands – are distinguished by a sort of ingrained pessimism. They will almost always answer that the stocks are too large, just to show how difficult it is to sell products. Furthermore, they rarely consider a full order book as a positive factor. The results are corrected for this lack of objectivity, and then the arithmetic mean of the three values is calculated.
The producers' confidence indicator reflects the economic sentiment of manufacturing companies. Studies have shown that the trend of the sentiment indicator is three to five months ahead of the actual production by the manufacturing industry, one of the most important business cycle indicators.
In addition to the monthly producers' confidence, quarterly results are available on among other things capacity utilisation and production bottlenecks. This information acts as a bridge to the other business cycle survey, the investment forecasts. Increasing capacity utilisation rates, together with bottlenecks resulting from insufficient production capacity, have a positive effect on investment by manufacturing companies.

5. Investment expectations survey

Investment by manufacturing companies is generally the source of future production growth trends. This spending category can fluctuate strongly and these fluctuations may be an indicator of favourable or unfavourable developments in the economy. For this reason surveys of investment decisions, with their attendant capacity expansion or reduction, are very important. The object of the survey of investment forecasts is to provide an up-to-date insight into the investment behaviour of companies, particularly in the manufacturing industry.
Twice a year (spring and autumn) the survey is conducted among a sample of companies asking them how much they expect to invest in fixed capital in the current and subsequent year. The spring survey also asks about realised investment expenditure in the previous year.
At the request of the European Commission, which partly funds the studies, the autumn survey also asks about the motives for intended investments and how a number of factors influence this investment behaviour. The survey sample is stratified: companies with 200 or more employees are always included, while companies with 10 to 200 employees are selected at random. The results are grossed up by raising the counted number per cell by the quotient of the survey population divided by the response. The division of companies into various cells is based on the size and activity of the company. The sample is identical for both the spring and autumn survey in one year.
In the autumn survey companies are asked to state their motives for the expected investments. The answers to this question give an impression of what companies are aiming to achieve by means of the investments. By buying a new machine, for example, a company may only want to replace an old one. Often, however, companies will also want the new machine to be more efficient than the old one. In that case there are two objectives. Companies are requested to state one or more of the following motives for investment:

- replacement;
- expansion of production capacity
  - with the same products
  - with different products;
- increasing efficiency
  - by automating and/or mechanising production processes;
  - by saving energy and/or raw materials;
- protection of environment (including improvement of working conditions);
- other motives.

In their decision to invest, companies can be inhibited or stimulated by a large number of factors, and the autumn survey asks them about these. They are asked to indicate for each of the following factors whether or not they had a stimulating or inhibiting effect (and if so: to what degree):

- demand for the product;
- financial factors: e.g. availability of assets, return on investment in own company as opposed to investment elsewhere;
- technical factors: e.g. technical development, available manpower, government regulations;
- other factors: e.g. tax climate, transferring production overseas.

6. The role of expectations in the economy

Within the science of economics expectations of companies are very important. Companies take decisions based on what they expect will happen in the future. And vice versa, the decisions they make now will affect the future. Thus the present and the future combine to form a complicated connection with each other. When company directors' expectations are pessimistic, they make other investment decisions than when they feel more optimistic. Investment in its turn is the basis for future growth possibilities. There are different views about the way expectations are formed; there is an economic view that assumes more or less perfect information and in which companies predict the future quite accurately on average. But there are also economic schools which believe that the expectations are far from perfect.
On markets with wholly flexible prices and capacities expectations are less important than on less flexible markets. Full flexibility implies that in cases of surplus or shortage, companies will sell off or buy capital goods immediately for prices that they think they are worth. In this 'classic' assumption of flexible markets, only the present is really important for investment decisions: too many capital goods can be sold tomorrow without loss. In cases of less flexible or static markets, the acquisition of capital goods is no longer without consequence for the future: companies get stuck with an over-capacity they cannot use. Such situations arise when the demand for products falls by more than expected when the decision was made to invest. The opposite situation occurs if a company did not anticipate an increased demand for a product or new product, loses a share of the market and can only increase the capacity of the production quickly at considerable extra cost. In the absence of perfectly functioning markets and an accurately foreseeable future, investment decisions have an inter-temporal character: decisions that are made now influence future decisions. Against this background the expectations for prices, sales and markets are very important for the micro-economic description of investment behaviour.
The acquisition of capital goods is a consequence of decision making. This is different in the case of investment or de-investment in stocks. Stock fluctuations are not only caused by changes in production but also by short-lived swings in the demand of products. Because it is relatively expensive to keep large stocks, companies balance the costs of large stocks against having to give consumers 'no' for an answer. Here too insight in trends of sales and production in the near future is important, even though the buffer function of stocks has become less important through the years because of the increasing adaptability of production processes. In addition to expectations and the anticipation of future developments, existing bottlenecks may also be a reason to increase or reduce production capacity.
The business sentiment survey (Section 4) and the investment forecasts (Section 5) give an explicit insight into the expectations of companies and the bottlenecks they encounter or that they have solved. The business sentiment survey focuses mainly on short-term expectations concerning the production process and possible bottlenecks. The investment forecasts look further ahead and ask companies to look at least a year into the future. The two surveys complement each other. On the one hand there are short-term production decisions with the inherent influencing factors; and on the other, the long-term investment decisions. In both cases the expectations for the future volumes, capacities and prices and the (existing) bottlenecks play an important role.

7. Users and dissemination

There is widespread interest in business cycle statistics, both nationally and internationally. As explained in Section 2, press agencies and other media are important customers. Other important and internationally oriented intermediaries are the UN, the OECD and Eurostat, the statistical office of the European Commission. Alongside these, there are also more specialised intermediaries, for example, sector-oriented federations, which collect data, analyse them and then publish them for their members.
One important group of users of business cycle data are financial organisations and monetary institutions, to whom quick and timely economical news is vital. Banks and their economic research departments contact Statistics Netherlands regularly for additional information and more detailed interpretations they can use for their own reports on the Dutch and international business cycle. Not only are they interested in whether branches of the manufacturing

industry achieve better or worse than expected, but mainly in the effect of this on inflation or deflation. For central banks this may be a reason to increase or reduce interest rates, with all the consequences this will have for future investment and share prices.
With the realisation of the European Monetary Union and the further centralisation of European monetary policy, the importance of business cycle statistics will increase even further. Interest rates will not depend primarily on Germany and its business cycle, but on developments across Europe as a whole. While the Netherlands has been in a favourable position up to now with its hard guilder, in the future an attractive financial position will depend on favourable trends in the business cycle.

Business cycle data are also very important as indicators of economic instabilities and tensions. As a result of the Mexico crisis (1994–1995), for example, the IMF made agreements with its members about the timely distribution of the main monetary and business cycle indicators.
Companies themselves use the business cycle data for economic analysis and market research in their own sector or that of their customers. For them timeliness is less important than for financial institutions, they need data that are sufficiently detailed and from which they can distinguish information on their sector of interest.
In addition to analysis, some business cycle data are used for the compilation of own business cycle indicators, particularly by banks. Because of the often predictive nature of these indicators, it is not always the precise number that is important, but rather the direction in which certain economic variables, GDP for example, move. Besides these traditional uses of business cycle data, there has been an increasing interest in a more model-wise approach recently. For Europe and the Netherlands, the European Commission and the Dutch national policy analysis bureau respectively use economic models which describe the cyclical phenomena and how they are connected.

So business cycle information is used for a wide variety of purposes. To fulfil the demands of the various user groups, Statistics Netherlands makes the information available in a number of different ways. As mentioned above press releases are published to inform the public of the most important data. Institutions and companies that need more detailed underlying information quickly can use *StatLine,* Statistics Netherlands' databank, accessible through the Internet. Once a month Statistics Netherlands also publishes the *Conjunctuurbericht* (Dutch Economic Indicators) in Dutch and English, which contains a brief description of various business cycle data for the whole economy. Also monthly, the *Industriemonitor*, (Manufacturing Industry Monitor) which describes the current state of affairs and expectations for all eight sectors by means of various short-term statistics. Articles are also published periodically in a number of external magazines and journals.

8. Challenges for the future

Business cycle research continues to develop. On behalf of users, responding companies and economic science we face a number of challenges:

- *More extensive business cycle surveys of the services sector*: until now collecting and publishing short-term statistical information on the services sector has only be done on a very modest scale. Despite the increase in the economic significance of services in the past decade, the availability of information on this sector has lagged behind. A recent international survey among users showed that there is a strong demand for short-term information on this sector. Anticipating this demand the European Commission is preparing to broaden and intensify business cycle surveys for services. Recently the members of the EU adopted a legal framework for the further development and implementation of, among other things, short-term services statistics.
- *New methods to collect information*: using new communication technology, Statistics Netherlands is trying to lighten and/or reduce the response burden for companies. Where possible and desirable the paper survey forms have been replaced by electronic questionnaires or extraction systems, which extract the data directly from the company accounts. Moreover, the possibilities of using data from already existing fiscal and other registrations are being examined. Obviously, for the business cycle surveys, whose data refer mainly to expectations, these data cannot be found in existing registrations. But electronic questionnaires are an option and from the experiments now being carried out, the participating companies seem enthusiastic.
- *New processing methods*: at an increasing number of statistical bureaux it is becoming generally accepted to correct the raw data for non-economic influences like seasonal and calendar effects. Until now Statistics Netherlands has only used these corrections on a small number of statistics, among which the business sentiment indicators and the production index. But we intend to extend the practice in the near future to other short-term statistics. This means that the seasonally adjusted series and trends will be available alongside the original series in the near future, presenting a broader and clearer picture of economic developments.
- *Improvement of business cycle publications*: In the near future a start will be made with the development of a new broad business cycle publication. With this publication *De Nederlandse Conjunctuur* (The Dutch business cycle), named after the series of the same title published in the thirties under professor Tinbergen which was discontinued at the start of World War II, Statistics Netherlands anticipates an increasing demand for more co-ordinated and integrated business cycle information. The publication will be based around the Quarterly National Accounts and contain an economy-wide range of monthly and quarterly indicators on the supply and demand of goods and services, labour, prices, economic expectations and foreign developments, supplemented with economic background analyses and comments.
- *Micro-economic research*: Statistics Netherlands is currently working on the development of an internal databank in which separate company data are integrated for each company. Missing data are estimated, so in principle records are complete for all companies, and the total of all the records adds up to earlier published total results. This makes it possible to conduct longitudinal studies at company level on economic relationships. In consultation with the companies, a trial period is now in progress in which – under very strict conditions - external researchers can study anonymised microdata. This clears the road for new empirical research in the field of micro-economic behaviour. Until now such empirical micro-economic business cycle studies have hardly been carried out in the Netherlands because of the lack of the necessary long-term data files.

Against the background of the increasing importance of business cycle research in general and the possibilities for new micro-economic research in particular, the science of economics faces a number of interesting challenges. Statistics Netherlands hopes and expects that science will turn this to its advantage.

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Testing effects of incentives and a condensed questionnaire on response rates

Jan van den Brakel and Robbert Renssen [1)]

1. Introduction

The Netherlands Fertility and Family Survey (NFFS) publishes demographic figures on relationship formation, childbearing, working mothers, and the practice of birth control. The survey was conducted in 1977, 1982, 1988, 1993 and 1998. In 1993 the survey was redesigned to fit in with requirements of the UN research programme on changing fertility and family patterns in the ECE region (Latten, 1998). The target population of the NFFS 1998 consists of men and women living in the Netherlands, who were born in the period 1945–1979 (i.e. around 18–52 years of age). Data are collected by means of computer assisted personal interviewing (CAPI).

As in other Statistics Netherlands surveys, response rates of the NFFS tend to be low, especially among men. Following response rates of less than 50% for the NFFS 1993, we conducted a field experiment in an attempt to improve the rates for the NFFS 1998 by means of an incentive. In addition we tested the effect of presenting a condensed questionnaire to respondents who refused to complete the regular questionnaire of the NFFS 1998.

Several empirical studies have showed that incentives tend to lead to higher response rates (e.g. Goyder, 1987; Berk et al., 1987; Berlin et al., 1992; Singer et al., 1996; Singer, 1998; Groves and Couper, 1998). Nevertheless incentives are not extensively used as an instrument to induce cooperation of respondents in household surveys. Warriner, Goyder, Gjertsen, Hohner and McSpurren (1996) found that monetary incentives induce cooperation more effectively than small presents, while James and Bolstein (1992) found empirical evidence that the highest marginal effects on response rates are obtained with relatively small incentives. Lastly, pre-paid incentives tend to lead to higher response rates than promised incentives (Groves and Couper, 1998). To find out whether incentives would have similar effects for the NFFS, we tested the effect of a small promised as well as a prepaid monetary incentive in this experiment. A telephone card with a value of NLG 2.50 with the specially designed NFFS and the Statistics Netherlands logo was used as a modern monetary incentive.

Bethlehem and Kersten (1981) proposed the *central question method* to obtain information from non-respondents on the most important variable of a survey. Respondents who refuse to participate in the regular survey are asked to answer only one question concerning the central issue of the survey. The idea is based on the experience that interviewers can usually persuade refusers to answer just one question.

In order to obtain at least some information from non-respondents on the most relevant variables of the NFFS, we considered implementing a kind of central question method as standard for the NFFS 1998. This would entail that respondents who continue to refuse to complete the regular questionnaire of the NFFS, are asked to complete a condensed version of the questionnaire in a last attempt to obtain at least some information. However, giving the interviewers the opportunity of offering potential non-respondents a condensed questionnaire should not result in a decrease of the response rates for the regular questionnaires. Before implementing the two measures as standard in the NFFS 1998 a controlled field experiment was conducted to test the effects of both measures on the response rates of the NFFS. The application of an incentive should result in a significant improvement of response, while the application of a condensed questionnaire should not result in a significant decrease of the response to the regular questionnaires. The design of this experimental study is described in Section 2. Results are presented in Section 3, and some conclusions are given in Section 4.

2. Experimental design

The purpose of this field experiment was to test the effect of two factors on the response rates of the NFFS 1998. The experiment was conducted in the winter of 1997, before the field work of the regular NFFS 1998 started. The first factor, denoted by A, was an incentive by means of a telephone card. Three levels were distinguished:

- A_1 the respondent did not receive a telephone card (no incentive or standard procedure),
- A_2 the respondent received a telephone card from the interviewer only if he or she participated in the NFFS (promised incentive),
- A_3 the respondent received a telephone card with the advance letter, regardless of whether he or she decided to participate with the NFFS or not (pre-paid incentive).

The second factor, denoted by B, was the possibility for the interviewer to offer a condensed questionnaire if the respondent refuses to complete the regular questionnaire of the NFFS. Two levels were distinguished:

- B_1 the interviewer did not have the opportunity to offer a condensed questionnaire if the respondent refuses to participate with the regular NFFS (standard procedure),
- B_2 the interviewer was asked to offer respondents a condensed questionnaire if they refused to participate with the regular NFFS.

The set up of the experiment was a 3x2 factorial design, i.e. all six possible crossings between the levels of the two factors were tested. Respondents in the treatment combination A_2B_2 also received the promised incentive if they completed only the condensed questionnaire. Testing both factors in one factorial design is much more efficient than conducting two separate experiments (Cochran and Cox, 1957). In the first place, if both factors are tested in two separate field experiments, more experimental units are required to measure treatment effects with the same precision, which consequently increases costs. In the second place, in a factorial design, interaction effects between the two factors can be tested.

The variation in response rates of respondents living in the same geographical region or interviewed by the same interviewer tend to be smaller than the variation in response rates of respondents living in different geographical regions or interviewed by different interviewers. Consequently, it might be efficient to use geographical regions or interviewers as block variables in a randomised block design (RBD) (Fienberg and Tanur, 1987, 1988, 1989 and Van den Brakel and Renssen, 1996, 1998). The disadvantage of using interviewers as a block variable in an RBD is that each of the six different treatment combinations must be conducted by each interviewer. This increases the risk that interviewers will confuse the different treatments in conducting the fieldwork, and consequently distort the experiment. Moreover, if interviewers know that they are participating in the experiment there is always the risk that they will

introduce a bias due to selective behaviour. This can be avoided by keeping the experiment 'blind', i.e. neither interviewers nor respondents know that they are participating in an experiment. Therefore we decided to use only the municipalities with different urbanisation levels as block variables in an RBD so that each interviewer could be assigned to only one of the six treatment combinations. The consequence of randomising interviewers over the treatments is an increase of the variance of the treatment effects, which results in a less precise comparison of the treatments. This is, however, less harmful than the introduction of bias due to selective behaviour of the interviewers once they know that they are participating in an experiment, or distortion of the experiment by interviewers confusing the different treatment combinations when conducting the fieldwork.

Municipalities in the Netherlands are classified into five different levels of urbanisation. Because response rates tend to correlate with urbanisation levels, for this experiment we selected the municipalities from the five different urbanisation levels as follows. First, the two largest cities (Amsterdam and Rotterdam) with the highest degree of urbanisation were selected. Furthermore one municipality was drawn randomly from each of the five different urbanisation levels. This consequently led to seven blocks or municipalities. Within each municipality, six interviewers were drawn randomly from the interviewer corps of Statistics Netherlands. As a result 42 interviewers were selected for this experiment. Subsequently, in the interview area of each interviewer a sample of persons from the target population of the NFFS was drawn. Within each block the six interviewers together with the sample drawn in their interview area were randomised over the six different treatment combinations of the experiment. Neither the interviewers nor the respondents knew that they were participating in an experiment. A separate interviewer instruction session was held for each of the six different treatment combinations to explain to the interviewers how to conduct the NFFS with their specific treatment combination.

3. Results

A total of 547 people were approached and asked to complete a NFFS questionnaire, thus participating in the experiment. Table 1 gives the response results for the six treatment combinations. In this experiment 264 respondents were assigned to the condensed questionnaire alternative (B_2). From this group, 138 respondents were offered a condensed questionnaire as they did not want to participate in the regular NFFS. Only seven of them were willing to complete the condensed questionnaire.

It follows from Table 1 that the response rates for the regular NFFS decrease dramatically when interviewers have the option of offering a condensed questionnaire to respondents who refuse to participate in the first place. For example, in the treatment group with no incentive (A_1), the response rate for the regular questionnaire drops from 46% to 35% if an interviewer has the opportunity to offer a condensed questionnaire. Moreover, the number of non-respondents who are willing to complete a condensed questionnaire is very small (only 7 out of 138 non-respondents to the regular questionnaire). Furthermore, response increases if an incentive is given, with a prepaid incentive (A_3) resulting in a higher response than a promised incentive (A_2).

Table 1
Response results for the six different treatment combinations.

Treatment		Response behaviour		Total
Incentive	Question-naire	Response	Non-response	
A_1	B_1	45 (46%)	52 (54%)	97
	B_2*)	27 (35%)	50 (65%)	77
A_2	B_1	53 (57%)	40 (43%)	93
	B_2*)	46 (50%)	45 (50%)	91
A_3	B_1	63 (68%)	30 (32%)	93
	B_2*)	53 (52%)	43 (48%)	96
Total		287 (52%)	260 (48%)	547

*) Only 7 out of the 138 non-respondents to the regular questionnaire completed a condensed questionnaire

In order to test whether both treatments have a significant influence on the response rates, the response behaviour in this experiment was analysed by means of a logistic regression model (see e.g. Agresti, 1990). If y denotes the response behaviour, which is the dependent variable in this model, the probability of response, i.e. Pr(y = 1), is assumed to depend upon:

- a general mean (u),
- the factors of the experiment, i.e. the main effect of an incentive (A_k with k = 1,2,3), the main effect of a condensed questionnaire B_l with l = 1,2) and the interaction effects between these two factors (AB_{kl}),
- the block variables, i.e., seven municipalities (P_r with $r = 1, \ldots, 7$),
- a covariable of respondents gender (x_h with $h = 1,2$).

Table 2:
Results of the logistic regression analysis of the response rates.

Variable	Effect	Standard deviation	Wald statistic	Degrees of freedom	p-value
Incentive (factor A)			9.010	2	0.011*
Promised incentive (A_2)	0.403	0.300	1.826	1	0.177
Pre-paid incentive (A_3)	0.922	0.307	9.005	1	0.003*
Condensed questionnaire (factor B)					
Condensed quest. allowed (B_2)	–0.635	0.323	3.879	1	0.0498*
Interaction between A and B			0.992	2	0.609
Prom. inc./cond. quest. (AB_{22})	0.062	0.445	0.019	1	0.890
Pre-paid inc./cond. quest (AB_{32})	0.405	0.444	0.832	1	0.362
Block variables (municipalities)			14.383	6	0.026*
Covariable (gender)					
Male (x_1)	–0.484	0.197	6.072	1	0.014*
General mean (u)	–0.505	0.311	2.641	1	0.104

*) Regression coefficient significantly unequal to zero at a significance level of 0.05 (since the p-value of the Wald statistic is smaller than 0.05)

This results in the following logistic regression model:

$$\log\left(\frac{\Pr(y=1)}{1-\Pr(y=1)}\right) = u + A_k + B_l + AB_{kl} + P_r + x_h$$

whereby 'log' denotes the natural logarithm. The selection of the two treatment factors and their interactions as well as the block variable as explanatory variables in this model follow directly from the design of this experiment. Gender is included as a covariable, because in former NFFS's the response rates among men tended to be significantly lower than among women. The identification of the model is obtained by defining the following variables equal to zero: the control group of the incentive factor (A_1), the control group of the condensed questionnaire factor (B_1), the interaction parameters AB_{11}, AB_{12}, AB_{21} and AB_{31}, one of the block variables (P_7) and the women of the covariable gender (x_2). The analysis was performed with SPSS, logistic regression procedure. The results are summarised in Table 2.

Hypotheses concerning interaction effects, main effects and local control variables were tested at a significance level of 0.05. No significant interaction effects between the two treatments (offering an incentive and a condensed questionnaire) could be found.

The main effect of an incentive is a significant increase in the response rates. Compared with the control group (no incentive) the promised as well as the pre-paid incentive had a positive effect on the response, but only in the case of the pre-paid incentive was a significant increase obtained. The effect of a promised incentive on the response rates was positive but not significant. In conclusion, the pre-paid incentive resulted in the highest effect on the response rates.

The main effect of the option to offer a condensed questionnaire is just significantly negative. Consequently, there is a tendency that the response rates of the regular questionnaire will decline if the interviewer has the alternative of offering a condensed questionnaire to potential non-respondents.

The covariable (gender) and the block variable (municipalities) have a significant influence on the response rates. The response of men is significantly lower than that of women. As former NFFS's seemed to demonstrate, men appear to be less interested than women in the topics covered by the NFFS .

4. Conclusions

The results shown by our experiment, with the most positive and significant effect on the response rates resulting from an incentive given in advance, seem to be in accordance with the results of an experiment by the National Medical Care Expenditures Survey, conducted by Berk et al. (1987). They, too, found that pre-paid incentives led to increased response rates over no incentives and promised incentives. Groves and Couper (1998, Ch.10.4) also emphasise that incentives given in advance appear to induce cooperation more effectively than promised incentives.

The purpose of offering a condensed questionnaire to potential non-respondents was to obtain at least some information about the most important questions. However, it should not result in a decrease of the response to the regular questionnaires of the NFFS. In our experiment, this alternative had a (slightly) significantly negative effect on the response rates of the regular questionnaire of the NFFS. Moreover, the number of condensed questionnaires completed by respondents who refused to complete a regular questionnaire was very small. A possible explanation for this phenomenon is that the length of the questionnaire is not a decisive factor for the respondent's response behaviour. If an interviewer has the option of offering a condensed questionnaire, he or she might be inclined to stop trying to persuade the respondent to complete the regular questionnaire too soon. If the length of the questionnaire is not a decisive factor for the respondent, this will consequently result in lower response rates. Moreover, offering a condensed questionnaire could diminish the relevance of the survey in the eyes of the respondent. Offering a shorter questionnaire to potential non-respondents or refusals in a CAPI survey during the initial contact has the risk of lower response rates to the regular questionnaire. This can be avoided if non-respondents are recontacted at a later date to offer them the condensed questionnaire as an attempt at refusal conversion.

Turning to the practical consequences of this field experiment, the pre-paid incentive (in the form of telephone card) was implemented as standard in the NFFS 1998. Furthermore, it was decided not to use the condensed questionnaires to obtain at least some relevant information from potential non-respondents, since the experiment had shown that this might result in lower response rates for the regular NFFS. A response rate of approximately 57.5% was obtained in the NFFS 1998, approximately 7.5% more than the NFFS 1993. However, it should be noted that this is a net effect which cannot be attributed to the implementation of the pre-paid incentive alone. There were at least four factors that had a strong negative effect on the response rates of the NFFS 1998 compared with the NFFS 1993. Firstly, response rates dropped during this period in almost all social surveys conducted by Statistics Netherlands. With the incentive, this negative trend was turned into a positive one for the NFFS. Secondly, during the fieldwork for the NFFS 1998, the interviewers of Statistics Netherlands faced severe capacity problems and thus very heavy workloads, which may have had a negative effect on the overall response rate. These same capacity problems forced Statistics Netherlands to recruit new and inexperienced interviewers, some of whom were involved in the fieldwork for the NFFS 1998. Since the response rates of new interviewers are significantly lower than those of skilled interviewers, this may have resulted by a negative effect on the overall response rate too. Thirdly, the target population of the NFFS 1993 consisted of people aged around 18–42 years, while that of the NFFS 1998 was extended to include people aged 43–52. In the NFFS 1998, the response rate of this group of older people appeared to be lower than that for the group of 18–42 years of age. Finally, the fieldwork period for the NFFS 1998 partially overlapped with the football World Cup, when response rates were lower.

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Note

[1)] The authors wish to thank Martin Widdershoven, who was in charge of the organisation and operation of the fieldwork for this experiment.

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Digital topographical map as a source for the compilation of area-based statistics

Mathieu Vliegen and Niek van Leeuwen

1. Introduction

Statistics Netherlands has a very long history of area-based statistics. Local authorities have sent in figures on land cover and land use at the request of Statistics Netherlands for a long time. In 1976 the compilation process of area-based statistics was based completely on analogue topographical maps (scale 1: 10,000), on which local authorities indicated land-use categories. In 1989 Statistics Netherlands introduced a PC-based Geographical Information System (GIS) together with aerial photographs (scale 1: 10,000) in order to enhance the quality of the respective statistics. With the introduction of GIS the municipal authorities no longer had a role in the compiling process. Moreover, by creating a digital land use map a better linkage of the land-use statistics with their geographical component could be realised, as well as an increase in productivity by about fifty percent (Lengkeek and Meuldijk, 1994).

Recently the Topographical Agency - the national mapping agency in the Netherlands - introduced the digital topographical map (scale 1: 10,000) on the market. With the introduction of this map Statistics Netherlands is now entering a new phase in the compilation of area-based statistics. For this digital map is very rich in content and can, therefore, be used for the compilation of more detailed area-based statistics. In addition, this digital map creates the opportunity for more standardisation in the field of area-based statistics.

In the meantime a system has been developed for the compilation of statistics on the area covered by buildings based on the digital topographical map. This system is described in Section 2. The basic territorial units used to compile these statistics are reviewed in Section 3. Section 4 presents preliminary results on the area covered by buildings and Section 5 touches on some problems relating to the use of the digital topographical map for the compilation of area-based statistics. Lastly, Section 6 looks at the prospects with regard to the integration of the digital land-use map of Statistics Netherlands with the digital topographical map of the Topographical Agency.

2. Digital topographical map and area-based statistics

Background

The decision to develop a system for the calculation of figures on the area covered by buildings was prompted by the new law covering the municipal fund which came into force on 21 October 1996, replacing the 1984 law on municipal funding. Revenues collected by local authorities – e.g. local taxes and rates - are only enough to finance part of their expenditure. The remainder of their costs are financed by central government in two ways: funds for a specific purpose, or a lump sum of a more general character. The latter has been institutionalised in the Municipal Fund, which is subject to law – the so-called Municipal Fund Act.

Payments by central government to individual local authorities on the basis of the Municipal Fund are subject to a comprehensive list of criteria, whose outlines are defined in the new 1996 Act. The new law also enables the Board of the Municipal Fund - the Ministry of Home Affairs and the Ministry of Finance - to determine the exact list of criteria and their definitions by decree. With respect to one aspect of this list, in 1997 the Board requested Statistics Netherlands to carry out a number of pilot projects. The aim of these projects was to replace the existing criterion on the volume of buildings by a criterion based on the area covered by buildings, using the digital topographical map of the Netherlands. One of the major considerations for this change was the status of this digital map. It is expected to become the standard to be used by all levels of government, as well as by the business community (RAVI, 1997).

When the results of these pilots turned out to be satisfactory enough compared with the existing volume criterion for the funding purposes, the Board of the Municipal Fund commissioned Statistics Netherlands to build a GIS application to calculate the respective area-based figures annually. The introduction of these figures in the list of criteria will probably take effect on 1 January 2001.

Content

The digital topographical map (scale 1:10,000) of the Netherlands is a product of the Dutch Topographical Agency. The first edition was released at the end of 1997 and it is to be updated in a four-year cycle. The map consists of a Digital Landscape Model (DLM), which provides the topography itself, and a Digital Cartographic Model (DCM) with symbols of entities in the terrain for the cartographic representation of the topography. Only the DLM part of the topographical map is of interest for compiling area-based statistics. The volume of data it contains amounts to approximately 2.5 GB.

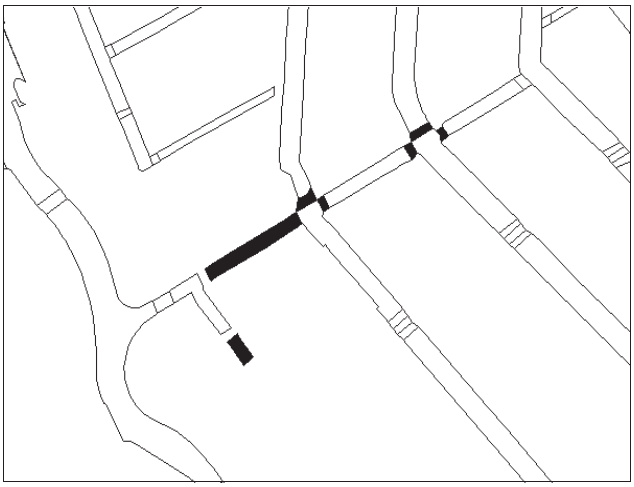
As the Topographical Agency produces its digital maps in a Microstation® Design-format, to use them Statistics Netherlands had to convert them into a GIS format: ArcInfo®. The need for this conversion had an added advantage: using GIS for this conversion gave us the opportunity to develop a tool to check the consistency of the topographical data regarding the multi-coded area and line information with respect to the application to be developed. For this reason we shall continue to use the conversion program we developed, even when the map becomes available in ArcInfo® GIS format.

The overall DLM consists of real area representations of land cover elements with a minimum width of 2 metres for roads and 6 metres for ditches, canals, rivers and lakes. Narrower roads and ditches, as well as railways are represented as separate line elements or as multi-coded area borders. The land cover areas are classified into main categories such as area covered by buildings, roads, vegetation elements and hydrography. The area covered by buildings is represented in the map as an area covered by (1) a single building, if the area exceeds 9 m², (2) a block of buildings if it exceeds 2,000 m² or when terraced houses are linked together all around, and (3) a high building, if the height exceeds 35 metres or if the building has more than 10 floors.

The system

Basically the system consists of three modules, each of which can be performed on a routine basis. In the first module the topographical map is converted into a GIS format and the inconsistent area and line information is processed. The

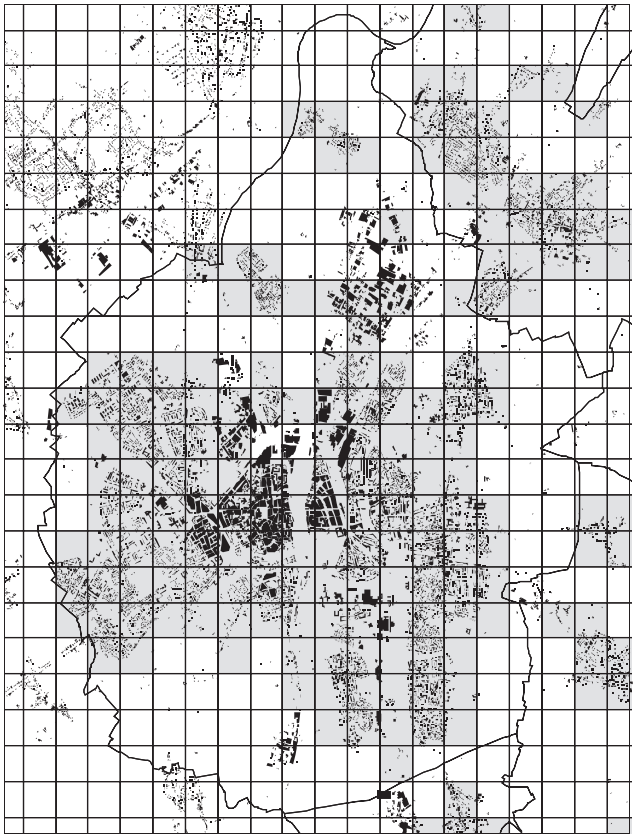
Figure 1
Example of water area made consistent (canals in Amsterdam)



inconsistent data are automatically drawn from the map for inspection and made consistent. The consistent data are subsequently entered in the system.

As pointed out above the consistency check on the topographical data regards only the multi-coded area and line information of the topographical map with respect to the applications to be developed. Figure 1 gives an example of such a case after such a conversion process. This figure shows that some of the area code for water was missing (black). Moreover, the code for water attached to line information in the original map was extracted (lines).

Figure 2
City of Maastricht: area covered by buildings (black), built-up area (grey) and non-built-up area (white)



In the second module the calculations are performed. This module was developed on the basis of previously established requirements of the Board of the Municipal Fund. First, the system should be able to perform the calculations on the area covered by buildings at the level of built-up and non-built-up areas within the municipalities. The module should moreover perform some additional calculations with respect to other area-based statistics to be used for funding purposes in the near future, namely:

– land area and water area. The water area should be calculated for coastal and inland waters separately;
– area with certain soil characteristics - namely Holocene clay and peat - which are found up to a depth of 8 metres from ground level, with a cumulative thickness of at least 5 metres. The respective calculations on the area of Holocene clay and peat should be performed for the area covered by these soils for built-up and non-built-up areas separately;
– the length of the banks of all inland waters - rivers, canals, ditches as well as lakes.

For the calculations of the area of Holocene clay and peat an additional map with the respective boundaries of these soils was required. The Netherlands Institute of Applied GEOSIGNS TNO provided this digital map.

All the area calculations are integrated in one system. They will be performed for the areas concerned every time part of the digital map is updated. The calculations are made by overlaying the relevant maps. Figure 2 gives an example of such an overlay for the calculations of the area covered by buildings for built-up and not built-up areas (see Section 3) of the city of Maastricht.

In a third module, relevant cartographic maps as well as tables showing the relevant statistics are produced for each municipality. These maps and tables can be produced on request. The maps show cartographic representations of the area of water, the delimitation of the built-up area(s) within the municipalities, as well as the area covered by buildings and the areas of Holocene clay and peat respectively. The statistics refer to (1) the area of land, the area of coastal and inland waters and the length of the inland water banks for the municipality as a whole, and (2) the area covered by buildings and the areas of Holocene clay and peat for all built-up and non-built-up areas within the municipality respectively. For this module an ArcView® application was constructed.

3. Built-up areas

The delimitation of the built-up and non-built-up areas was linked to the delimitation of settlements, which was developed for another funding criterion for local authorities: potential users of public facilities in settlements within municipalities (Vliegen and Van Dosselaar, 1998) [1].

The delimitation of settlements was based on previous studies at Statistics Netherlands on the delimitation of localities in a GIS-environment. For this purpose a grid map was constructed consisting of grids of 500 x 500 metres with at least 25 addresses per grid as a proxy for the locality [2]. Hence, the locality was defined as a configuration of such grids which are contiguous on least at one grid side, or as an isolated grid with 25 addresses or more. The Board of the Municipal Fund adopted this definition as a proxy for the definition of a settlement with only one amendment: the proxy should not cross municipal boundaries. Localities extending across the territory of two or more municipalities were therefore split up into more than one settlement.

This definition of a settlement will also be used for the delimitation of a built-up area within a municipality. Non-built-up areas are, therefore, defined as grids of 500 x 500 metres with fewer than 25 addresses per grid, as well as grids with no address.

The Geographic Base File (GBF) is used as the source for defining the grid map. The GBF is an automated file containing all postal addresses in the Netherlands with a municipal code and name, postal code, census tract and district code as well as the co-ordinates of the grids of 500 x 500 metres.

4. Preliminary results

Area covered by buildings

Table 1 summarises the main results of the calculations performed on the area covered by buildings for the built-up and non-built-up areas. The built-up and non-built-up areas are grouped together according to the degree of urbanisation of the municipalities. [3)]

The figures in Table 1 show that buildings cover only a small part of the land area, namely 2.5%. This percentage is higher for built-up areas (10.6%) than for non-built-up areas (0.8%), although these percentages vary strongly with the degree of urbanisation of the respective municipalities. The area covered by buildings in built-up areas ranges from one fifth of the land area in the case of very strongly urbanised municipalities to just under seven per cent in the non-urbanised ones; in non-built-up areas the percentages vary from three per cent of the land area in strongly urbanised municipalities, to almost one percent in non-urbanised ones.

Area covered by buildings and population statistics

Since population statistics are also compiled for the national grid map - by combining the GBF and the municipal population registers (Vliegen en van Dosselaar, 1998) - it is possible to relate these statistics to the area covered by buildings. This procedure leads to some interesting results as Table 2 shows.

The figures on the area covered by buildings and the population are used to construct a new density measure, reflecting the population density for places where people actually live and work. The figures on this new density measure are, of course, much higher than the traditional density measure, which is based on the total area of land. The latter amounted to 459 inhabitants per square kilometre for the Netherlands in 1997. The population density based on the area covered by buildings, on the other hand, comes to 18,776 inhabitants per square kilometre (see Table 2).

Naturally, the new population density is higher for built-up areas than for non-built-up areas. However, the difference between the two figures is very large: 24,751 versus 3,913 inhabitants per

Table 1
Area covered by buildings in built-up and non-built-up areas by urbanisation of municipalities, 1997

Urbanisation	Built-up areas			Non-built-up areas			Total		
	Area of land	Area covered by buildings		Area of land	Area covered by buildings		Area of land	Area covered by buildings	
	km²	km²	in % of land area	km²	km²	in % of land area	km²	km²	in % of land area
Very strongly urbanised	419.6	87.4	20.8	292.0	9.1	3.1	711.6	96.5	13.6
Strongly urbanised	926.0	132.6	14.3	1 296.3	20.9	1.6	2 222.2	153.6	6.9
Moderately urbanised	1 085.2	125.0	11.5	3 142.5	34.1	1.0	4 227.7	159.2	3.8
Hardly urbanised	1 491.3	135.2	9.1	8 809.4	77.6	0.9	10 300.6	212.8	2.1
Non-urbanised	1 676.9	111.1	6.6	14 626.9	96.0	0.7	16 303.8	207.1	1.3
Total	5 598.9	591.4	10.6	28 167.1	237.7	0.8	33 766.0	829.1	2.5

Table 2
Area covered by buildings, population and population density for built-up and non-built-up areas by urbanisation of municipalities, 1997

Urbanisation	Built-up areas			Non-built up areas			Total		
	Area covered by buildings	Population	Population density	Area covered by buildings	Population	Population density	Area covered by buildings	Population	Population density
	km²	x 1000	per km²	km²	x 1000	per km²	km²	x 1000	per km²
Very strongly urbanised	87.4	2 742.7	31 374	9.1	1.2	133	96.5	2 743.9	28 442
Strongly urbanised	132.6	3 627.7	27 349	20.9	51.7	2 470	153.6	3 679.4	23 957
Moderately urbanised	125.0	3 103.3	24 817	34.1	116.1	3 405	159.2	3 219.4	20 228
Hardly urbanised	135.2	3 005.4	22 228	77.6	317.0	4 085	212.8	3 322.4	15 612
Non-urbanised	111.1	2 157.8	19 430	96.0	444.1	4 626	207.1	2 602.0	12 567
Total	591.4	14 636.9	24 751	237.7	930.2	3 913	829.1	15 567.1	18 776

Table 3
Area covered by buildings for built-up and non-built-up areas by actual situation of the topographical map, 1997

	1992	1993	1994	1995	1996	1997	Total
	km² (%)	km² (%)	km² (%)	km² (%)	km² (%)	km² (%)	km² (%)
Built-up area	121.5 (20.5)	104.6 (17.7)	105.3 (17.8)	152.0 (25.7)	92.3 (15.6)	15.7 (2.7)	591.4 (100)
Non-built-up area	46.1 (19.4)	31.4 (13.2)	55.4 (23.3)	42.4 (17.8)	50.5 (21.3)	11.9 (5.0)	237.7 (100)
Total	167.5 (20.2)	136.0 (16.4)	160.7 (19.4)	194.4 (23.5)	142.9 (17.2)	27.6 (3.3)	829.1 (100)

square kilometre. The density figures for built-up and non-built-up areas also vary with the degree of urbanisation of the respective municipalities. The population density for built-up areas decreases from the very strongly urbanised municipalities (31,374 inhabitants per sq.km.) to the non-urbanised ones (19,430 inhabitants per sq.km). Surprisingly enough, however, in the case of the non-built-up areas the population density increases from the very strongly urbanised municipalities (133 inhabitants per sq.km) to the non-urbanised ones (4,626 inhabitants per sq.km).

5. Topographical map and area-based statistics

As stated in Section 2, the topographical map will be updated within a cycle of four years. For this purpose the Topographical Agency has divided the country into four parts. Practically, this cycle of four years implies that the area statistics based on this map will reflect the actual situation at four points in time for several parts of the country. However, the cycle is planned to begin in the year 2001.

Until then the topographical map will reflect the situation at even more points in time. The first edition of this map, released at the end of 1997, reflects the situation at six points in time, namely from 1992 to 1997. The consequences of this can be deduced from the figures in Table 3. One third of the area covered by buildings in fact represents the situation of more than four years prior to 1997. For the built-up areas this percentage is still higher, namely almost 40 per cent.

The fact that part of these figures are so outdated raises a serious problem with regard to their usefulness, particularly for the figures on parts of the country where town planning is booming. For the time being indexing the figures can enhance their usefulness, until the Topographical Agency realises its cycle of four years. At study is presently being carried out to determine the best method for indexing the figures on the area covered by buildings for the most recent year of the digital topographical map.

6. The future

A pilot study is now being carried out on the possibility of integrating the digital topographical map of the Topographical Agency and the digital land use map of Statistics Netherlands. On the one hand, the topographical map contains much detailed information, but lacks relevant land use categories such as residential and industrial areas. On the other hand, the digital land use map partly lacks basic land cover elements. The final outcome of this pilot study may be a new digital map consisting of basic land cover elements (topographical map), supplemented with basic land use categories (land use map). Such a map may be expected to be more suitable for administrative as well as statistical purposes.
Both parties - the Topographical Agency and Statistics Netherlands - are involved in this pilot study. The element of timeliness is also a special point of investigation: we are looking into whether the production processes of both organisations can be tuned in such a way that an update of the new map containing topographical elements and land-use categories can be realised in a cycle of two years.

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Notes

1) This criterion aims at correcting financially the imbalance in expenditures between cities and towns maintaining most of the larger public facilities on the one hand, and suburbs and rural areas generally operating smaller facilities while simultaneously using the bigger facilities of the cities and towns on the other hand.
2) The criterion of at least 25 addresses is derived from the guidelines for the delimitation of census tracts in rural areas. Such tracts have to be delimited in the case of a grouping of at least 25 dwellings, the distance between the dwellings being less than 100 metres. Transformed into a grid system of 500 x 500 metres, the criterion implies that there should be a maximum distance of 100 metres between pairs of addresses within a grid. This yields a number of at least 25 addresses for the whole grid of 500 x 500 metres.
3) The urbanisation is based on the address density of the area surrounding each location, i.e. every address (Van de Stadt en Vliegen, 1994).

Household scenarios for the European Union: methodology and main results

Maarten Alders and Dorien Manting

1. Introduction

Forecasting household trends makes it possible to prepare for future demands for public and private services, for outlining policies in the field of housing, social care, social security, welfare, etc. The forecasts are also of interest to the private sector, as the household is the basic consumer unit.
At the request of the European Commission, Statistics Netherlands has prepared internationally consistent household forecasts for all fifteen member countries of the European Union. This was necessary as most member states have not (yet) produced their own national household forecasts and the available household scenarios were not consistent with each other.
The Scenarios cover the period 1995–2025. For each country, they project the number of persons in institutional households by sex and single year of age, and the number of persons in the following four (private) household positions by sex and single year of age:

- living alone
- living as a couple
- living at the parental home with one or both parents
- living in another household position

The latter category includes people without a partner who live with children or with other adults. Moreover, the scenarios specify the number of one and multi-person households as well as the average number of persons per household. This article summarises the findings reported to the European Commission (Alders and Manting, 1998a and 1998b).

2. Converging and diverging trends

To analyse demographic trends and compile the household scenarios the EU countries were clustered.
Countries within each cluster experience rather similar demographic developments:

northern cluster:	Denmark, Finland and Sweden
central and western cluster:	Austria, Belgium, France, Germany, Ireland, Luxembourg, the Netherlands and the United Kingdom
southern cluster:	Greece, Italy, Portugal and Spain

The following three countries represent the clusters: Italy, the Netherlands and Finland.

Before discussing the household scenarios, it may helpful to present some trends in the four household positions. Trends are discussed on the basis of uncorrected information from the Labour Force Surveys[1)] (LFS) 1983–1996. To use them for the scenarios, data were compared with data from other sources.
This comparison resulted in a number of corrections. LFS time series are not always available, and where they are available, figures for before 1991 and after 1992 generally have to be interpreted with caution, as the time series for most countries are interrupted, for several reasons.

Living at the parental home

Most children live at home until at least age 15. After this age, the proportion of children starts to decline in all countries, although at different rates.

At almost every age and in every country, relatively more young men live at the parental home than young women. There is a clear difference between southern European and other European countries. To give an example, more than 40 per cent of 30 year-old Italian men still live at their parents' home, compared with only 10 per cent of Dutch men of that age (Table 1). Northern European countries have the lowest proportions of children living with their parents.

In Italy, as well as in the other southern European countries, leaving home has been increasingly postponed since 1983. This is also the case in some countries in the central and western European cluster, France, for example. But in other countries, such as the Netherlands, there has been almost no change.

Because of these different trends since the beginning of the 1980s, involving minor changes in central and western European countries and a large delay in the south, countries now differ more from each other than they did at the beginning of the 1980s.

Living alone

Living alone is much less popular in southern than in northern European countries. Up to around age 50, very few men and women

Table 1
Percentage of persons living at home at ages 20 and 30, by sex and country, 1995–1996

	GR	IT	PT	ES	AT	BE	DE	FR	IE	LU	NL	UK	DK[1]	FI
Age	*Men*													
20	84	96	91	95	87	82	83	78	76	85	81	72	67	34
30	44	43	38	44	22	9	15	12	23	20	10	11	7	7
Age	*Women*													
20	76	91	83	92	75	77	67	64	63	77	65	55	48	24
30	20	27	24	30	10	4	6	6	13	10	2	6	1	1

N.B.: Greece (GR), Italy (IT), Portugal (PT), Spain (ES), Austria (AT), Belgium (BE), Germany (DE), France (FR), Ireland (IE), Luxembourg (LU), the Netherlands (NL), United Kingdom (UK), Denmark (DK), Finland (FI).
1) Denmark, based on data for 1992–1993.

Table 2
Percentage of persons living alone at selected ages, by sex and country, 1995–1996

	GR	IT	PT	ES	AT	BE	DE	FR	IE	LU	NL	UK	DK[1]	FI
Age	*Men*													
20	8	1	1	0	4	3	9	10	2	3	10	5	25	21
30	7	6	2	2	14	12	23	16	7	12	18	16	30	23
65	4	8	4	4	10	11	11	12	14	9	12	14	17	16
80	15	18	15	8	13	28	24	20	28	18	23	29	37	38
Age	*Women*													
20	8	1	2	0	4	3	12	12	3	4	14	5	30	25
30	4	4	2	1	10	7	14	10	4	7	11	8	15	18
65	12	13	9	6	17	15	20	18	13	13	19	19	27	27
80	49	51	31	32	60	60	69	59	49	49	69	58	77	74

N.B.: Greece (GR), Italy (IT), Portugal (PT), Spain (ES), Austria (AT), Belgium (BE), Germany (DE), France (FR), Ireland (IE), Luxembourg (LU), the Netherlands (NL), United Kingdom (UK), Denmark (DK), Finland (FI).
[1)] Denmark, based on data for 1992–1993.

Table 3
Percentage of persons living with a partner at selected ages, by sex and country, 1995–1996

	GR	IT	PT	ES	AT	BE	DE	FR	IE	LU	NL	UK	DK[1]	FI
Age	Men													
20	1	0	2	1	2	2	5	5	2	3	4	6	8	14
30	45	44	50	47	56	62	59	69	58	60	71	66	63	62
60	92	83	90	86	84	71	86	83	73	80	84	81	81	75
80	74	69	67	72	73	60	70	73	51	58	74	63	63	16
Age	Women													
20	8	4	5	3	10	8	16	16	4	10	18	16	21	27
30	72	61	64	62	69	72	72	76	67	75	82	68	75	70
60	75	69	72	76	67	64	73	73	68	73	76	73	71	63
80	23	23	28	27	17	22	19	28	16	20	26	28	23	1

N.B.: Greece (GR), Italy (IT), Portugal (PT), Spain (ES), Austria (AT), Belgium (BE), Germany (DE), France (FR), Ireland (IE), Luxembourg (LU), the Netherlands (NL), United Kingdom (UK), Denmark (DK), Finland (FI).
[1)] Denmark, based on data for 1992–1993.

in most southern European countries live alone (between 1 and 5 per cent on average). For the over-fifties, living alone becomes increasingly more common both for men and women. As women generally live longer than men, more women live alone at older ages. To give an example, about half of Italian women aged 80 live alone compared with less than a fifth of Italian men of the same age 80 (Table 2).

Age and sex-specific patterns of people living alone are rather similar in all other EU member states. However, in central, western and northern countries, a large proportion of young people tend to live alone for some time, whereas this is quite rare in the southern countries. At age 20, for instance, one in ten Dutch men live alone, compared with one in a hundred Italian men. As this solitary phase is generally temporary, it leads to a peak in the proportions of persons living alone at ages between 20 and 30. On the whole this peak occurs a few years later in men's course of life than in women's, as men leave home and marry a few years later than women.

Through the years, the proportions of young persons living alone have increased significantly in almost all countries, both at young ages and middle ages. In southern European countries these increases were much smaller than in central and western European countries. Only among people who are about 60 to 75 years old have the proportions of persons who live alone decreased. More couples survive because both men and women have increasing life expectancies.

Living with a partner

Most people live with a partner, either in a marriage or a long-term relationship. The proportion of persons living with a partner generally increases rapidly between the ages of 20 and 30. For example, about 4 per cent of Dutch men live with a partner at age 20, against 71 per cent at age 30 (Table 3). After that, it the percentage increases at a much lower rate or remains more or less stable.
At later ages, between 50 and 70, the proportions of persons living with a partner decline relatively slowly, followed by a more rapid decline after about age 70.
Relatively more women live with a partner at young ages than men, because women are on average two to three years younger than men when they marry. Because wives generally survive their husbands, far more men aged 50 and over are married than women. In Italy, for instance, at age 80 about 70 per cent of men and just over 20 per cent of women live with a partner.

Because most young people from southern Europe live at home, relatively fewer 20–30-year olds in these countries are in couples compared with the rest of the European Union. The proportion of middle-aged people living with a partner is generally highest in the southern European countries.

Between 1983 and 1996, fewer and fewer people lived with a partner at young ages, with union formation and marriage being increasingly postponed. Later on in life, on the other hand, more and

Table 4
Percentage of persons in other household positions at selected ages, by sex and country, 1995–1996

	GR	IT	PT	ES	AT	BE	DE	FR	IE	LU	NL	UK	DK[1]	FI
Age	*Men*													
20	6	3	6	4	7	13	4	7	20	9	4	16	79	32
30	5	7	10	7	7	18	3	3	12	9	1	7	9	8
60	4	8	5	8	6	18	3	4	12	10	3	4	2	9
80	11	13	17	20	14	12	5	6	22	24	3	8	0	47
Age	*Women*													
20	8	4	9	5	11	12	5	7	30	10	4	24	51	25
30	4	9	10	6	11	17	9	8	16	8	5	19	1	11
60	12	16	17	15	16	20	6	8	18	13	8	8	2	10
80	29	26	40	42	23	17	12	13	35	30	4	14	0	26

N.B.: Greece (GR), Italy (IT), Portugal (PT), Spain (ES), Austria (AT), Belgium (BE), Germany (DE), France (FR), Ireland (IE), Luxembourg (LU), the Netherlands (NL), United Kingdom (UK), Denmark (DK), Finland (FI).
[1)] Denmark, based on data for 1992–1993.

more men and women lived together. This is largely the result of a continued increase in life expectancy for both men and women.

Other household positions

All those people who are not a child, not single, and not living with a partner belong to the category 'other'. This category therefore includes single parents and members of multi-family households. In general, the proportion of others is low at young ages and high at old ages (Table 4). Most countries show a peak at young ages, probably based on one-parent families and the phenomenon of students sharing houses.

In most countries, the proportion of persons living in an 'other' household position is declining, especially in the second half of life.

Institutional population

Information on institutional households is scarce in both censuses and surveys. The censuses taken around 1990 show that in the European Union about 1 per cent of the population does not live in a private household. For the purpose of the compilation of the household scenarios, a few countries generated more detailed (age and sex-specific) information on institutional households. The age patterns show a rise in the proportions with age, especially at advanced ages. In the Netherlands, proportions are less than 1 per cent for persons younger than 60, compared with 27 per cent for men and 40 per cent for women older than 90 years.

3. Background of household trends

The household developments described above are closely related to demographic developments and to socio-economic, cultural, technological and policy-related conditions.

Demographic backgrounds of household trends

Postponement of first marriage is accompanied by higher proportions of young adults living at home (especially in the southern European countries), higher proportions of people living alone (especially in the central, western and northern European countries) and by lower proportions of young couples. In most northern, and central and western European countries there is no longer a close link between leaving home and getting married. In the Netherlands for instance, it has even become more common to leave home to live alone than to leave home for the purpose of forming a union (Mulder and Manting, 1994). However, there are exceptions to this rule, like Belgium where the majority of youngsters (still) leave home to marry (Corijn and Manting, forthcoming). Postponement of entry into a union goes hand in hand with a lengthening of the period of living alone among young people in some countries, but with a lengthening of the period of living at the parental home in others.

The decrease in the proportion of young couples and the increase in the proportion of young adults living alone is also closely linked to the timing and incidence of first childbirth. Relatively low fertility rates in the last two decades have led to large numbers of childless women and relatively large numbers of childless couples. But marriage and childbearing are much more closely linked in the southern European countries than in the northern ones. For example, just under half of Danish children are born outside marriage, whereas the proportion is only three out of every hundred in Greece (Eurostat, 1997). And thus, postponement of family formation in southern European countries is more closely linked to the number of young couples than in the northern ones.
A lower proportion of couples in their thirties and forties may also be the result of the increase in childlessness at these ages, as couples without children have much higher divorce rates than couples with children. Furthermore, unmarried unions, which are more and more common in the central, western and, in particular, northern European countries, are more likely to break up than marriages (Hoem and Hoem, 1992; Manting, 1995).

Increasing life expectancy has led to more couples among people aged between 60 and 70. An increasing tendency of children to stay at home in some countries also leads to a decrease in proportions of 60–70-year-old women living alone.
The decreasing number of people in other household positions is partly because the number of multi-family households is on the decline, although this is to a minor extent counteracted by an increase in the number of one-parent families.

Social and cultural backgrounds

Secularisation has led to a declining commitment of people to normative guidelines of the church in recent years(Lesthaeghe, 1983, 1991). As a result, non-traditional social bonds such as

one-parent families and cohabitation, as well as living alone, have become increasingly acceptable.

The loss of the societal functions of marriage is also seen as a major cause of changes in living arrangements. Functions such as procreation, education, care and socialisation of children, economic and social security of the individual members of the family have increasingly been taken over by the state and private institutions. Both men and women have become less dependent on marriage and the family for the fulfilment of a variety of needs (Espenshade, 1985). As such, marriage has become less attractive, leading to a decline in the number of marriages, and more vulnerability to divorce (Roussel, 1989).

Individualisation can be observed in most European countries. With the need for more privacy and independence from others, individualisation is one of the reasons for the increasing number of one-person households (Van de Kaa, 1987; Kuijsten, 1996). Young people increasingly tend to live alone before they commit themselves to others.

Economic backgrounds

Favourable economic conditions may allow people to choose between living alone and living with others, depending on their individual values and preferences. A relatively low income makes it more difficult to live alone or in a small household, as the latter is relatively more expensive than a large one (Burch and Matthews, 1987).

In the past years, an increasing uncertainty on the labour market, an increasing number of temporary contracts and a decreasing labour force participation among the young are seen as major causes of the delay of young persons in leaving home in some countries (see for instance Galland, 1997; Nave-Hertz, 1997).

Another response to recent labour market situations is the increase in educational participation in order to enhance career opportunities. In all countries, duration of educational participation has increased through the years, with major repercussions for demographic and household behaviour. Increasing enrolment in the educational system and higher educational levels have led to postponement of union formation, marriage and fertility in several European countries. Furthermore, they have also influenced the process of leaving home, as many young people leave their parents to enrol in education in another city.

The increasing level of education or, more generally, emancipation of women has stimulated the decline in marriage and fertility rates as well as the rise in divorce rates (Blossfeld, 1995). Emancipation also led to economic independence of women. This economic independence of women through their participation in the labour market or through individualisation of social security means marriage offers fewer material advantages, which also results in greater marriage instability (Roussel, 1989).

Policy-related conditions

Divorce laws differ strongly between the countries of the European Union. In the southern European countries and in Ireland, the law is quite restrictive, contributing to low divorce rates.

Housing policies may have influenced the timing of leaving home to a large extent. In the Netherlands and Denmark, for instance, housing needs of young people are recognised (Jones, 1995), which probably explains the low proportions of young persons living at home in these countries. In Italy and Belgium, on the other hand, the housing situation stands in the way of leaving home among the young: housing is expensive and rented accommodation is in limited supply.

Social security measures in the form of public assistance, student grants, child benefits, and rent subsidies may also have an important impact on household formation and dissolution. The choice between leaving home and studying, for example, partly depends on the availability of student grants. Rent subsidies provide a greater degree of independence to those who are not able to obtain a mortgage. The possibility of receiving an assistance benefit can influence the choice of whether or not to divorce. Child benefits and facilities for combining parenthood and employment have been generated to stimulate higher fertility.

Technological backgrounds

The introduction of the contraceptive pill initially went hand in hand with a fall in the number of families with relatively many children. Another consequence of the introduction was postponement of fertility among young couples. Nowadays, it also enables couples to realise their voluntary childlessness.

Other modern technological developments, such as urbanisation and increasing mobility, have made individuals less dependent on other household members (Burch and Matthews, 1987). Telecommunications and cars have rendered physical distance increasingly irrelevant, enabling people to act more independently. For older people, in particular, it has become easier to live alone.

4. Three Household Scenarios

The complexity of numerous determinants influencing past household behaviour makes it difficult to predict future behaviour. Furthermore it is not always easy to predict whether or not differences between countries will increase or decrease. To express the uncertainty about future household developments, two completely different scenarios have been drawn up: the *Individualisation Scenario* and the *Family Scenario*. A third scenario, the *Baseline Scenario*, is the average of the other two. Separate scenarios were produced for the three clusters of countries already defined above: the so-called northern, southern and central and western clusters.

The household scenarios had to meet a number of conditions. First of all, they had to be made consistent with the latest set of long-term *European Population Scenarios* (De Beer and De Jong, 1996) and with the new *Labour Force Scenarios* (De Jong, forthcoming). Three long-term European Population Scenarios are distinguished: the Low, Baseline and High Population Scenario. The same distinction was made for the Labour Force Scenarios. Furthermore, consistency with (six) national household projections was preferred. For several reasons, however, the scenarios do not completely correspond with these national forecasts. The main reason is that the scenarios differ from official predictions by their nature. National statistical agencies often attempt to make a prediction of the most likely future, whereas the European Household Scenarios aim to explore realistic boundaries of future household developments within the context of consistency with European Population and Labour Force Scenarios.
The scenarios are illustrated by the age patterns of Italy, the Netherlands and Finland (Figures 1, 2 and 3).

The Individualisation Scenario

The Individualisation Scenario assumes that long-term trends of individualisation, emancipation and secularisation will lead to higher proportions of people living alone and fewer people living together

Figure 1
Population by sex, age and household position in 1995 and 2025 as percentages of the population in private households

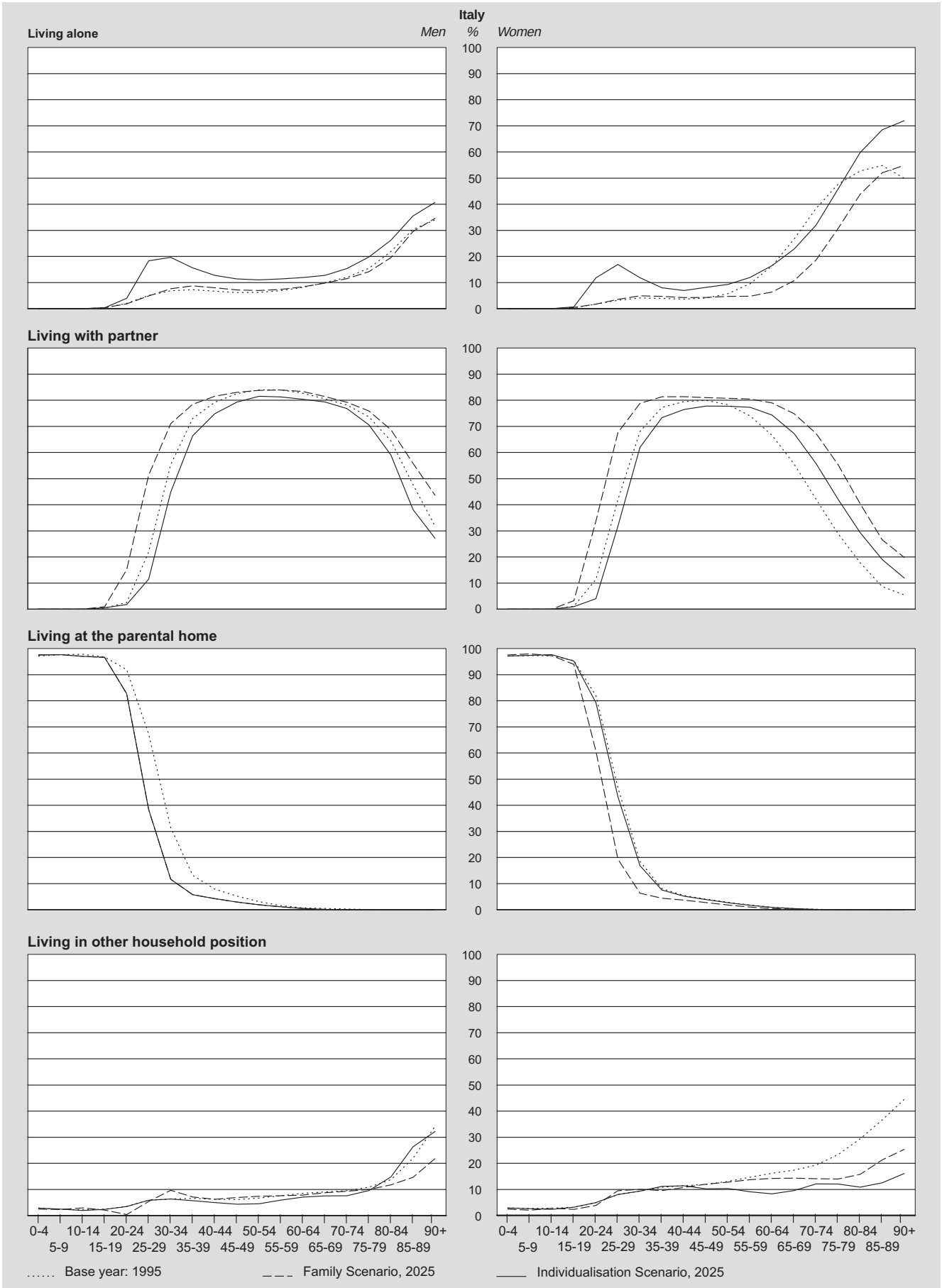


Figure 2
Population by sex, age and household position in 1995 and 2025, as percentages of the population in private households

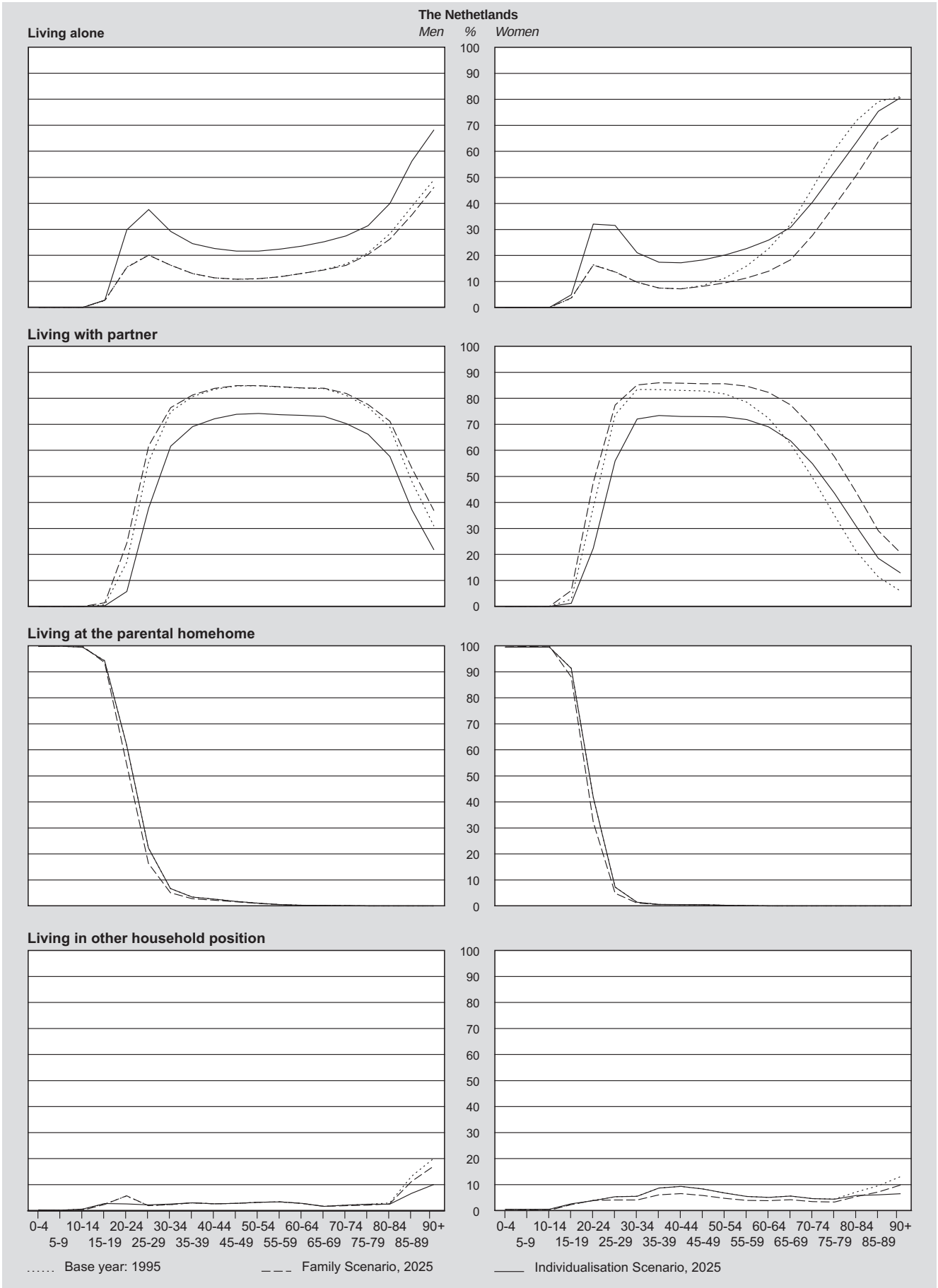
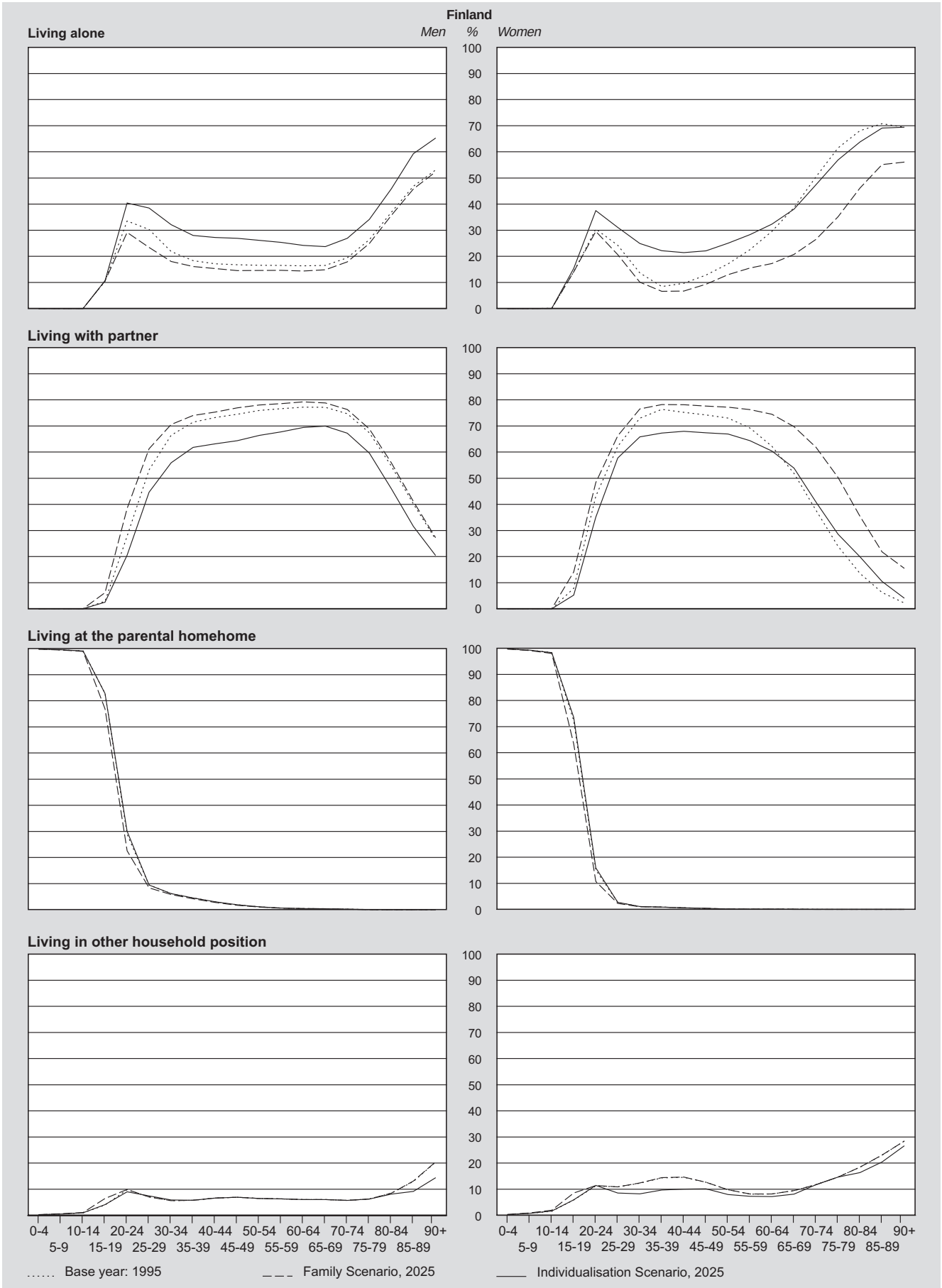


Figure 3
Population by sex, age and household position in 1995 and 2025, as percentages of the population in private households



as a couple. A slowing down of economic growth will to some extent counteract the increase in the number of persons living alone.

Cultural trends accelerate the process of leaving home while economic trends hinder the same process: the proportions of young persons living at the parental home are therefore held almost constant. The relatively low proportions of people living in an other household position do not change significantly in the central and western and in the northern clusters. In the southern cluster, proportions decrease at older ages, because of the diminishing influence of multi-family households.

It was decided to combine the Individualisation Scenario with the Low Population Scenario, which assumes a relatively low fertility, a slower increase in life expectancy and a relatively low international net migration. Differences in life expectancy between men and women will remain more or less constant. These assumptions will most likely be accompanied by an increase in the proportions of people living alone: low fertility is generally associated with a delay in union and family formation and with more young adults living alone.
They will generally also go together with more childless couples and more small families at middle ages. Childless couples as well as small families have a much higher likelihood of divorce than couples with (relatively many) children. Future childless couples will more often cohabit than marry. Generally speaking, cohabiting couples are more likely to end up alone than those who are married. Due to a moderate increase in life expectancy and a constant level of excess male mortality there will be more one-person households among those who are 80 years or older.

The Individualisation Scenario is also consistent with the Low Labour Force Scenario in terms of qualitative economic assumptions. The assumption of an unfavourable economic climate in the Low Labour Force Scenario will somewhat counteract the assumed increase in the number of one-person households. It will also make the wish of a growing number of young people to live independently from their parents impracticable. Both scenarios are consistent with the population structure of the Low Population Scenario.

The Family Scenario

The Family Scenario assumes that the slowing down of secularisation, emancipation and individualisation, together with a relatively strong economic growth, will lead to an increase in the number of couples at all ages. In the Family Scenario, the process of leaving home is accelerated due to a relatively strong economic growth. Leaving home earlier leads to earlier union formation and thus to more couples at young ages. The age pattern of living alone at young ages hardly changes. The proportions of middle-aged people living with a partner increase slightly, due to a slowing down of union instability. As a result the proportions of people living alone at these ages stabilise. The relatively low proportions of people living in an other household position do not change significantly in the northern cluster. In the central and western and especially in the southern cluster, proportions decrease at older ages, because of the diminishing influence of multi-family households.

The Family Scenario is consistent with the High Population Scenario and the High Labour Force Scenario. The Family Scenario is therefore coupled with expectations such as high fertility, high life expectancy and a converging trend in sex-specific life expectancy. These assumptions, together with the assumption that this is a family-oriented scenario, will lead to a relatively large increase in the proportions of persons living with a partner. This increase is further stimulated by the fact that economic growth will be relatively strong, according to the High Labour Force Scenario, which is also consistent with the population structure of the High Population Scenario.

The Baseline Scenario

This third household scenario is the average of the other two. It assumes that historical trends will largely continue until 2000. Its population structure is identical to that of the Baseline Population Scenario. This household scenario should not be interpreted as the scenario which predicts the most likely future.

Convergence or divergence?

As shown above, differences between southern Europe and the rest of Europe with respect to children living at the parental home have increased. Trends in living alone show a completely different picture. In a general sense, there are leading, middle-bracket and lagging countries, closely corresponding with the northern, central and western, and southern European countries. This general picture is supported by a number of studies of household trends and living arrangements in Europe, which show that northern European countries lead the way with regard to new demographic developments, whereas southern European countries seem to be lagging behind (Blossfeld et al., 1993; Van de Kaa, 1987). On the other hand, delay of entry into a union is a common trend in most countries.

Empirical analyses provide mixed evidence with regard to the longstanding debate on the issue of convergence or divergence in future household trends in Europe. Broadly speaking, discussions evolve around the question of whether or not country-specific demographic differences in Europe since the mid-1960s will continue to diminish. Those in favour argue that demographic changes since the beginning of the 1960s can be understood in terms of the so-called Second Demographic Transition (Lesthaeghe and Van de Kaa, 1986). In principle, the Second Demographic Transition assumes that at some time in the future, all countries will have undergone this transition. Opponents of convergence argue that there are many variations in time and space that do not really show a declining trend. They say that differences in household structures between countries cannot solely be interpreted as differences in the rate at which countries follow the basic demographic changes as described by the Demographic Transition (Kuijsten, 1996).

In the Individualisation Scenario, which focuses on developments in trends in living alone, it is assumed that the northern countries lead the way ahead of the central and western countries, which in turn are followed by the southern countries. The Family Scenario assumes that differences between the various countries remain more or less stable over time. Within the clusters, future trends will differ between the countries to a certain degree, based on different population structures.

No time series are generally available for the institutional population, nor are there sufficient other sources of information. For these reasons estimated age profiles of the institutional populations are assumed to be constant over the period 1995–2025.

5. Main results of the scenarios

All three scenarios predict an increasing institutional population, varying from 6.0 to 7.5 million for the European Union in 2025. As the proportions of persons in institutional households are held constant over time, this is a consequence of the ageing of the population. This fact emphasises the importance of the underlying Population Scenarios for the outcomes of the different Household Scenarios.

The Individualisation Scenario projects a declining population in private households, from about 366 million in 1995 to 352 million in

Table 5
Number of persons by household position in 1995 and 2025; three scenarios.

	1995	2025			1995	2025		
		Individu-alisation Scenario	Baseline Scenario	Family Scenario		Individua-alisation Scenario	Baseline Scenario	Family Scenario
	x 1 000 000							
	Living alone				*Living with a partner*			
EUR 15	42.0	71.3	59.4	45.5	179.5	172.8	201.2	232.7
Greece	0.8	1.4	1.2	0.9	5.1	5.4	6.1	6.9
Italy	4.6	7.3	6.2	4.9	26.1	26.0	29.3	32.8
Portugal	0.5	1.3	0.9	0.5	4.6	4.8	5.6	6.5
Spain	1.5	5.3	3.7	2.0	17.9	18.6	21.4	24.6
Austria	0.9	1.6	1.3	0.9	3.7	3.7	4.3	5.1
Belgium	1.1	2.1	1.7	1.2	4.7	4.3	5.1	6.0
France	7.0	12.7	10.6	8.1	28.5	27.7	32.0	36.7
Germany	12.7	17.8	15.4	12.5	41.6	38.1	45.1	53.1
Ireland	0.3	0.7	0.5	0.4	1.4	1.4	1.7	2.0
Luxembourg	0.04	0.09	0.07	0.04	0.2	0.2	0.25	0.31
Netherlands	2.0	3.5	3.0	2.3	8.1	7.7	9.2	10.7
United Kingdom	7.1	12.4	10.4	8.0	28.4	26.3	31.0	36.1
Denmark	1.1	1.4	1.2	1.0	2.5	2.3	2.8	3.3
Finland	0.9	1.3	1.1	0.9	2.4	2.2	2.6	3.0
Sweden	1.7	2.4	2.1	1.8	4.3	4.0	4.8	5.7
	Living at parental home				*Living in other household positions*			
EUR 15	118.4	85.6	96.9	111.7	26.4	22.2	23.9	25.8
Greece	3.7	2.7	3.1	3.4	0.7	0.5	0.6	0.7
Italy	20.4	12.8	14.3	16.0	4.9	3.7	4.3	5.0
Portugal	3.8	2.8	3.1	3.4	1.0	0.7	0.8	1.0
Spain	15.9	10.2	11.5	13.3	3.7	2.6	3.1	3.6
Austria	2.5	1.8	2.1	2.5	0.7	0.6	0.7	0.8
Belgium	2.9	2.2	2.6	2.9	1.3	1.0	1.1	1.2
France	18.1	14.1	16.0	18.6	3.3	3.2	3.3	3.5
Germany	22.2	16.4	18.6	21.9	4.2	4.0	4.0	3.9
Ireland	1.5	1.0	1.2	1.4	0.4	0.4	0.4	0.5
Luxembourg	0.13	0.11	0.14	0.17	0.04	0.03	0.04	0.05
Netherlands	4.6	3.6	4.4	4.9	0.6	0.6	0.6	0.6
United Kingdom	17.6	13.9	15.2	17.7	4.6	4.1	4.0	4.0
Denmark	1.4	1.1	1.3	1.5	0.2	0.1	0.2	0.2
Finland	1.3	1.1	1.2	1.4	0.4	0.3	0.4	0.5
Sweden	2.4	1.9	2.3	2.7	0.4	0.4	0.4	0.4

2025 (Table 5). This is mainly the result of the combination with the Low Population Scenario, which predicts a declining overall population. The number of children living with their parents will fall from 118 to 86 million in 2025, despite the assumption that the proportion of children living at home will remain more or less constant. The number of couples as well as the number of persons in other household positions will decline as well. In contrast, the number of persons living alone will rise from 42 to 71 million. In 2025, almost one in every five people will live alone, compared with only one in nine today. Consequently, the average household size will decrease from about 2.5 in 1995 to 2.1 in 2025. The number of households will increase from 148 to 172 million in 2025.

Even in the Family Scenario, which assumes that the proportions of persons in one-person households will remain stable, the number of persons living alone increases to almost 46 million in 2025. This increase is mainly caused by the growing number of people, in particular elderly people. The growing number of persons living with a partner, rising from 180 to 233 million in 2025, is the result of the younger ages at union formation, together with a slowing down in the increase in divorce rates, a higher life expectancy of men and women and a growing population. Both the number of children and the number of persons living in other types of household will fall. As a result of these trends, the number of private households will grow by 30 million in the next three decades, while the average household size will decrease to about 2.4. The Baseline Scenario figures for the 15 countries in the EU in 2025 are 388 million for the total population and 382 million for the private population. Here again, the number of persons living alone is predicted to rise. Whereas the number of persons living with a partner will also increase, the number of children living at home and the number of persons living in an other type of household will drop. Again, the number of private households will increase, whereas the average household size will decrease.

In the Individualisation Scenario, in particular, the proportional increase in the number of one-person households is the largest in the southern cluster and smallest in the northern cluster. In all three scenarios the numbers of people living with a partner increase in the southern European countries. In most other countries, however, the numbers decrease in the Individualisation Scenario.

In the southern European countries the numbers of children living at home decrease in all three scenarios. In other clusters the numbers generally stabilise in the Family Scenario.

Developments in the numbers of people by household position differ between men and women and between age groups. In all scenarios and countries, the number of men living with a partner is similar to the number of women living with a partner.

The numbers of men and women living alone in the 15 EU countries both increase by about 15 million until 2025 in the Individualisation Scenario. For both sexes, the increase in absolute numbers is largest for the age group 20–64 years. The relative increase among men, however, is largest for those in the age group 65-79 years.

The Family Scenario foresees an increase in the number of men living alone and a stabilisation of the number of women living alone. The increase for men takes place in all age-groups, whereas an increase for women only occurs among those younger than 20 and older than 80 years. There is a relatively large decrease among 65–79 year old women, which is the result of the increase in the number of women living with a partner.

The Individualisation Scenario projects a drop in numbers of persons living with a partner in 2025, caused by decreasing numbers of these people aged between 20 and 65 years. There is, however, an increase in the number of people older than 65 years, especially for women.

In the Family Scenario the total number of men and women living with a partner increases by 30 per cent to about 233 million in 2025. The assumption of union formation at an earlier age in the Family Scenario leads to an increasing number of people younger than 20 living with a partner. The increasing numbers for the age groups 20–64 years and 65–79 years are the result of increasing population numbers and increasing proportions of people, especially women, living with a partner.

It is assumed that the majority of people younger than 20 years live at the parental home. For this age group the number living at home decreases in the Individualisation Scenario and the Baseline Scenario, whereas it increases in the Family Scenario. The decrease in the Individualisation Scenario is the result of low fertility leading to smaller new birth cohorts together with a stabilisation or a small decrease in the proportions of persons living at the parental home. The increase in the Family Scenario is caused by relatively high fertility, despite the assumed decrease in the proportions of people living at the parental home. The number of people of 20 years or older living at the parental home falls in all three scenarios.

The numbers of people in other household positions are comparatively small. These numbers generally decrease for men and for women. They increase, however, for men of 65 years or older. In all three scenarios fewer women live in other household positions. Fewer elderly women, in particular, are members of a multi-family household.

Note:

1) Household figures for the base year are estimated from the EU regulated 1995/1996 Labour Force Surveys. These Eurostat data sets do not always correspond exactly with the data published by the countries for various reasons: different weighing procedures, different kinds of data subsets, mid-year figures instead of figures for 1 January, and possibly differing definitions.

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Analysing well-being in relation to characteristics of the population

Gerda Gringhuis and Abby Israëls

1. Introduction

In 1995 the Department of Health and Social Welfare at Statistics Netherlands started a project for the development of a *Conceptual framework for well-being and health* for statistics in this field. The conceptual issues were described in an internal report by Ankersmit, De Bruin and Van Maanen; Ankersmit and Gringhuis (1997) published the first empirical results based on the 1995 data from the Dutch Quality of Life Survey, and Ankersmit and Verweij (1998) published the corresponding results for 1996. The present authors analysed the same data in more detail (Gringhuis and Israëls, 1998), examining relations between the well-being indicators as well as those between these indicators and individual characteristics. Furthermore we tried to identify groups, distinguished by a number of background variables, which score positively or negatively on the majority of the indicators. This article demonstrates some of these analyses.
Section 2 gives a description of the concepts and the data. Section 3 shows the empirical relations among the well-being indicators. Sections 4 and 5 explain the well-being indicators by the individual characteristics.

2. Definitions and description of the data

'Well-being' is defined as a concept consisting of five elements:
1. objective quality of the various aspects of life;
2. satisfaction with the various aspects of life;
3. quality of social functioning;
4. appreciation of the macro-social environment;
5. general happiness.

Sub-elements can be formed for each of these elements, such as the various aspects of life (health, work, etc.) for elements 1 and 2. More information on the conceptual framework, including supposed relations between the elements and sub-elements, is given in the internal report by Ankersmit, De Bruin and Van Maanen. So far, one or more indicators (or sub-elements) have been operationalised for each element, using existing questions from the Quality of Life Survey. This results in 18 indicators, most composed as a kind of sum score of several survey items (see table 1). Although this method of describing well-being is influenced by the data that are at our disposal, it does enable us to obtain a first operationalisation of the concept of well-being. In the future the conceptual framework should have its impact on the questions to be asked in the survey.
The data set we used was taken from the Quality of Life Survey for two years, 1995 and 1996, with a total response of 7,951 people aged 18 and older in the Netherlands. For both years, a sample was drawn from the postal address register, and each household at a sampled address was visited. Within each household only one person was interviewed. In order to correct for these unequal probabilities, the respondents are usually weighted by their household size. Selective non-response is a second reason for using individual weights. To correct for this, the response is weighted to known population figures of age, sex and other characteristics. In the published tables which present means and totals for the entire population or sub- populations, these weights have been applied. We did not use these weights for the analysis presented here. Differences between weighted and unweighted analyses were only minor, as the weights have little impact on the correlations. So ignoring the weights may improve the accuracy of the parameter estimates.

Table 1
Elements and indicators of well-being

No. of element		No. of indicator	
1	Objective quality of aspects of life	1	Inconvenience in living environment*
		2	Completed level of education
		3	Work and working conditions*
		4	Income and household income*
		5	Household composition
		6	Contact with family, friends and neighbours*
		7	Versatility of leisure and cultural activities
		8	Health*
2	Satisfaction with aspects of life	9	Appreciation of home and living environment*
		10	Evaluation of work*
		11	Appreciation of financial means of household
		12	Family, friends and acquaintances*
		13	Satisfaction with leisure activities
3	Quality of social functioning	14	Disabilities*
		15	Keeping oneself informed of the news
4	Appreciation of the macro-social environment	16	Opinion on the statement 'in the Netherlands the environment is strongly polluted'
		17	Judgement on Dutch society
5	General happiness	18	General happiness*

* composite variable

Table 1 lists the 18 well-being indicators. Indicators that are compositions of more than one item are marked by an asterisk. For instance, indicator 18, *general happiness*, is a summary of a question on the perception of a person's own general satisfaction and their own general happiness. Scores on these indicators are composite. Each indicator is categorised in an ascending order of well-being. High scores indicate well-being.

3. Relations between well-being indicators

Correlation matrix

In this section we shall look at how the well-being indicators are connected by means of a correlation matrix. The most important aim of this matrix is to give more insight into the inter-relations between the indicators. Moreover, it facilitates the interpretation of separate regressions of the 18 indicators on background characteristics (Gringhuis and Israëls, 1998). Two strongly correlated indicators will have more or less the same regression equation, so one should not interpret both regressions independently. In our example this is true for *health* (ind.8) and *disabilities* (ind.14). Ideally, one would find some dimensions (components or factors) that can explain the indicators or their association to a large extent.
Strictly speaking, the indicators are ordinal variables, but we shall consider them as quantitative with the class number as category quantification. Actually, the classes had been created with the aim that the indicators could be considered quantitative. Hence, we can use the correlation coefficient as measure of association of two indicators. Notice that the correlation only considers *linear* association. Extra analyses justified the original ordering of the categories and confirmed that relations between indicators are rather linear [1)]. Table 2 contains the correlation matrix of the 18 indicators. The option "pairwise deletion' implies that each correlation is computed for the people who answered the pair of questions. Most of the correlations are based on more than 7,900 people. The correlations with evaluation work (ind.10) are only based on the 3,779 respondents (maximum) who have a job, while for income there is a large item non-response as well.

As we can see from in Table 2, nearly all correlations are positive, although the majority of correlations are rather low. The correlation between *health* (ind.8) and *disabilities* (ind.14) equals 0.75, but only three other correlations are higher than 0.4, viz. those between

- *income* (ind.4) and appreciation of *financial means of household* (ind.11),
- *education* (ind.2) and *versatility of leisure and cultural activities* (ind.7),
- *satisfaction with leisure activities* (ind.13) and *general happiness* (ind.18).

Most of the correlations with *general happiness* (ind.18) are above 0.20, which is to be expected as this indicator measures a perception of general well-being, although it is not measured as an overall variable. We could have provided list-wise correlations, i.e. correlations based on the respondents who answered all the questions. However, this would exclude all those who do not have a job, as well as those who a have missing value on any of the other questions. As a result of this restriction to people with work, many of these list-wise correlations are much lower than the corresponding pairwise correlations. Having a job or not explains the correlations to some extent.

Factor analysis

As we are primarily interested in the associations, we provide the results of a factor analysis on Table 2, i.e. using pairwise correlations, but the principal components analysis (PCA) solution would not be very different. We used a maximum likelihood (ML) factor analysis on the 18 indicators. It should be kept in mind that our factor analysis is still in a purely exploratory stage: there has been no proper selection of the variables, the hypothesis of multivariate normality would be discarded when tested, and the use of pairwise correlations is questionable as input for a real factor analysis. An alternative would be to drop *evaluation of work indicator* and possibly *income*. The method used could be considered as a method for all cases with an imputation for non-available data, in such a way that the correlations do not change. The usual model tests are no longer valid.

As nearly all correlations are positive, the first (unrotated) factor represents a kind of general happiness. The highest loadings (correlations of the variables with this factor) are found for *general happiness* (ind.18), *health* (ind.8), *disabilities* (ind.14), *income* (ind.4) and *versatility of leisure and cultural activities* (ind.7). As the

Table 3
Factor loadings (maximum likelihood; varimax rotation)

No.	of indicator	Factor				
		1	2	3	4	5
1	Inconvenience in living environment					.50
2	Completed level of education	.66				
3	Work and working conditions	.48				
4	Income and household income	.61			.44	.20
5	Household composition				.29	
6	Contact with family, friends and neighbours			.35		
7	Versatility of leisure and cultural activities	.58		.36		
8	Health		.80			
9	Appreciation of house and living environment					.51
10	Evaluation of work				.22	.20
11	Appreciation of financial means of household	.30			.51	.29
12	Family, friends and acquaintances			.53		
13	Satisfaction with leisure activities			.48	.20	
14	Disabilities	.23	.85			
15	Keeping oneself informed of the news					
16	Opinion on the statement 'in the Netherlands the environment is strongly polluted'					
17	Judgement on Dutch society			.27		
18	General happiness	(–.01)	(.17)	.59	.48	(.06)

Table 2
Correlation matrix of well-being indicators

		Well-being indicators							
		Incon-venience in living environ-ment	Completed level of educa-tion	Work and working conditions	Income and household income	House-hold compo-sition	Contact with family, friends and neigh-bours	Versatility of leisure and cultural activities	Health
		1	2	3	4	5	6	7	8
Correlation coefficients well-being indicators									
1	Inconvenience in living environment	1.00	–0.09	–	–	–0.03	–	–0.11	0.05
2	Completed level of education	–0.09	1.00	0.29	0.40	0.09	0.04	0.47	0.23
3	Work and working conditions	–	0.29	1.00	0.24	–	–	0.13	–
4	Income and household income	–	0.40	0.24	1.00	0.12	–	0.30	0.20
5	Household composition	–0.03	0.09	–	0.12	1.00	–0.05	0.10	0.17
6	Contact with family, friends and neighbours	–	0.04	–	–	–0.05	1.00	0.19	0.06
7	Versatility of leisure and cultural activities	–0.11	0.47	0.13	0.30	0.10	0.19	1.00	0.28
8	Health	0.05	0.23	–	0.20	0.17	0.06	0.28	1.00
9	Appreciation of home and living environment	0.27	–	0.05	0.12	0.10	0.05	–	0.08
10	Evaluation of work	0.09	0.09	0.16	0.16	0.06	–	0.07	0.13
11	Appreciation of financial means of houshold	0.05	0.20	0.16	0.49	0.19	0.04	0.17	0.16
12	Family, friends and acquaintances	0.03	0.12	0.06	0.14	0.10	0.28	0.22	0.19
13	Satisfaction with leisure activities	0.04	–	–	0.08	–	0.11	0.15	0.16
14	Disabilities	–	0.25	0.05	0.21	0.20	0.05	0.31	0.75
15	Keeping oneself informed of the news	0.03	–	–	0.10	0.08	0.03	–	–
16	Opinion on the statement in the Netherlands the environment is strongly polluted'	0.08	0.07	–	0.10	0.06	–	–	0.07
17	Judgement on Dutch society	0.09	0.11	0.11	0.13	0.07	0.08	0.12	0.16
18	General happiness	0.05	0.10	–	0.21	0.26	0.14	0.20	0.31

– = not significant (p <=0.01)

second and further unrotated factors are difficult to interpret, we present the results of a rotated solution.

Table 3 gives the solution obtained by rotating the original five-factor solution. For the sake of clarity, only loadings above .2 are shown. Loadings smaller than –.2 did not occur. Although labelling the factors is questionable, we could characterise them as
factor 1: socio-economic status,
factor 2: physical constraints,
factor 3: positive contacts,
factor 4: financial situation,
factor 5: living environment.

For *general happiness* (ind.18) we also present the loadings smaller than .2, in order to demonstrate how the five factors correlate with this 'general indicator'. It appears that *general happiness* has different aspects. It is strongly correlated with 'positive contacts' (factor 3) and 'financial situation' (factor 4) as results from the high loadings on these factors. But it is also related to *health* (ind.8) and *disabilities* (ind.14) via 'physical constraints' (factor 2).
Keeping oneself informed of the news (ind.15) and opinions on *in the Netherlands the environment is strongly polluted* (ind.16) have little association with the other well-being indicators, which also appears from the correlation matrix. Neither indicator has a factor loading larger than .2 (or smaller than –.2).

Although the factor analysis showed some dimensions related to well-being, the loadings are too low to be able to replace the indicators by a small number of dimensions. PCA does not provide this option either. For this reason, Gringhuis and Israëls (1998) performed a separate regression analysis for each indicator. The next section gives a short description of this, and in Section 5 we present an alternative method, which can reduce the 18 regressions into a small number, a method called 'redundancy analysis', 'PCA with respect to explanatory variables' or 'restricted rank regression'.

4. Separate explanation of indicators by characteristics of the population

The easiest way to investigate relations between the indicators and characteristics is to perform a separate regression analysis (or analysis of variance) for each indicator, as Gringhuis and israëls (1998) did. These relations may be regarded as 'explanations' of the indicators by the characteristics. In order to make this more acceptable, we dropped the indicators that are actually individual characteristics: *education* (ind.2), *work and working conditions* (ind.3), *income* (ind.4) and *household composition* (ind.5).

The individual characteristics considered were *sex*, *age*, *completed level of education, marital status*, *nationality* (Dutch vs. non-Dutch), *social participation* (student, employed, other) and *household income*. By way of an example we summarise the results of one of the indicators: *general happiness* (ind.18). The best explanatory characteristics for this variable are (in descending order) *marital status*, *income*, *age* and *social participation*. Being widowed or divorced gives a negative coefficient, which points to a lower level of well-being. There is a non-linear (rather parabolic) relation with age: people in the extreme categories (18–24 and 75+ years) have the most favourable score, and people from middle categories (between 35 and 54 years) the lowest. Higher income, having a job or being a student have a positive impact on *general happiness*. This indicator is actually a decomposition of two variables: *(perception of) satisfaction* and *(perception of) happiness*. The first is more related to *social participation*, the second to m*arital status*.

5. Simultaneous explanation of indicators by characteristics of the population

Although the 18 indicators cannot be summed up in a very small number of characteristics (Section 3), it is still possible that the 18 relations with the individual characteristics can be summarised by a much smaller number of dimensions/components. This happens if there are strong dependencies among the 18 regression equations. As explanatory variables we use *sex*, *age*, *education*, *marital status*, *nationality*, *social participation* (employed/student vs. other) and *household income*. Although we might consider all 18 indicators in such a simultaneous analysis, we dropped five of them. Indicators 2 to 5 were dropped as these are actually explanatory variables, and *evaluation of work* was dropped because of the missing values for the people without a job.

Table 4a
Redundancy analysis: loadings for indicators

No.	of indicator	Dim. 1	Dim. 2	Variance explained	R^2
1	Inconvenience in living environment	–.10	.10	.01	.03
6	Contact with family, friends and neighbours	.07	–.09	.01	.03
7	Versatility of leisure and cultural activities	.51	–.14	.28	.31
8	Health	.37	–.06	.14	.15
9	Appreciation of house and living environment	.04	.25	.06	.07
11	Appreciation of financial means of household	.33	.38	.26	.27
12	Family, friends and acquaintances	.19	.03	.04	.04
13	Satisfaction with leisure activities	.04	.08	.01	.02
14	Disabilities	.41	–.11	.18	.19
15	Keeping oneself informed of the news	–.08	.32	.11	.12
16	Opinion on the statement ‘in the Netherlands the environment is strongly polluted’	.10	.07	.01	.03
17	Judgement on the Dutch society	.19	–.04	.04	.04
18	General happiness	.26	.13	.09	.11
	Total			1.25	1.41

Table 4b
Redundancy analysis: (standardised) coefficients and category scores for explanatory variables

Characteristic	Category	Coefficients per variable		Category scores	
		Dim. 1	Dim. 2	Dim. 1	Dim. 2
Sex	men/women	.03	.00		
Age		–.35	.44		
Education		.25	–.04		
Marital status		.03	.04		
	Unmarried			.02	–.03
	Married			.01	.03
	Widowed			–.04	.00
	divorced			–.10	–.12
Nationality	Dutch/non-Dutch	–.01	–.08		
Employed or student	no/yes	.23	.02		
Income (guilders/yr.)		.12	.11		
	<17,500			–.22	–.23
	17,500–20,000			–.16	–.14
	20,000–24,000			–.13	–.11
	24,000–28,000			–.08	–.09
	28,000–34,000			–.05	–.04
	34,000–43,000			.02	.01
	43,000–55,000			.09	.08
	55,000–80,000			.13	.12
	>80,000			.18	.18
	unknown			.03	.04

This meant we could now use more than 7,500 cases for our analysis. The remaining 13 indicators are listed in Table 4a. In order to show that both discrete and numerical variables can be incorporated as explanatory variables into the simultaneous analysis, we consider *age* as a quantitative variable, coded by its category numbers, whereas *marital status* and *income* are considered to be categorical. For the binary variables there is no difference between numerical coding or categorisation. The variables and categories are listed in Table 4b. All quantitative variables are standardised beforehand (variance equal to 1). This was also done afterwards for the categorical variables, using the coefficients for the dummy variables as quantifications. Hence, columns 3 and 4 present coefficients for standardised variables, whereas columns 5 and 6 present the coefficients for 0–1 variables. For the analysis of the 13 simultaneous relations, we chose a redundancy analysis, i.e. a PCA of the dependent variables with respect to the explanatory variables, of the indicators on the characteristics of the population. See Van den Wollenberg (1977) or Israëls (1987) for a description of the method. Although the method resembles a PCA, it does not explain the total variance of the complete variables, but only as far as it can be explained by the explanatory variables. Whereas, like factor analysis, PCA investigates the relations between a number of response variables, redundancy analysis only analyses the relations between the parts of the indicators that can be explained by the explanatory variables. It thus tries to explain the sum of all 13 squared multiple correlation coefficients (R^2) of the separate regressions for each indicator by only a few relations (dimensions). As this sum is equal to 1.41 (see the last column of Table 4a), the mean R^2 is equal to .108, the 'redundancy index'. The first dimension of redundancy analysis explains 61% of this $\sum R^2$, and the second dimension another 28%. It appears that only two linear combinations of the explanatory variables are sufficient to explain nearly 90% of the variance of the indicators that can be explained. Column 6 of Table 4a gives the value of R^2 for each indicator, and Column 5 the variance that is explained by the first two dimensions. The middle columns give the loadings (correlations) between the indicators and the dimensions. Notice that the variance explained equals the sum of squared loadings for these two dimensions. Using more dimensions would make the variance explained still closer to the value of R^2. The coefficients for the explanatory variables in Table 4b can be interpreted in the same way as in a regression analysis. Each coefficient gives the increase in a dimension, keeping the other explanatory variables constant. The first dimension shows a high score of 'well-being' for young people, high incomes, high education, having a job (or being student) and married or unmarried. The well-being indicators that are most influenced by this profile are (in descending order): *versatility of leisure activities, disabilities, health, appreciation of financial means and general happiness*. The second dimension provides most of the remaining explanation: older people with a higher income, married and with Dutch citizenship score higher on *appreciation of financial means, keeping oneself informed of the news* and *appreciation of home and living environment*. Sex does not have much impact on either dimension. Notice also that the income quantifications appear to be ordinal and nearly equal on the two dimensions. Considering this variable as numerical would not alter the conclusions.

Note

1) This is controlled by comparing the results of a principal components analysis on the indicators with the class numbers as scores, with those of a multiple correspondence analysis (HOMALS) where the indicators are introduced as qualitative. The order of the scale values produced by the multiple correspondence analysis were usually the same as the order supposed, and the relations were almost the same as found by the principal components analysis.

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Atlas of plant communities in the Netherlands[1)]

Lodewijk van Duuren, Joop Schaminée [2)] *and Eddy Weeda* [2)]

1. Introduction

Mapping the occurrence of species is a well-established way for understanding the 'behaviour' of these species, and many national and European atlases of plant and animal species have been published. In the Netherlands maps on species levels are published for vascular plants, mosses, stoneworts, mushrooms, mammals, birds, fish, reptiles, amphibians, ground beetles, butterflies and some smaller insect groups.
However, national atlases or maps on a national scale on plant community level (e.g. salt marshes, dry calcareous grasslands, wet heaths) are seldom seen, although their value for scientific interest or environmental policy is undeniably high (Van Duuren, 1996). Maps with the distribution of plant communities can be used to establish gaps in data used for classification of vegetation, to protect plant communities, for spatial and environmental planning, for a better understanding of the relationship between vegetation and abiotic factors such as soil types and groundwater regime and as a framework for related flora and fauna data.
In 1995 a project was started in the Netherlands to publish an atlas with distribution maps of all plant communities of the Netherlands. The executive work was mainly done by IBN-DLO, while Statistics Netherlands shares responsibility for the supervision and organisation. Several other institutes give financial support. This article gives some information about this atlas project.

Table 1.
Example of a relevé

Vegetation with Common polypody and Crowberry in the dunes of Terschelling

size: 10 x 10 m		coverage herb layer: 100%
author: V. Westhoff		coverage moss layer: 100%
date: 01–08–1939		location: G5.61.43
Herb layer:		
Polypodium vulgare	2	r = rare, coverage < 5%
Empetrum nigrum	4	+ = few, coverage < 5%
Hieracium umbellatum	1	1 = abundant, coverage < 5%
Festuca rubra subsp. dumetorum	+	2 = very abundant, coverage < 5% or coverage 5–25%
Hypochaeris radicata	+	
Calamagrostis epigejos	+	3 = coverage 25 – 50%
Jasione montana	+	4 = coverage 50 – 75%
Carex arenaria	1	5 = coverage 75 – 100%
Ammophila arenaria	2	
Salix repens	+	
Viola canina subsp. dunensis	r	
Moss layer:		
Hypnum cupressiforme	3	
Pleurozium schreberi	3	
Dicranum scoparium	+	

2. Method

As far as possible a complete distribution pattern of each plant community is presented on a grid map. For each grid cell of 5×5 km the presence or absence of a plant community is indicated. Each plant community is illustrated by a map of the 'recent' distribution - in the period since 1975 - and a map of its 'historical' distribution - the period before 1975. The map is based on data from three different sources, which are described further below; these sources can also be distinguished on the map (see figure 1). The computer program VEGATLAS (S.M. Hennekens, IBN-DLO) was used to store and map the data.

Vegetation data in the form of relevés

The main source for the atlas is the database of the project on the new classification of the plant communities in the Netherlands (Mucina et al., 1993). In order to classify the plant communities in the Netherlands more than 200,000 relevés have been collected and stored in a database (TURBO(VEG) S.M. Hennekens, IBN-DLO, Wageningen). A relevé is a sample in the field measuring mostly 1, 4 or 100 square metres. For each sample all the occurring plant and moss species are recorded and for each species a measure for the quantity (numbers or coverage; see example in Table 1). The relevés are partly derived from publications, for a large part also from unpublished sources such as notes in note books. For the benefit of the 'atlas of plant communities' project additional relevés were collected and stored in the same system. Because the criteria for suitability for the atlas project are less precise than for the classification, more relevés can be used than are selected for making the classification of the vegetation types. For instance, relevés of which the mosses are not determined can often not be used for the classification, but usually are suitable for the atlas.

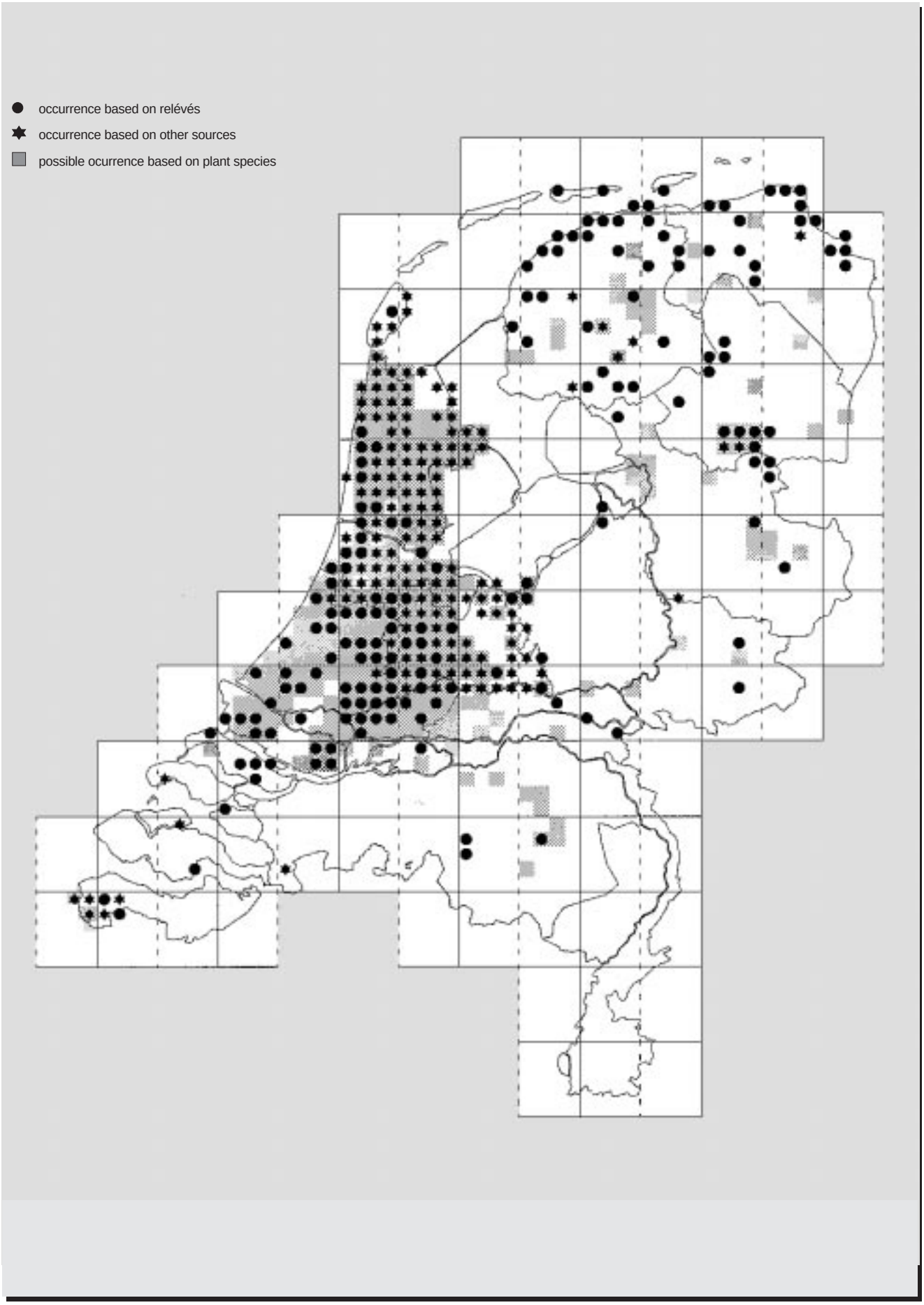
Other vegetation data

In addition to the basic data in the form of relevés, all other data about the occurrence of plant communities can be used for the atlas. However, it is impossible to check these data for a correct classification as they will already have been classified. Such data include description of occurrence of certain types in literature, vegetation maps and verbal contributions. Because of their different character, these data are marked with a different symbol on the map.

Flora data

Because the above-mentioned data are not collected systematically, certainly not all occurrences are covered by the dots on the map. To gain an insight into the 'completeness' of the maps a method was developed based on the distribution of so-called diagnostic species (see also Rodwell et al. 1993). The idea underlying this method is that the occurrence of a characteristic species of a certain plant community also to a certain degree predicts the occurrence of the plant community itself. Because the distribution of plant communities is not completely comparable with the distribution of such species, the latter data can only be used to give an insight into the possible distribution. The source of the flora data is the flora atlas of the Netherlands and a database with recent data about the distribution of plant species in the Netherlands (Florbase of FLORON, Leiden).
This 'possible' distribution is partly derived from the flora data on the basis of expert judgement. First the characteristic or diagnostic species are selected. Secondly each selected species is assigned a

Figure 1. Wolffio-Lemnetum gibbae since 1975



weighting factor. The higher the value of the weighting factor, the more characteristic the species. If the sum of the values of the selected species that occur in a certain grid square (5 × 5 km) exceeds a threshold value, a grey square is indicated on the map. The selection, weighting factors and threshold values are determined for each plant community by the author of the map (see example in the framework).

Weighting factors for the plant community *Isoetum-Lobelietum*

Species	Weighting factor
Isoetes echinospora	2
Isoetes lacustris	2
Lobelia dortmanna	2
Littorella uniflora	1
Eleocharis multicaulis	0.5
Juncus bulbosus	0.5
Elatine hexandra	0.33
Luronium natans	0.33

Threshold value for each grid cell (above this value the grid cell is indicated): 2.8

Example
Isoetes lacustris + Littorella uniflora = 3: indication: grey cell on map
Isoetes lacustris + Eleocharis multicaulis = 2.5: no indication: blank cell on map
Isoetes lacustris + Eleocharis multicaulis + Elatine hexandra = 2.83: indication: grey cell on map

Abiotic data

Abiotic data are of minor importance and only used for a small number of plant communities, which are strongly and clearly related to one abiotic factor. For the occurrence of *Spergula-Corynephoretum* the presence of drift sands is essential. This means that the distribution map of drift sands determines the potential area of this community. The distribution of the abiotic data can be combined with a map of the plant community in the program VEGATLAS in order to see the relation between the two and to give an insight into the completeness of the vegetation data.

3. Results

The results are initially published in a series of four volumes, according to the division of the classification of the plant communities in the Netherlands:
Volume 1: Communities of open water, marshes and wet heathlands
Volume 2: Communities of grassland, dry heathland and fringe communities
Volume 3: Communities of pioneer habitats, salt marshes and tall forb communities
Volume 4: Communities of scrubs, woodlands and clearings

The first volume is planned for 1999. Together the four volumes contain 300 maps of the plant communities of the Netherlands. Each map is accompanied by an introductory text, with at least the following parts: ecological explanation, distribution and changes in distribution, completeness of the map and the area in Europe. Each volume and each vegetation class has a more general introduction, which is also intended for readers with less specialised knowledge. The basic data, which are often more detailed than the published data, can be used in different ways for different projects.
A more dynamic view of the project *Atlas of Plant Communities in the Netherlands* is available on Statistics Netherlands' website: www.cbs.nl.

4. Maps on a European level

Mapping plant communities in the Netherlands is an important project for several reasons. However, in some aspects mapping these communities on a European level would be even more important, as this often covers the whole distribution area of the community. In our view the main aspects are:
– establishing gaps or overlaps between the national data;
– protection of plant communities;
– relation to abiotic data: ecological significance of the plant community;
– framework for related flora and fauna data.
If one or more classes of the European vegetation classification are published, it will be of great value to use the collected basic data (relevés) with the method described in this article to make maps of the distribution of plant communities on a European level. If the grid system of the *Atlas of the Flora Europaea* is used, 'potential actual' maps based on characteristic species can also be made. A first example of such an approach was presented by Zuidhoff et al. (1995), covering the distribution of eutrophic grazed grasslands of the *Cynosurion cristati*.

For further information or comments on this contribution, contact Lodewijk van Duuren: ldrn@cbs.nl.

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Notes

1) This contribution appeared in the 1998 Winter issue of *Netherlands Official Statistics*. Because serious errors in Table 1 and in the map on page 25 in that issue may have led to misinterpretation, the article has been reprinted here.
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