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Record Linking as a Shared Service: Methods and Organisation at Statistics Netherlands

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Contents

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RECORD LINKING AS A SHARED SERVICE: METHODS AND ORGANISATION AT STATISTICS NETHERLANDS

Summary: The present paper discusses the purpose of record linking at national statistical institutes. It argues that the use of record linking considerably increases the relevance of social statistics and the possibilities for applied social policy research. Besides, the application of record linking also increases the efficiency of statistics production and the accuracy of statistical outputs and it diminishes the administrative burden caused by statistics on businesses and households. The paper points out that it will be hardly possible to produce relevant social statistics in future without matching data from different sources. However, safeguarding confidentiality as well as meticulously observing personal data protection acts remain preconditions for any national statistical institute involved in linking personal data. The paper focuses on the methods used for linking personal data at Statistics Netherlands and the organisation of the record linking process.

Keywords: Statistical information processing; statistical policy; record linkage; data sharing; statistical integration; administrative registers; household surveys; microdata files

Excerpts from the Statistics Netherlands Act (Act of 20 November 2003 enacting a Law governing Statistics Netherlands):

[…]

CHAPTER 5. ACQUISITION, USE AND PROVISION OF DATA

Part 1. Acquisition

[…]

Section 34. The director general of statistics may **enter tax and social insurance numbers** as referred to in Section 47b (3) of the State Taxes Act in a register and use them for statistical purposes. The director general may **use a tax and social insurance number** in communications with persons and agencies in so far as they themselves are authorised to use that number in a register.

Section 35. The director general of statistics may **process personal data** as referred to in Section 16 of the Personal Data Protection Act for statistical purposes.

[…]

Kingdom of the Netherlands 2003, p. 8.

1. Introduction

These are turbulent times for official statistics. Almost every statistical office is faced with a steady reduction of its budget. Combined with the present very high interest in the European Union for budgetary statistics and macro-economic performance, the budgetary base for both social and environmental statistics becomes tighter and tighter.

On the other hand we notice an ongoing trend towards evidence-based policy-making which requires more and more quantitative policy information (see e.g. Statistics Netherlands and Central Commission for Statistics 2003). The structural indicators of European economic reform, the OECD World Forum on Key Indicators as well as the development of national indicator systems are the many reactions to this trend. A large part of policy performance indicators has to be provided by social statistics. However, the proliferation of mostly not well-defined performance indicators may cause a gradual shift in the orientation of social statistics towards the peculiarities of the political decision-making process of the day and a crowding out of the interests of academic research and the society at large with regard to social statistical data.

Facing both trends are the major challenges for social statistics in this decade. The rising demand for more and better performance indicators should be used as a leverage to the increase the priorities for social statistics. One key factor in this process is demonstrating the value added of official social statistics for government and society in general. The fact that other government agencies are also facing budget cuts offers additional opportunities to strengthen the role of official social statistics in society.

One way of increasing the value added of social statistics is showing interrelationships among different policy domains. Government registers and other administrative sources usually contain a lot of very detailed management information, but for obvious reasons this information restricts itself to a particular area, e.g. taxation, social welfare, job centres, primary schools, hospitals or registered medicines. Combining the right data from these mutually independent information systems and turning them into relevant statistics should be the core business of a national statistical institute. Record linking and development of versatile databases are the prerequisites for intensifying cross-statistical reporting, which is of particular importance to social reporting.

The present paper addresses the issues involved in data sharing and record linkage for official statistics, i.e. combining data from different sources at unit level in order to produce multi-data-source statistics. The paper describes the methods used at Statistics Netherlands and the organisation of the record-linking process.

The next section answers the question why statistical offices should link data. Section 3 discusses government data management in the Netherlands and the registers that can be used as a basis for social and spatial statistics. Personal identifiers that

are available for record linking at Statistics Netherlands are discussed in section 4. Matters of privacy and confidentiality are considered in section 5. Section 6 describes the procedure for personal data linking at Statistics Netherlands. Section 7 presents the main conclusions.

2. Why should we link data?

Record linking is a procedure to find pairs of records in two data files that represent the same entity, in our case the same person, family or household. Through record linking it becomes possible to merge data on persons and households from different sources, i.e. registers and other administrative files with personal data, household surveys and business surveys with data on persons (e.g. on employees and self-employed).

There are many reasons why it is useful to link information stemming from different sources. In the first place the policy relevance of (core) statistical output increases by combining data from different sources. In general, policy information on small population groups, for example on specific ethnic minorities, can only be produced by adding characteristics from the Population Register (such as country of birth) to various administrative files. Privacy concerns or simply lack of information are the common reasons for not being able to include this kind of background characteristics in all administrative files. The results of the Dutch 'virtual census' of 2001 could not have been produced without large-scale linking of different data sources (Schulte Nordholt et al. 2004).

In the second place the possibilities for applied social research increase by combining data from different sources. Research on social phenomena usually requires a large set of personal or household characteristics in order to establish interactions and possible causes and effects. Especially by linking household survey and administrative record data we are able to create much richer cross sectional and longitudinal microdata files for academic and social policy research than otherwise would have been possible. The 'Centre for policy-related statistics' at Statistics Netherlands is an important user of these microdata files.

In the third place the efficiency of statistics production increases by combining data from different sources. Sample designs can be made much more efficient. A recent example is a living conditions survey among ethnic minorities in large cities. Without the possibility of matching data, the costs of this survey would be many times higher than the present costs. Besides, the number of questions (variables) can be reduced in household questionnaires, because they are already available from administrative sources. The household sampling frame at Statistics Netherlands contains a lot of personal characteristics that need not be collected anymore in the surveys themselves.

In addition, a rich household sampling frame opens up the possibility for a statistical office to providing sampling facilities for household surveys carried out for government departments by e.g. research institutes or for surveys financed by academic research programmes. Applied in the right way, this activity could yield a very welcome benefit for social policy makers and the academic research community.

Non-response rates in household surveys are particularly high in the Netherlands. High non-response makes survey estimates questionable, because it introduces a potential bias that is difficult to measure. Linking administrative sources with survey information makes it possible to search for the characteristics that correlate highly with the probability of response and with the target variables in the survey. Through record linking it becomes possible to adjust more effectively for selective non-response.

Last but not least, political pressure towards a once-only data supply by citizens to the government increases. In the Netherlands, Statistics Netherlands has free access to all information collected at all levels of government for administrative and regulatory purposes (Statistics Netherlands 2004*b*, Section 33). So, it cannot in future continue to collect data in household surveys which is already available in government registers, unless there are very urgent reasons to do so. But even then it will be under debate.

3. Government data management

Within the government sector the number of large personal databases is growing, as well as their quality. Examples in the Netherlands are the Population Register, the Jobs and Social Security Register ("Insurance Policy Register"), educational registers, databases with job-seekers and with vacancies, hospital registers etc. From these registers a whole series of statistical outputs can be published. These developments will mean that Statistics Netherlands will be losing its monopoly as the processor of large-scale data sets. Statistics Netherlands will more and more be forced to demonstrate its value added for Dutch society within a competitive environment. Critical success factors in this process are:

- Producing timely and high quality data;
- Developing a general methodology for register-based statistics;
- Enriching administrative data with information from household sample surveys;
- Matching data files, both cross sectional and longitudinal;
- Creating an analytical environment for academic and policy research;
- Positioning Statistics Netherlands as a 'Bureau of Standards' for classifications, definitions and harmonised key data.

The Dutch government is running a programme to develop a system of 'authentic registers'. This programme is called 'Streamlining Key Data'. Central government, local government and their agencies are engaged in a joint project to restructure their information infrastructure. The underlying principle of the 'Streamlining Key Data' programme is that the government should not ask what is already known. Government agencies are no longer responsible for the *independent* collection of the data they need to perform their duties ('front-office'), but the required data shall be collected on just one occasion and then made available to the relevant agencies ('back-office'). The benefits of this programme are a structural reduction of the administrative burden ('red tape') imposed to the public and the business community, one-stop shopping for government services, improvement of measures to combat fraud, more transparent policy-making and accountability and a greater efficiency within the public sector. The Action Plan 'Another Government' has set the target date for the introduction of the principle of once-only data supply to the government for citizens and businesses at 1st January 2007.

Table 1. Authentic registers in the Netherlands

Register	Official name	Dutch abbreviation	State of play	Statistics Netherlands
Population Register	Municipal Personal Records Database	GBA	Operational	Primary data source for the (longitudinal) 'persons backbone' (including the household sampling frame)
Business Register	Key Business Register	BBR	Under development	General Business Register
Real Estate Register	Key Buildings Register	BGR	Under development	Statistical Database Real Estate
Geographical information	TOP10 Vector Database	TOP10-Vector	Operational	Cartographic boundary files
	Key Addresses Register	BRA	Under development	Address File
	Land Register	KADASTER	Operational	No full access yet

As a result of the 'Streamlining Key Data' programme, one register is chosen to fulfil the role of *authentic register* for each of the most important basic data elements that are needed for government processes (person, business, organisation, real estate, topographical object, vehicle and the like) and every piece of data (a characteristic of an object) is gathered and registered only once. The authentic register should contain 'the truth' and should therefore be of very high quality. Besides their register-specific information need, all government agencies should copy the infor-

mation they need only from the authentic register in question. At present six registers are designated as authentic register for the public sector (see Table 1). During the next years, a few more registers (e.g. on work and income and on vehicles) will be added to this list.

A number of authentic registers is still under development (e.g. for businesses and buildings). Statistics Netherlands has created administrative databases in these areas for statistical purposes. These databases will be replaced by the authentic registers when these are fully operational.

For regional statistics, Statistics Netherlands keeps a gazetteer with all relevant regional breakdowns (provinces, urban areas, municipalities, cities, towns, neighbourhoods, postcodes, NUTS, etc.)

4. Identifiers for data linking

The most straightforward procedure in linking data files is using a unique identifier. Nearly all registers and administrative sources that Statistics Netherlands collects at unit record contain identifiers. The most important administrative sources for social and spatial statistics are listed in Table 2.

Table 2. Key registers and administrative sources for social and spatial statistics in the Netherlands

Domain	Identifier	Remarks
Population (persons, families and households)	A-number	The Population Register also includes the Sofi-number.
Education	Education number	The Education number equals the (future) Sofi-number of the pupils and students.
Work and income	Social and fiscal number (Sofi-number)	The new Citizen Service Number (CSN) will most likely become identical to the Sofi-number.
Health care	Care Identification Number (CIN)	The CIN has still to be determined, but most likely it will be identical to the new Citizen Service Number (CSN).
Business and institutions	Business and Institutions Service Number (BIN) is under development	Every enterprise and non-profit institution has a unique number in the Business Register, but different unique numbers are used per domain (e.g. corporate tax, VAT, social insurance) and business units are not stable over time.
Real estate	Geographical codes	Co-ordinates at a scale of 1:10,000.

Statistics Netherlands has a number of personal identifiers at its disposal. First of all the A-number from the Population Register. The A-number of a person has a 1:1 relationship with a person's tax and social insurance number (Sofi-number), which is also recorded in the Population Register. The Education number of pupils and students is identical to their Sofi-number, despite the fact that most of them do not yet work or receive a benefit. At present health care registers usually contain a person's Sofi-number, but in future this number will be replaced by a 'Care Identification Number'.

The intention is that as from 2007 every person living in the Netherlands will be assigned a Citizen Service Number to be used in all (electronic) communications between citizens and the government and its agencies (as part of the Action Plan 'Another Government', see previous section). It is as good as certain that the Citizen Service Number will be identical to the present Sofi-number and that the Care Identification Number will become identical to the Citizen Service Number.

Although it may be obvious for Statistics Netherlands to use the Sofi-number as the personal identification number in microdata files of persons, there are at least two reasons not to do so. The first reason is one of disclosure control. A person's Sofi-number is not confidential and may be known to others. Using this number in statistical databases opens the risk of disclosing a large number of characteristics of a person. The second reason is that we can never be sure that this number will never change. Although it is very unlikely that this number will change because of the large costs it will bring about for administrations, it is not impossible. Therefore, Statistics Netherlands uses unique 'Record Identification Numbers' for every person to store and match personal data. These identifiers are only used at Statistics Netherlands and do not contain any form of information on the person.

Statistics Netherlands does not collect personal identifiers in household surveys. Either the identifier is already available in the sampling frame, or we match the survey data using postcode, house number, date of birth and sex. Asking persons for their personal identifier is sometimes useless, because people simply do not know their identifier (e.g. their A-number), or it is not advisable because of (selective) non-response and measurement errors (see e.g. Jenkins et al. 2004).

Health care registers in the Netherlands do not yet contain personal identifiers. A national Care Identification Number is not yet operational. For the years 1995-2001 the Hospital Discharge Register was for example linked to the Population Register on the basis of the date of birth, sex and postcode of patients (De Bruin et al. 2004; Verweij and De Bruin 2004).

A unique Business and Institutions Service Number (BIN) is in the making in the Netherlands. Each enterprise and non-profit institution already has a unique identifier in a certain domain, like corporate tax, value added tax, employment office, environmental protection and employers' contributions to social insurance schemes and pension schemes. However, as part of the 'Streamlining Key Data' programme (see section 3 above) a unique identifier (BIN) will be proposed in 2005 for all con-

tacts between the government and the business and non-profit sector and within the public sector. This identifier will be provided by the Key Business Register.

5. Privacy and confidentiality concerns

Data matching opens up enormous possibilities for official statistics and social research, but it also means an intrusion on people's privacy. Statistical offices therefore have to be very careful in using the instrument of record linking. They need to assess the trade-off between society's need to know and the efficiency of statistics production on the one hand and the information privacy of individuals on the other hand.

First of all, any data matching performed by a statistical office is for statistical purposes only. This is the principle of 'administrative immunity': information collected or maintained for statistical purposes must never be used for administrative or regulatory purposes.

Secondly, respondents should be made aware of the fact that their data will or may be matched with other sources and they should be offered the choice not to participate in such a survey ('informed consent' and the right to privacy).

Thirdly, a meticulous observation of the personal data protection act[1] by the statistical office is a precondition for building trust with the public at large. The statistical office should take every precaution that personal data is well protected and confidentiality should be one of the top policy priorities of every statistical office.[2] A statistical office's 'Code of Practice' can emphasize the compliance with these principles (ISI 1986; UNSC 1994; Statistics Netherlands 2004*a*).[3]

A sound confidentiality policy implies that access to personal identifiers should be limited and that only a few persons at the office can have access to these identifiers. Besides, staff members of statistical offices should only have access to those characteristics and variables they need for their work. Most staff members do not need the full range of a person's data stored in all the statistical databases. Disclosure control is not just an issue that applies to data users outside the statistical office, it also bears on data users inside the office.

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[1] For the Netherlands, see Kingdom of the Netherlands 2000.

[2] Besides, record linking techniques can also help in checking confidentiality. Probabilistic record linking can help statistical offices determining the extent of confidentiality of statistical files with personal data.

[3] Statistics Netherlands also employs a 'personal data protection officer', who is in charge of the compliance with the personal data protection act at Statistics Netherlands.

6. Procedure for data linking

Matters of confidentiality are a precondition for the process of record linking. The risks of unauthorised data disclosure should be minimised. Achieving the highest quality in data matching is the objective of the record linking activity. The preconditions and the objectives of record linking are the reasons to create a separate unit at Statistics Netherlands responsible for matching personal data. This central record linking unit is part of the Division for Social and Spatial Statistics and renders its services to Statistics Netherlands as a whole. Record linking is thus organised as a shared service within the organisation and linking of personal data files at any other unit at Statistics Netherlands is strictly forbidden.

By concentrating all linking activities within one unit, all knowledge on and experience with linking techniques are joined and will continue to increase. This central record linking unit works according to a standard service level.

Record linking is an essential phase in the production process leading to the *Social Statistics Database* (SSD), the overarching database on which all output of social and spatial statistics is or will be based (Statistics Netherlands 2001; Van der Laan 2002; Houbiers 2004).

The procedure at Statistics Netherlands for matching files with personal data is as follows. The unit that needs to use linked data sends in a request to the central record linking unit, stating the statistical purpose of the request and the reasons why the specific linkage is needed. This request should be accompanied by the supply of:

- Data file(s) to be matched;
- BLAISE data model of the file with a complete record description;
- Code book of all variables in the file;
- Frequencies of all variables in the file.

The linking request is usually processed within three to five days. All data files are matched with the '*persons backbone*'. This is a longitudinal file starting in 1995 of all persons who ever lived in the Netherlands. This file is kept by the central record linking unit and is fed by the Population Register, tax registers, employment registers (e.g. frontier workers), education registers (e.g. foreign students) and other official population sources. Every person in the persons backbone has a unique ID.

Linking process

The objectives of every matching strategy are to maximise the number of matched records and to minimise the number of false matches. Alternatively, the number of false non-matches (non-linked pairs that are a true match) should be minimised. In our linking process a distinction is made between:

a) *primary* matching variables: these key variables have to be identical in both files ('exact matching');

b) *secondary* matching variables: these key variables may differ to a certain extent in both files (e.g. to allow for misspellings or figure inversions). The matching criterion used specifies which differences are allowed to call the match successful ('probability matching').

Statistics Netherlands does not use techniques of 'statistical matching' (otherwise known as 'synthetic matching') to create linked microdata files of persons or households.

Linking a personal data file to the persons backbone is performed in the following steps as part of the standard service level.

Starting question: Does the file to be matched includes a Sofi-number?

- Yes → go to *Step 1*;
- No → go to *Step 2*.

Step 1

The records are matched with the persons backbone using the Sofi-number as primary matching variable and sex and date of birth as secondary matching variables. The match is called successful, if there is:

a) no difference in the Sofi-number *and*

b) no difference in sex, day of birth, month of birth or year of birth *or*

c) only one mismatch in sex, day of birth, month of birth or year of birth.

The records that could not be matched in Step 1 move to Step 2.

Step 2

The records are matched with the persons backbone using postcode, house number (including extensions and additions), date of birth[4] and sex as primary matching variables. The match is called successful, if there are no differences in *all* the keys used.

The records that could not be matched in Step 2 move to Step 3.

Step 3

The records are matched with the persons backbone using the Sofi-number as the only primary matching variable.

Output

During the linking process three files are created:

[4] Depending on the data source in question, instead of date of birth only year of birth or month+year of birth could be used. Incidentally, a person's name is used to link records.

1. *RINI file*: This file includes all personal identifiers from the original file including a unique Record Identification Number RINI.
2. *Baseline file*: This file includes all statistical variables of the original file and the statistical variables added using the persons backbone including a unique Record Identification Number RINS. Information on the way in which the match was realised is added to the baseline file or otherwise the reason for the non-match.
3. *RINI-RINS file*: This file pairs all RINI and RINS used at the matching process.

With every record linking activity the central record linking unit produces a standard linking report describing the files used, the methods used, the matching rates and the record description of the baseline file accompanied by the updated code books.

Characteristics of the non-matched records are also produced. These records have to been examined by the statistical units in order to assess the quality of the linking process. However, the number of non-matched records is usually that small that there is hardly any cause for possible biases in the statistical outputs. The linking process of preliminary data usually results in a number of non-matched records of 0.1 percent of the number of records involved. Linking final data produces a number of non-matched records of less than 0.01 percent of the number of records involved.

The files (1) and (3) above stay within the central record linking unit and only file (2) is exported. The identifiers RINI and RINS do not contain any form of information on the person in question and are used to safeguard the confidentiality of the personal data. Consequently, the users of the linked baseline file do not have access to any direct personal identifiers.[5] To obtain access to any identifiers, at least *two* other files are needed, i.e. the RINI-RINS file and the RINI file. All linked data files are placed on the internal SSD server and are subject to the SSD authorisation rules.

7. Conclusions

This paper has argued that the use of record linking considerably increases the relevance of social statistics and the possibilities for applied social policy research. Its application also increases the efficiency of statistics production and the accuracy of statistical outputs. By using data matching in preference to fresh data collection, the administrative burden caused by statistics on businesses and households diminishes.

The general conclusion has to be that in the future it will be hardly possible to produce relevant social statistics without matching data from different sources. Combining records from registers and other administrative sources and linking them to

[5] However, for internal use the statistical variables in these baseline files are not subject to disclosure control. Although obvious identifiers have been removed from the baseline files, potential disclosure of personal data is still possible within Statistics Netherlands itself, i.e. the personal data files could still be identifiable.

household or business surveys already is or will become current practice at national statistical institutes. Not only for statistics production data linking is an essential tool, but also for policy research the use of linked microdata sets is invaluable. Providing access to microdata for scientific purposes is almost as high priority for national statistical institutes as the application of record linking itself.

Safeguarding confidentiality as well as meticulous observation of personal data protection acts remain preconditions for any national statistical institute involved in linking personal data. Every precaution should be taken that personal data is well protected.

The production of social statistics will continue to operate on fairly scarce resources. It will therefore involve the development of flexible databases and utilising them in a wide variety of ways (see e.g. Statistics Finland 2003). Parallel and analytic use of different types of data is the key to increase the potentials of social statistics to respond in a cost-efficient way to new information needs.

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