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## **A comparison of the five Labour Force Surveys of the DACSEIS project from a sampling theory point of view**

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# A comparison of the five Labour Force Surveys of the DACSEIS project from a sampling theory point of view

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**Abstract:** Labour market data are important for the assessment of the working of the national social and economic policies and as an indicator for social trouble spots. The European Union therefore pays very much attention in the harmonisation of the national Labour Force Surveys to be able to have comparable data of high quality.

In this paper these surveys, that are included in the DACSEIS project (IST-2000-26057) are compared from a sampling theory point of view to show the similarities as well as the differences of these surveys from this aspect.

**Keywords:** Official Statistics, Labour Force Surveys, Sampling Theory, Sampling Frames, Sample Designs

## 1 Introduction

In 1935 P. V. Sukhatme of the Department of Applied Statistics, University College, London, wrote in a well-known paper: “In social research it is often required to estimate the average value of a character of some individuals. Until recently such averages have been calculated only from the data of general census. However, it is obvious that an exhaustive enquiry is not at all necessary for the attainment of sufficiently accurate averages and, therefore, in the last few years many social researches have been based on the data supplied by the process of sampling” (Sukhatme, 1935, p. 235).

And where did we go since then? The sampling theory defined as the analysis of sampling methods and appropriate estimation procedures is more or less fully developed. Sample surveys are in widespread use and generally accepted. The world market for opinion and

market research has become a big industry with a turnover of more than 16 billions of Euro in the year 2000 (source: [www.adm-ev.de](http://www.adm-ev.de); “Zahlen”, edition 4/2001).

The development of the theory of sampling began not until the end of the 19<sup>th</sup> century. At this time the Norwegian Director of the Bureau of Statistics Anders N. Kiaer became active because of the high expenses of the national censuses and the long lasting analyses of the census data. After using a sample of the Norwegian population in addition to the censuses in 1894 for the first time, in the following years he presented his intuitively motivated ideas of what he called the “representative method” at several meetings of the International Statistical Institute. Because of this efforts Kiaer may be considered as the man who gave the go-ahead not only for the use of sampling methods in official statistics but also for the entire sampling theory and practice.

Since this starting point, the sampling theory has been constantly improved with important contributions of men like Arthur L. Bowley, Ronald A. Fisher, Jerzy Neyman, W. Edward Deming, M. H. Hansen, W. N. Hurwitz, William G. Cochran, F. Yates, V. Godambe and others. After this “theoretical (methodological) period” in the first half of the 20<sup>th</sup> century, in the 2<sup>nd</sup> half of this century the research was mainly motivated by practical problems: data imputation, variance estimation in complex samples or the investigation of surveys in the World Wide Web are examples for this “practical period” of the sampling theory (compare for example: Quatember, 2001).

One of the most important subjects of the current official statistics is the investigation of the national labour markets. In the following sections the national Labour Force Surveys of the countries, which are participating in the DACSEIS project, are compared from a sampling theory point of view. This is a product of the author’s function as the head of workpackage 2 of this project. In this workpackage information about the structure of different national surveys and their universes had to be gathered to yield a basis for Monte Carlo simulation studies of these surveys for a comparison of different variance estimation methods, that could be used in these surveys. After some comments on labour market data in section 2, different population characteristics of the five countries, that seem of some importance with regard to the interesting surveys, are compared. In section 4 of this paper the relevant Labour Force Surveys are compared with respect to the sampling frames used, the sample designs, the non-response, the weighting procedures and at last the variance estimation methods currently used by the national statistical institutes. With this information the reader should at the end be able to form his own opinion about the comparability of these national survey results and the necessity of a standardisation and harmonisation of the various complex surveys.

## 2 Labour market data

One of the main objectives of official statistics is to gather information about the national labour markets. This information is important in an international as well as in a national context for the assessment of the working of the national social and economic policies and as an indicator for social trouble spots. The European Union is therefore very much interested in the harmonization and standardization of the national Labour Force Surveys (=LFS) of the EU with the object of having comparable data of high quality.

Before reaching this goal various problems have to be solved. We may categorize them in at least three fields: At first it should — of course — be guaranteed, that the same person with the same labour market position should give the same answers independently of the country, in which the LFS is conducted. Alois van Bastelaer has pointed out in an article published in the Journal of Official Statistics in 1994, that the structure of the questionnaire or the method of interviewing influences the choice of answers (see: van Bastelaer, 1994). And he stated, that these characteristics of the survey design are not standardized in the various EU Labour Force Surveys.

The second domain of problems is of – let’s say – structural nature. This point refers for example to the fact, that within the same unemployment rate (according to the ILO definition of employment) there may be hidden social phenomena of very different quality and quantity, depending on the percentage of minor employment (Litz, 2000, p. 80). The social and economic policies of countries with high percentages of minor employment have to be very much different to the policies of countries with low percentages.

The third field concerns the question of accuracy: Are the national EU Labour Force Surveys comparable from this point of view, too? With this question we get in the middle of the statistical sampling theory. This problem is the subject of the DACSEIS project, where partners of academic and official statistics from six countries are working together. One of the main goals of the project is to look at the accuracy of the sample results of different national surveys. The Labour Force Surveys, that are included in the DACSEIS project, are the five national surveys of (in alphabetic order)

- Austria
- Finland
- Germany
- the Netherlands and
- the United Kingdom.

### 3 Population Characteristics

We will start the comparison of the five surveys of the national labour markets, which are included in the DACSEIS project, with a comparison of some population characteristics, that might be interesting with regard to these labour markets.

In 1999 the size of the population of the five countries, in which these surveys take place, varied from 5.165 millions in Finland to 82.087 millions in Germany (data from the population projections in: Statistik Austria, 2001, p.508 or [www.europa.eu.int/eurostat.html](http://www.europa.eu.int/eurostat.html)). The Austrian population-size was 8.093 millions, the Netherlands’ population-size was 15.810 million, whereas in the UK there lived about 58.744 million people.

Comparing next the age structures of these populations, we find the distributions of “population by age-groups” shown in Table 1.

Table 1: Percentages of Population by age-groups (see the national population projections in: Statistik Austria, 2001, p.510f; source: UN)

Country	under 15	15 - under 30	30 - under 45	45 - under 60	60 and older
Austria	17.0	19.5	24.7	18.9	19.9
Finland	18.4	18.7	22.1	21.2	19.6
Germany	15.8	17.9	24.6	19.3	22.4
Netherlands	18.5	19.8	24.1	19.5	18.0
United Kingdom	19.2	19.4	22.6	18.4	20.4

Table 1 shows, that Germany had at the key-date 1st of January 1999 the lowest proportion of the under 15-population, but the highest of the oldest age group of 60 and older. In the UK in turn there was the highest proportion of the youngest age group within the five countries, which means, that there will be the highest extent of young persons on the UK labour market in the future.

The proportions of the female population of these countries lie within an interval from 50.6% for the Netherlands to 51.5% in Austria (see the national population projections in: Statistik Austria, 2001, p. 510f).

The share of foreigners living in these countries — another important indicator of social tasks, that are connected with the labour market situations — is shown in Figure 1. These proportions differ very much starting with Finland and 1.6%. The next two countries are the UK and the Netherlands with 3.6 and 4.2%. Germany and Austria have proportions of foreigners of about 9%.

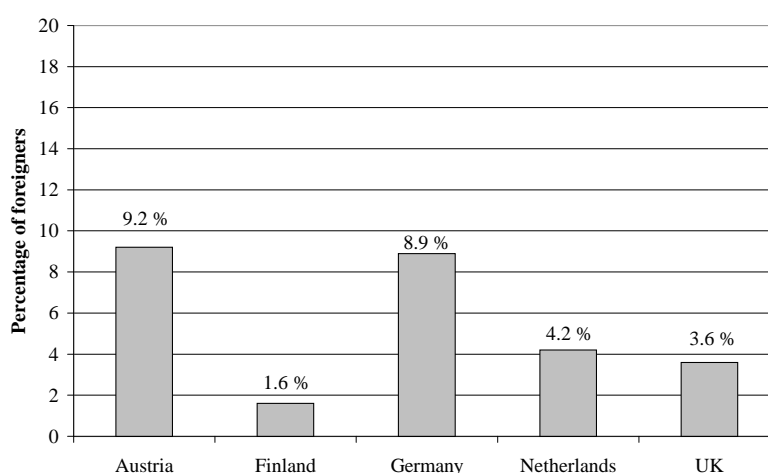


Figure 1: The share of foreigners, as of January, 1<sup>st</sup>, 1999 (UK: January, 1<sup>st</sup>, 1997) (Statistik Austria, 2001, p.516; source: EUROSTAT)

With regard to our surveys the number of private households within the five countries is interesting, too. In Table 2 we show these numbers, the proportions of so-called “single-households” and the mean values of the variable “persons per household”. The highest proportion of single-households was found in Germany, where in each third household there lived only one person. In the UK on the other side only 26.7% of all households were single-households.

Table 2: The number of private households in 1990/91, the percentages of “single-households” and the average value of persons per households (Statistik Austria, 2001, p.516; source: EUROSTAT; joint programme of the national censuses)

Country	Households (in millions)	% of single households	mean of persons per household
Austria	3.013	29.7	2.5
Finland	2.037	31.7	2.4
Germany	35.256	33.6	2.5
Netherlands	6.162	29.9	2.4
United Kingdom	22.422	26.7	2.5

The mode of the variable “persons per household” had value 1 (=single-household) in Austria, Finland, and Germany, whereas in the Netherlands and in the UK it had value 2 in 1991.

Next, we take a look at some population characteristics regarding directly the national labour markets: If we count the number of employed and unemployed persons of these countries, we can find that in 1999 there were 3.856 millions in Austria, 2.642 millions in Finland, 39.595 millions in Germany, 7.890 millions in the Netherlands, and finally 28.889 millions in the UK (Statistik Austria, 2001, p.527; source: EUROSTAT; national Labour Force Surveys).

Another fact that is interesting with respect to these labour markets is the proportion of women in employment within of the female population of age “15 to 65” within the five countries: These “ratios of earnings” were in 1998 as shown in Figure 2. The highest percentage could be found in Finland, whereas the lowest was that of Austria.

Before we finally look at the unemployment-rates of these countries, to get an impression of the extent of social problems with regard to these facts, we might at first have a look at another influential variable for the social policies: This is the percentage of part-time employment. These numbers differ very much from country to country. As you can see from Figure 3, the percentages of part-time employment lie within an interval from 9.9% (in Finland) to 30.4% (in the Netherlands).

The following unemployment-rates (Figure 4) were calculated according to the ILO-definition of unemployment: “Unemployed persons aged 15 years and over who are without work, are available to start work within the next two weeks and have actively sought

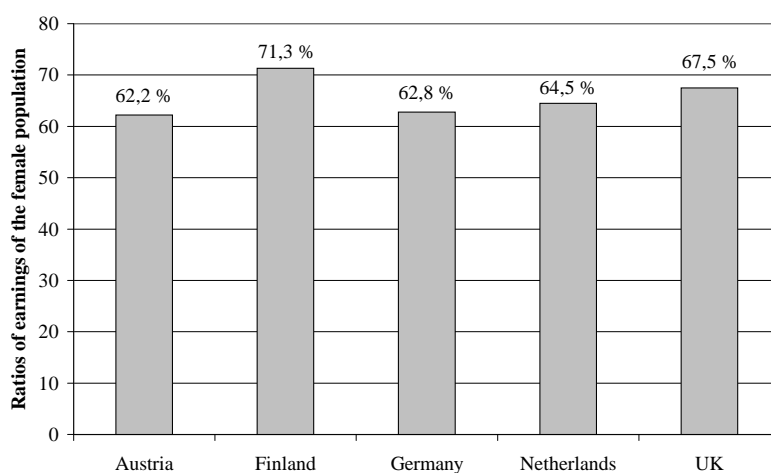


Figure 2: “Ratios of earnings” in 1998 for the female population of age “15 to 65” (Baratta, 2001, p.27; source: OECD).

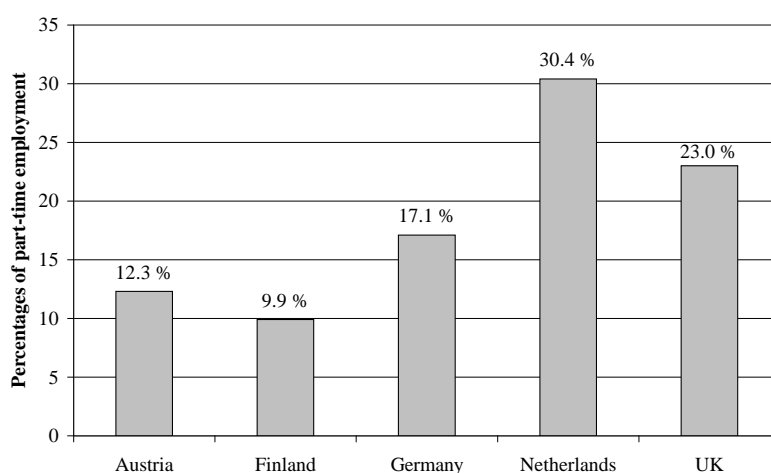


Figure 3: Percentages of part-time-employment in 1999 (Baratta, 2001, p.27; source: OECD)

employment at some time during the previous four weeks” (see: [www.europa.eu.int/comm/eurostat/Public/datashop/print-product/EN?catalogue=Eurostat&product=1-un020in-EN&mode=download](http://www.europa.eu.int/comm/eurostat/Public/datashop/print-product/EN?catalogue=Eurostat&product=1-un020in-EN&mode=download)). Of course these rates change constantly. The unemployment rates as shown in figure 4 refer to June 2001. The lowest rate can be obtained in the Netherlands with only 2.3% and the highest of 9.0% can be found in Finland.

Comparing finally the part-time-employment rates with the unemployment-rates, we can obtain, that in countries with higher part-time-employment-rates there are lower unemployment rates with the exception of Austria, where both rates are relative low.



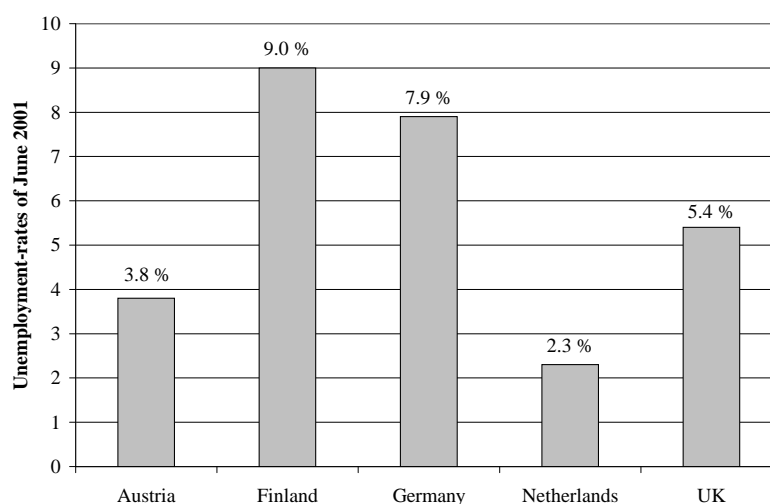


Figure 4: The unemployment-rates of June 2001

## 4 The Labour Force Surveys

At first sight these five surveys look as different as possible. But a closer look makes clear, that in countries of very different geographical and social structures not only the economic or the governmental systems but also the survey and sample designs for labour force data have developed differently. Realizing this, the equalities of the surveys are much more surprising than the inequalities.

In Austria and Germany currently there is no continuous survey of the labour force, but the LFS of the European Union is part once a year of the so called “microcensus”. The data therefore refer to a very short time period. In Austria the microcensus will be converted into a continuous survey in 2003. In Germany this will happen in 2005 (Bihler, 2001). The other three Labour Force Surveys are conducted continuously, in Finland and the Netherlands each month, whereas in the UK it is conducted quarterly. In the following section for our purpose of a comparison of these Labour Force Surveys (only) the most important facts regarding the five surveys from a sampling theory point of view are described (For descriptions that go down to the last detail the interested reader can use the stated references).

### 4.1 The sampling frames

#### 4.1.1 The Austrian sampling frame

The basis from which the main sampling frame (Haslinger, 1994) for the Austrian Microcensus (=AMC) is built is the dwellings stock (dwellings inhabited or not) of the Austrian Housing Census which is performed together with the population census every 10 years. For example for all AMC’s from March 1994 until December 2004 the census of 1991 builds this basis. Even when the universes of persons, families or households are the primary

goal of the questions, it is the dwellings stock that builds the basis for the sampling frame. The reason is that there is no central register of persons in Austria.

In order to make sure, that the sample persists a reasonable representative image of the reality, this basis has to be supplemented annually by the annual rise in dwellings. This is summarized in the “statistics of the building activities” of each year (in Austria called “Wohnbaustatistik”).

In order to be able to take a stratified sample by systematic selection of the dwellings, the dwellings stock of the census has to be rearranged.

Since 1994 — similar to the first period of the AMC from 1967 to 1973 — to build the sampling frame at first this stock is partitioned in two disjunctive sets of dwellings (see Figure 5). One set consists of all dwellings, that are situated in large, urban municipalities (Austr.: “Gemeinde”), the other set of all in small ones. The definition of “large municipalities” differs from federal state to federal state.

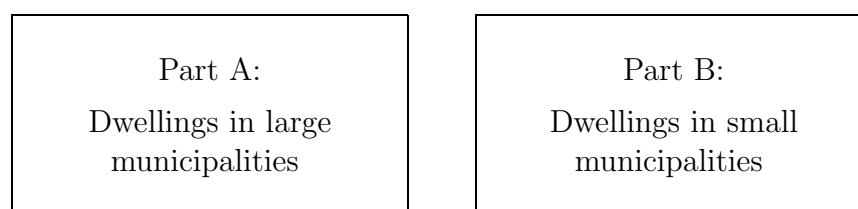


Figure 5: The partition of the universe of dwellings for the Austrian Microcensus

The elements of part A of the dwellings stock become allocated in nine federal state strata. Within each federal state the dwellings are arranged by some dwellings characteristics (like kind of dwelling or period of construction). At last the dwellings of each federal state are arranged once again within all these groups strata regionally according to municipality characteristics. These lists of dwellings build the sampling frame for the selection of dwellings in this part of the dwellings stock.

All dwellings of part B of the dwellings stock are located in small, rural municipalities, which are the primary sampling units of this part of the population. Within the selected primary sampling units the dwellings are arranged according to several dwelling characteristics.

In 1991 1.9% of the Austrian population lived in the non-private households of institutions or communal accommodations. To paint a representative image of the entire population this part of the population has also to be investigated in the survey. Therefore in March of each year additionally to the survey in private households, only the core program is conducted also in the institutional households of halls of residence, boarding schools, old people’s houses, prisons and others. The sampling frame from which this part of the sample is taken is an address list of all institutions with at least 50 inhabitants.

### 4.1.2 The Finnish sampling frame

The sampling frame (Statistics Finland, 2001) from which the sample is drawn is built from the Central Population Register (= CPR). The CPR contains in principle all resident persons. The Finnish system of registers is quite up-to date, especially in register data on individual persons. The updating delay in the CPR is normally less than one month.

### 4.1.3 The German sampling frame

The sampling frame (Gruber, 1996) used for the former territory of the Federal Republic for the German Microcensus (=GMC) and the integrated Labour Force Survey encompassed the population census and the census of buildings and housing of 1987. Only the number of persons and dwellings in each building (more exactly: address) could be used for constructing the sampling frame. For the new federal states, a comparable sampling frame was constructed from the *Bevölkerungsregister Statistik* (statistics based on the population register).

To build the sampling frame from which the sample can be taken, the buildings of the census of 1987 are regionally stratified at first. In the second step the buildings are stratified within each regional stratum by the variable “size of the building” (see Figure 6): The buildings are allocated to 3 size classes or strata depending on the number of their dwellings. Stratum 1 includes small buildings with 1 to 4 dwellings (mainly in rural areas) and a number of inhabitants not exceeding a certain value (Gruber, 1996, p.7). Stratum 2 includes medium-sized buildings with 5 to 10 dwellings (mainly in urban areas) and a number of inhabitants similar to stratum 1. The buildings of stratum 3, comprising 11 or more dwellings (mainly in urban areas) have the same maximum of inhabitants like the other strata. The additional stratum 4, which was of special nature, covered the population living in collective accommodations.

The components used for defining the sample units, which are clusters of households, are either one or more complete buildings or — as for large buildings — parts thereof. For a good regional representation the sample units are sorted in terms of region, i.e. within each stratum they are sorted by regional stratum subgroup, administrative district, community size class, community and sample unit number.

Another stratum serving to update the basic sample is added to the aforementioned subject-related strata. Annual updating of the sample is based on the data reported for building activity statistics. New buildings reported are assigned to the size classes specified above. They are grouped to form just one subject-related stratum (“stratum of new buildings”) per regional stratum.

For the new federal states of Germany the GMC-sample is constructed similar to the Länder of the former federal republic of Germany using the *Bevölkerungsregister Statistik* as the basis for the sampling frame.

### 4.1.4 The Dutch sampling frame

The sampling frame (Hilbink et al., 2001) for the Labour Force Survey is mainly based on the Geographical Base Register (= GBR). The GBR consists of all addresses in the

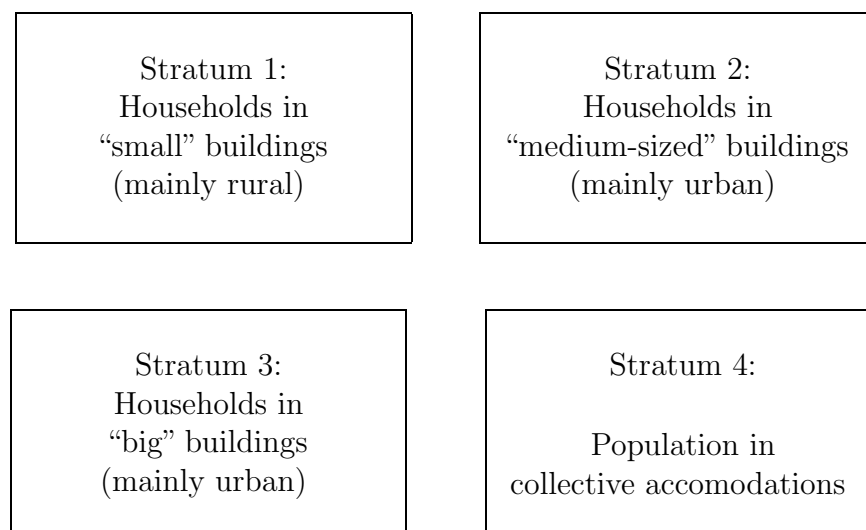


Figure 6: The partition of the universe of households within each regional stratum for the German Microcensus

Netherlands and is composed by the postal service. An additional register is used for the city of Amsterdam, namely the register of houses in Amsterdam. These two registers are combined into one list of addresses. Addresses not occupied by households, for instance belonging to amusement parks or campsites, are excluded.

For the statistic Registered Unemployment the registration of the Employment Exchange is used. This registration is called GIS, which is the Dutch abbreviation of Common Information System, formerly called ISVA (the Dutch abbreviation of Information System of Demand and Supply). This registration contains information about the labour force position of persons. A person can be registered as unemployed or employed or not registered at all. This information is used in the sample design and the weighting procedure.

#### 4.1.5 The UK sampling frame

The sampling frame from which the UK LFS is taken consists of different parts and is different for Great Britain and Northern Ireland, too (Labour Force Survey User Guide, 2000).

**Great Britain** The sampling frame from which most (99%) of the GB sample is taken is the “small users” sub-file of the Postcode Address File (= PAF). The PAF is a computer list, prepared by the Post Office, of all the addresses (delivery points) to which mail is delivered. “Small users” are delivery points which receive fewer than 25 articles of mail a day.

In addition to private households the PAF contains non-private and non-residential (and therefore ineligible) addresses, which cannot be identified as such prior to the interviewer making contact. Interviewers have instructions to exclude such institutions and classify

them as ineligible. About 11 per cent of addresses on the PAF are ineligible: allowance is made for this in determining the sample size needed to obtain the required number of interviews.

The 1991 Census defined communal establishments as accommodations where some sort of communal catering was provided. Contained within the classification were the following groups: The sampling frame for NHS accommodation (14 % of the total CE population) was specially developed for the LFS. All district health authorities and NHS trusts were asked to supply a complete list of their accommodation (this accommodation mainly comprises what was once known as “Nurses Homes”, but the coverage is more extensive than that name implies). Information was received from 417 out of the 455 authorities, trusts and teaching hospitals and the frame is therefore not complete. If the coverage of the frame is proportional to the coverage of authorities etc., then the frame contains 92 percent of all NHS accommodation.

Because the area north of the Caledonian Canal is sparsely populated, interviewing an unclustered face-to-face sample would be very expensive. So the choice lay between a clustered sample and one drawn from the telephone directory. The disadvantage of a clustered sample is the increased sampling error it entails. The disadvantage of a telephone sample is the bias resulting from non-coverage of people not on the telephone and, among those who are on the telephone, non coverage of ex-directory numbers and new numbers not yet in the directory. After investigations of the possible use of random digit dialling it was decided to draw the sample from the published telephone directory sampling frame.

**Northern Ireland** The source of the sample in Northern Ireland is the Valuation List used for rating purposes, excluding commercial units and known institutions, arranged into three geographical strata. These are

1. Belfast District Council area,
2. Eastern sub-region (most of Antrim, Down and part of Armagh),
3. Western sub-region (remainder of Northern Ireland).

#### 4.1.6 Summary

We summarize the main characteristics of the sampling frames of the five countries in Table 3.

In Table 4 the interval, in which the surveys are conducted is shown as well as the actual sample sizes (after nonresponse) and the number of (rotation) waves. The quarterly sample of the Austrian population includes approximately 0.7 % of the entire population. In Finland this percentage is 0.2 per month. 800,000 persons in Germany mean that about 1 % of the entire population is included annually. In the Netherlands 0.07 % of the population is sampled monthly. At last for the UK a sample size of 140,000 persons quarterly give 0.25 % of the UK population.

In each country a rotating panel system is used, which means that the survey units stay in the survey for several times. For Austria we have to add, that each dwelling (or household

or person) stays in the survey for eight times, but only for two Labour Force Surveys, because the LFS is conducted only once a year as a part of the quarterly microcensus.

Table 3: The sampling frames of the five national EU-Labour Force Surveys

Austria	<u>Dwellings</u> of the Housing Census
Finland	<u>Persons</u> of the Population Register
Germany	West: <u>Buildings</u> of the Population Census East: <u>Buildings</u> of the Population Register Statistics
Netherlands	<u>Addresses</u> of the Geographical Base Register
United Kingdom	<u>Households</u> of the Postcode-Address File / Telephone directory / Valuation List for Rating Purposes

Table 4: Real approximate sample-sizes (after nonresponse) and number of waves of the national EU-Labour Force Surveys

Country	Interval	Actual appr. sample-size	Waves
Austria	quarterly	24,000 dws resp. 53,000 ps	8
Finland	monthly	10,000 ps	5
Germany	annually	370,000 hhs resp. 800,000 ps	4
Netherlands	monthly	5,000 hhs resp. 11,000 ps	4
United Kingdom	quarterly	60,000 hhs resp. 140,000 ps	5

(dws: dwellings, ps: persons, hhs: households)

## 4.2 The sample designs

### 4.2.1 The Austrian sample design

The total sample size for 1994 was  $n = 30,800$  dwellings, which is about 1% of all dwellings in Austria (Haslinger, 1996). In each sample-dwelling all households, families and persons are asked. For all questions concerning these universes, the dwellings are clusters of units. Since in the larger federal states of Austria the “part B-universe” (see section 4.1.1) and

thus the cluster-effect to the accuracy of the sample-result is substantially higher than in the smaller ones the allocation of the total sample number on the federal states was disproportional. Altogether the survey is executed in more than 800 of the total of 2,333 municipalities.

But there is no independent selection of dwellings for each AMC, because there is a quarterly exchange of one eighth of the dwellings by new ones. Each selected dwelling therefore remains in the sample for at the most two years (= 8 AMC's). In this rotational system also the new built dwellings of the "statistics of the building activities" are included in the AMC's. This inclusion is the reason for the increasing of the total sample number during the period of ten years. For the annual LFS this means that one dwelling stays in the sample for two times, because there is an annual exchange of one half of the dwellings by new ones.

The method used for sampling in part A of the dwellings stock (in Austria this part is called the "one-stage area") is stratified random sampling of dwellings with proportional allocation of the sample number to strata. The method for part B is a two-stage sampling of dwellings (therefore this part is called the "two-stage area").

The actual selection of the dwellings of part A of the Austrian dwellings stock is done systematically from the selection frame of each federal state with the help of a starting number and a constant interval. In this way an approximately proportional allocation of the sample number of each federal state to each stratum, that were built by rearranging the dwellings due to several characteristics (see section 4.1.1), is guaranteed. This stratification by dwelling-characteristics may also produce a gain in precision, because most of the variables of interest (especially the labour force variables) should be correlated with these "strata-variables".

The selection-method used for part B of the dwellings stock, which consists of all dwellings of small municipalities, is a two-stage sampling with municipalities as primary sampling units and the dwellings as secondary sampling units.

In order to select the primary sampling units, they are stratified within each federal state by a combination of two municipality characteristics ("number of dwellings" and "district"). The stratum with the smallest municipalities is additionally partitioned into strata of almost the same proportion of dwellings in farm buildings (= agrarian proportion). Due to these conditions the municipalities of this sub-universe become distributed over 5 to 16 strata. Additionally it is paid attention to a representation of the political districts proportional to their number of dwellings. So there is a proportional selection of municipalities following the two-dimensional variable "number of dwellings and district". The problem of rounding is solved by minimizing the euclidian distances between the real and the rounded values with an optimization-method (Haslinger, 1996, p. 316). The primary sampling units within each two-dimensional stratum are selected randomly.

So in 1994 the selection of the dwellings of the two-stage area B could take place for each sampling municipality systematically with the help of a starting number and an interval.

For surveys in the period of 1994 to 2004 a sample from the census of houses 1991 would clearly no longer be representative, since the housing stock changes constantly. The newly built dwellings must be added annually into the sample. Nevertheless a period of 1-2 years passes between the completion of a dwelling and the inclusion into the sampling frame.

In the census of 1991 there were 154,000 persons living in no dwelling in the usual sense of a private household. 89,000 of them lived in institutional households, the remainder of 65,000 persons in communal accommodations. That were together only 1.9% of the total population, who however substantially differs in many features from the remaining population due to its specific life situation. The population of institutions is entered into the AMC annually in March by a special survey, which is executed not by face-to-face but by postal interviewing. The selection frame for this survey consists of all persons living in larger institutions (usually over 50 inmates). The address directory of these institutions is being updated with each census and in the meantime completed by known openings of institutions. Within these institutions only persons are chosen whose surnames begin with the initial letter N. Surnames with this initial letter are distributed approximately equal in all regions. The sampling fraction from the institutions with 50 or more inhabitants, obtained by means of the initial letter N, is about 2%.

#### 4.2.2 The Finnish sample design

According to Djerf (2001), “the data set of one month can be regarded as simple random sample of individuals aged from 15 to 74 years, although the true selection procedure is actually systematic sampling from the Central Population Register, where the Register is sorted according to the domicile codes before the sample selection. It means that the sample has implicit geographical stratification. So far we have not encountered any indications of selection bias due to systematic sampling, so the selection procedure can be approximated by simple random sampling without replacement” (p. 38). The sampling design is so based on element-level sampling. This is because it is possible to draw samples from the CPR covering the whole population. A separate sample is taken of persons aged over 75 years and children under the age of 15 years, who are not interviewed but their data are included in the response database on a quarterly basis for Eurostat purposes.

The total sample size is about 12,000 selected persons (including nonresponse) divided into five waves and four or five reference weeks. The reference quarters and years are respectively groups of 13 or 52 consecutive weeks. Procedures for the new allocation scheme of the sample, a SAS macro, has been developed and tested technically. The monthly sample allocates so, that the weekly sample sizes are equal in each wave.

#### 4.2.3 The German sample design

The sampling method applied (Gruber, 1996), i.e. sorting, defining zones, and sampling within the zones, guarantees for all these regions an effect similar to stratification.

A total of 20 1% samples of the sample units, which are clusters of households, families and persons are defined by random selection. The 1% samples are divided into 0.25% and 0.05% subsamples. The 0.25% subsamples, referred to as *rotation quarters*, permit an annual substitution of 25% of the sample districts, while the 0.05% subsamples serve to provide subsampling fractions like those required for the Labour Force Survey of the European Union and the supplementary program. To meet the accuracy standards demanded by the European Union, the sampling fractions for the Labour Force Survey subsample amount to 0.4%, 0.6%, 0.8% or 1%, depending on the administrative



region concerned. The result for the territory of the Federal Republic as a whole is a disproportionate sampling fraction of an average 0.45 % at present.

“Zones” are formed by 100 consecutive sample units each. The sample units of each zone are formed at random by permutation of numbers 0 to 99 by means of a random number generator. Sample units with the same number, i.e. the same “sampling number”, are grouped to form a (1 %-) sample. Thus the population is divided into 100 (1 %-) samples. The random number generator is also used to form at random four successive zones each by permutation of numbers 1 to 4. This permits to divide every 1 %- sample into 4 rotation quarters of 0.25 %. The 20 1 %-samples are determined at random by sampling from an urn an interval comprising 20 sampling numbers between 0 and 99. Subsequently, the first (1 %-) sample to be used for the 1990 microcensus was determined also by sampling from an urn. The subsamples, too, are obtained systematically with a random start. Within each sample unit the information are taken about all households, families and persons. The total sample-size of households is about 295,000 (about 650,000 persons) in western Germany and about 70,000 (about 160,000 persons) in eastern Germany.

#### 4.2.4 The Dutch sample design

In the Netherlands until 1999 the Labour Force Survey was conducted continuously (Hilbink et al., 2001). In 2000 the LFS changed into a rotating panel. The sample is drawn in the month November of the year preceding the survey year. The total sample consists of twelve subsamples: one for each month. The sample-size of contacted households per month is 10,000 with the exception of July and August, when the sample-size is halved. Six months after the drawing of the sample a supplementary sample from addresses of recently finished houses is drawn.

The Labour Force Survey is based on a stratified two-stage sample design. At first the population is stratified according to a combination of two regional classifications called COROP (Committee for the Co-ordination of a Regional Research Program) and RBA (Regional Employment Board). At second a two-stage sample is drawn from each stratum. In the first stage municipalities are drawn from which addresses are selected in the second stage.

In the first stage a systematic sample of municipalities is drawn in each stratum and the number of addresses to be sampled from the drawn municipalities is determined. The inclusion probability of a municipality depends on the number of addresses. If a municipality is large compared to the other municipalities in the stratum, it is possible that this municipality is selected more than once in a month, because the sample is drawn systematically. These so-called self-representing municipalities are separated from the rest of the municipalities and are drawn with certainty in the first stage. The number of addresses to be sampled in a stratum is proportional to the size of the stratum.

After the self-representing municipalities are separated, they are treated as an extra stratum. A systematic sample is drawn from the remaining municipalities. The number of addresses to be sampled in a stratum is computed again.

So the sample design for one month is constructed. The sampling interval in every stratum and the number of addresses to be sampled within a drawn municipality are known. Before

actually drawing the sample, the design is extended to a design for twelve months. For the Dutch LFS the sample designs for the twelve months of the year are made at once to make sure that the distribution of the sampled municipalities over the months is optimal.

For the self-representing municipalities no changes are necessary. The same sample design is used in every month. They are included with probability one and the number of addresses to be sampled is computed as described before. For the non-self-representing municipalities the computed sampling interval is adjusted. To make sure, that in each stratum twelve times the number of municipalities needed in a month is sampled, the sampling interval is divided by twelve. This results in the sampling interval that is actually used in drawing the systematic sample of municipalities. A part of the municipalities will appear more than once in the sample. This means that they will be examined in different months of the year. All (or nearly all) municipalities will be present in at least one month of the year.

The number of months a municipality is part of the sample is proportional to the number of addresses in the municipality. The selected municipalities have to be assigned to one or more months. This is realized as follows: The months of the year are put in an order that differs from the usual calendar. This alternative order of the months is used for all strata. The first sampled municipality is assigned to the first month. If this municipality is sampled twice, it is also assigned to the second month. If not, the second selected municipality is assigned to the second month. This is continued until the twelve months are covered. Then the process starts again from the first month in the alternative order. In this way the selected municipalities are divided equally over the months of the year. The alternative order of the months is used for all strata, but the month that is the starting point varies over the strata.

The starting value of the sampling scheme in a stratum is a fixed fraction of the sampling interval. This fixed fraction varies from year to year to make sure that the samples differ in the succeeding years.

In the second stage of the sampling process addresses are sampled from the selected municipalities. The numbers of addresses to be sampled in a selected non-self-representing municipality are computed in the first stage. The number of addresses to be sampled in a self-representing municipality is equal to the number of addresses in this municipality multiplied by the overall sampling fraction. In every selected municipality a random sample of addresses is drawn without replacement.

After addresses are drawn within the municipalities, clusters of addresses are formed that are close to each other. Each cluster of addresses is assigned to one of the months in which the municipality should be sampled. Because the addresses in a cluster are geographically close to one another, the features of the residents on the sampled addresses can be comparable. Nevertheless, this clustering has little effect on the variance of the estimates (de Ree, 1989).

Within a selected household all persons aged 15 and over are interviewed, with a maximum of four persons. When a household consists of more than four persons from the target population, the interviewer selects four persons before the interviews take place.

### 4.2.5 The UK sample design

The sample currently consists of about 59,000 *responding* households in Great Britain every quarter, representing 0.3 % of the GB population (Labour Force Survey User Guide, 2000). A sample of approximately 2,000 responding households in Northern Ireland is added to this, representing 0.4 % of the NI population, allowing United Kingdom analyses to be made.

Each quarter's LFS sample of 61,000 UK households is made up of five "waves", each of approximately 12,000 private households. In this "rotation"-system each wave is interviewed in five successive quarters, such that in any one quarter, one wave will be receiving their first interview, one wave their second, and so on, with one wave receiving their fifth and final interview. Thus there is an 80 % overlap in the samples for each successive quarter.

A systematic separately sample of addresses with a random start and constant sampling interval of 281 is drawn from the PAF for Great Britain south of the Scottish Caledonian Canal, from the telephone directory of the area north of the Caledonian Canal and from the "NHS-list".

So the sample in Great Britain is effectively stratified by area. The sample is allocated into 145 interviewing areas. Each of these areas is then split into 13 "stints". These 13 stint areas have been randomly allocated to the 13 weeks of a quarter. The same stint area is covered by an LFS interviewer in the same week each quarter. A systematic sample of addresses is selected for each quarter throughout the country and is distributed between stint areas to provide a list of addresses to be interviewed each week. So the sample is designed as a series of weekly two-stage-samples spread over the 13 weeks such that the whole country is covered in the quarter and therefore the quarter as a whole constitutes a single-stage-sample.

In Northern Ireland within each stratum rateable units are selected at random every quarter. Altogether, this provides every quarter a sample of approximately 83,200 addresses from the PAF, 300 telephone numbers for the north of Scotland sample, 40 units of NHS accommodation and 3,250 addresses in Northern Ireland. Including the response-rate this leads currently to the in section 4.1.6 mentioned sample of about 60,000 responding households every quarter.

### 4.2.6 Summary

If we summarize the sample methods, that are used for the different Labour Force Surveys, we find the similarities and differences in Table 5.

Two countries use rather simple methods: By means of a systematic selection out of the sampling frames, in Finland we get a stratified random sample of persons with proportional allocation of the sample-size using a geographical stratum variable. In the UK it is the same with the exception, that there we have a sample of households, which – for person-related data – gives a sample of clusters of persons.

For the Dutch LFS we have – like in the UK – a geographically stratified sample of households, but within the strata there is no unrestricted sample design used. What

Table 5: The sample methods of the national Labour Force Surveys

Austria	Stratified random sampling (of dwellings) with stratified random resp. two stage sampling within the strata
Finland	Stratified random sampling (of persons)
Germany	Stratified random sampling (of clusters of households)
Netherlands	Stratified random sampling (of households) with two stage sampling within the strata
United Kingdom	Stratified random sampling (of households)

is used, is a two stage sample procedure with the municipalities at the first and the households at the second stage.

In advance of the selection, the German sampling frame is rearranged by region and size of building. Within these strata clusters of households (= buildings, parts of buildings or several buildings) are built. These clusters are selected by a semi-systematic procedure. So this leads to a stratified random sample of household clusters.

The most complex sampling procedure is used in Austria. The sampling frame is rearranged in various ways. After allocating the total sample number disproportional to the stratum of dwellings in large (urban) and the stratum of dwellings in small (rural) municipalities, within the first stratum a systematic selection of dwellings leads therefore to a stratified random sample with federal state and some dwelling characteristics as strata variables. Within the second stratum a two stage method is applied with a stratified random sample of municipalities (strata variables: municipality characteristics) at the first and a systematic sample of dwellings within the selected municipalities at the second stage. Because of the ordering of the dwellings within each sample municipality due to dwelling characteristics, this sample becomes a stratified random sample of dwellings according to these dwelling characteristics on the second stage.

### 4.3 Nonresponse

Nonresponse may effect the accuracy of sample results, if the variables are differently distributed within the responding resp. the nonresponding survey units. We look at this potential source for the presence of a nonsampling error by obtaining the nonresponse-rate for each of the five national surveys: Two of them have nonresponse rates of about 15 %: Austria and Finland. In Germany this percentage is significant lower (about 3%), whereas in the UK it is beyond 25 % and in the Netherlands it is between 40 and 50 %. All surveys being voluntary (the Austrian and German microcensus have a mandatory core program, but the LFS questions are included in the voluntary special program), we

have also to add some item-nonresponse to this unit-nonresponse. So it seems, that the comparability of the national LFS-results is shaky from this point of view, too. But that's another story, that is not to be told here.

#### 4.4 The weighting procedures

The weighting of sample data serves two goals: First it compensates for nonresponse among different population subgroups and second it adjusts the distribution of certain characteristics in the sample to the population values. These values are taken from population projections, that are in our countries based more or less directly on Census data.

In Austria this process starts by calculating a basic weight for each record. This basic weight for each person depends on the stratum and the domain (part A or B as described in section 4.1.1), to which the person belongs (see: Burg). So each person's weight can be thought of as the number of people that person represents in this subgroup (post-stratification). In a further step, the adjustment to the population distribution takes place. This calibration is done by an iterative process. This raking adjustment of the basic weights is done in four steps. In step 1 the weights are adjusted so that the grossed up distribution concerning the variable federal state by age and sex equals the population projection. In step 2 this is continued for the variable federal state by nationality. In the third step the mean value of all persons living in one dwelling is computed, because it is wishful to have the same weights in one dwelling. Because of the possibility that by these calculations the adjustments in steps 1 or 2 are ruined, step 4 checks, if the distribution in any cell corresponds sufficiently to the structure of the population. In the case of not lying between some predefined ranges, further iterations are necessary. Anyway, the procedure stops after 100 iterations.

For the Finnish LFS at first the calculation of post-stratified weights for each person according to the variables sex, age and region is done. Then the calibrated weights are calculated according to sex, age, region, reference week (In the case of a continuous survey, response rates vary weekly, so that they must be balanced on monthly level) and register-based job-seeker status taken from a register maintained by the Ministry of Labour. For the calibration procedure a linear distance function is used available in the CLAN program (see: Statistics Finland, 2001, p.12ff).

In the German Microcensus in the nonresponse compensation step different so-called compensation types are formed by the combination of the following characteristics: household size, nationality, for Germans: place of residence, for one-person households: sex and age. For each household of these types at a regional level with at least 100,000 inhabitants the nonresponse is compensated. In the calibration step of the weighting procedure nationality in combination with sex is used as auxiliary variable. The adjustment is performed within regional strata with at least 500,000 inhabitants. Multiplying the household-related weight of step 1 by the person related weight of step 2 results in the respective person weight. In addition to the person weight, for household data a household weight is calculated as the mean value of all person weights of one household (see: Gruber, 1996, p.10ff).

In the Netherlands the weighting procedure for the Dutch LFS starts with deriving inclusion weights for the responding persons, that take into account the oversampling of addresses,

which occur in the register of the Employment Exchange, the undersampling of addresses with only persons aged 65 and more, the month of interview and the differences in response rates between geographical regions (see: Hilbink et al., 2001, p.8ff). These inclusion weights are the starting weights for a regression estimator using various combinations of the auxiliary variables area, age, sex, marital status and ethnicity. The method of Lemaitre and Dufour (1987) is applied in order to obtain equal weights for members of the same household.

Finally for the UK LFS, stage 1 of the weighting process corrects for nonresponse at a local area level. The raking adjustment in stage 2 grosses to national population estimates amongst young people for age and sex and in addition for all respondents for sex, region and age. The iteration of these estimates ceases, when all factors lie within some predefined range (Labour Force Survey User Guide, 2000, p.46ff).

## 4.5 The variance estimations used

Looking at the sample methods and weighting procedures, it becomes quite clear, that the estimation of variances for the sample results in a job, that is very different for the various surveys under investigation. Not only the various stratification and cluster schemes have to be taken into consideration. The different weighting procedures effect also the variance estimators differently. This subject is the task of other workpackages of the DACSEIS project.

At the present, the accuracy of the sample outcomes is estimated in the Austrian Microcensus with the formulas for unrestricted random sampling in consideration of the different sample fractions in the federal states.

This means that for the estimator  $T$  of a population total number  $\tau$

$$V(T) = \sum_i \frac{(N_i - n_i) \cdot (N - t) \cdot N_i}{n_i \cdot N^2 \cdot t}$$

( $N_i \dots$  number of persons within the population of federal state  $i$ ;  $n_i \dots$  number of persons within the sample of federal state  $i$ ;  $N \dots$  number of persons within the population;  $t \dots$  estimated number of persons in the Austrian population having the characteristics under interest) is the estimator of the variance of  $T$ .

In Germany this variance is estimated initially by a formula, that takes into account the selection of clusters of survey units and the stratification of these clusters. Then the design-effect is calculated as the ratio of this variance estimator and the variance estimator given by the unrestricted random sampling formula. These design-effects are calculated for many characteristics. With these data a linear regression model is built for three groups of these characteristics to compute finally the estimate  $V(T)$  for the variables in the German Microcensus by the variance for unrestricted random sampling multiplied by the calculated design-effect of the group to which the variable belongs (see: Gruber, 1996, p.12ff).

The sampling variances of the UK LFS estimates are calculated by treating each household as a PSU and the Interviewer Area as a stratum. The formula used is

$$V(T) = \sum_i \frac{N_i}{2 \cdot (N_i - 1)} \cdot \sum_{k=2}^{N_i} (Y_{i,k} - Y_{i,k-1})^2$$

( $N_i \dots$  PSUs in stratum  $i$ ;  $Y_{i,k} \dots$  the PSU total) (see: Labour Force Survey User Guide, 2000, p.125ff).

Statistics Finland approximates the sampling variances due to the calibration weighting procedure by the variance estimators for the generalised regression estimation.

At last in the Netherlands no estimation of the variances for the national LFS is done at all.

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