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Statistics and Models

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The world by numbers

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Information is a valuable commodity in our knowledge society. This is reflected in an increasing demand for statistics on a more frequent basis; this is because numbers in general, and statistics in particular, unite unordered facts and raw data in a logical way, rendering a phenomenon's key features visible. Numbers are used for verification, help to bring order and can create a feeling of security. This tendency underlies the belief that valid data can capture society's complexity in order to provide it with the best future possible.

The Federal Statistical Office's challenge is to adapt official statistics to society's changing realities and to convey the acquired knowledge in a suitable form so that politics, government and businesses, but also the general public, can understand it and use it for their own interests. There is a clash, however, between people's need for unequivocal statements and the fact that even statistics are not able to deliver a comprehensible depiction of the whole world. In the conversation between Caroline Schnellmann and Professor Beat Hulliger readers can discover the problems that people have when dealing with statistics (p. 6).

The complexity of the whole has to be transposed in statements, graphics, illustrations and models, in such a way that this simplification does not distort the facts. Indicators make it possible, for example to infer complex relationships from simple data. A summary on the opportunities and risks of a decision-making system based on indicators can be found on page 13.

BAK Basel produces forecasts for different areas of the economy by using a whole family of consistently interconnected models (p. 16). In many cases, the data bases and projected variables are supported by surveys and statistics from the FSO. Jakob Bernoulli, the mathematician from Basel, recognised as early as the 17th century that he would have to take a close look at the past in order to make relevant forecasts about the future. His problem, however, was the paucity of data available (p. 20).

The FSO has the great responsibility of gathering information on all important social, economic and governmental issues and to make it available in order to ensure transparency in public dialogue. In the execution of this task it must treat data with care and not overburden the respondents. With this in mind, the FSO has planned several modernisation projects and in this publication, Markus Schwyn presents on page 9 the new population census.

I wish you an interesting read.

The universal language of statistics

Information and data are extremely important in our information society and serve as the foundation for rational decisions. Due to fast developments in the IT sector and how these changes have permeated all areas of social life, a democratisation of data is taking place. For statistics – as a transparency assuring element in questions of social and political interest – this is an additional challenge.

Cornelia Neubacher and Ulrich Sieber

Statistics start on the playground. Because even the youngest of children make decisions using information – even if every now and then these decisions do not seem very rational. Whether when swapping collector's cards or refusing to eat salad… collected experiences are linked together with the probability of the outcome. The reflection results in guidance on how to act. In this way, statistics follow a person throughout their entire life, both consciously or unconsciously and in one's personal and professional life. If statistics are information – which is what the FSO presumes – then the use of statistics is a form of communication with all of its facets.

Statistics provide an overview of the bigger picture

Even if the world is seemingly becoming smaller and smaller and increasingly networked in light of globalisation, one critical aspect is often missing nowadays… an overview of the bigger picture. The flood of data is great. Either too much information is filtered or goes unfiltered. And while information is available at any time it is not always comprehensible. For the individual, it nowadays seems virtually impossible to consider all relevant information when making decisions.

Official statistics helps to offer an overview and order by collecting data and information about the relevant areas of society, including complex topics. This information is simultaneously made available to all interested parties. Comparisons across regions and periods are possible. Phenomena and developments, for example, can be recognised using indicators. Statistical findings need to be as neutral as possible. They only generate added value when they are suitable for recipients and users. In concrete terms for the FSO's communication service, this means making the basics brilliant.

In this process, there is no such thing as a foreign language when it comes to statistics. Rather, statistics are a type of universal language used to describe and to get to the bottom of phenomena, which can also be used to map out the future. The Federal Statistics Act describes the FSO as the Confederation's professional and independent central statistical agency, thus making it in a sense Switzerland's "statistical hub".

Continuity and description

Statistical surveys were accounted for in even the oldest of advanced civilisations when they were notably used for fiscal and military purposes. A census of the Helvetii was carried out for the first time in 58 BC following their thwarted, costly migration attempt to Gaul at Julius Caeser's behest. But it was only during the Ancien Régime that the statistical approach to both social and public life in Switzerland became more prevalent and gained increasing importance in the course of the 19th century.

The population census is undoubtedly the most well-known statistical survey worldwide. The desire for precise information on the country's demographic make-up was also the reason why a federal statistical office was created in Switzerland in 1850. Until 2010, the population census – with one exception – was carried out every ten years and established in law as early as 1860. Over time, this line of population statistics was expanded by a number of surveys and statistics which in turn occasionally became obsolete – such as the gas lantern census. New statistics emerged due to outside impetus, changing circumstances or the necessity of solving certain issues. Furthermore, as the Confederation had to increasingly assume new responsibilities, economic conditions were getting more and more complex and new statutory regulations were coming into effect, the statistical field also continued to expand and today covers 22 topics.

The Federal Statistics' and the FSO's mission is clearly established. The Federal Statistical Office's tasks and organisation are rooted in the constitution. In 1870, Parliament approved a law about official statistical surveys in Switzerland at the federal level for the first time. The basic mission calls for continuity in the description, specification and explanation of past development without evaluation or the derivation of recommendations for action. Statistical information, however, does not primarily serve to narrate history, but is the basis for the development and examination of political issues. The multi-annual programme for federal statistics establishes which statistics are collected by the federal office. To be incorporated into the multi-annual programme, it must be proven that there is a social requirement for the deliverable data. In 1891, the first Statistical Yearbook appeared, published

by the Federal Statistical Office. There is still great demand for this publication even though – compared with the first edition – it concentrates far less on dairies, fruit trees and cattle. The sequence and weighting of the topics in the Yearbook offers an exciting statistical journey.

Highly outcome oriented

Furthermore, official statistics should assume a bridging function that is free of influence and interests. The FSO therefore works with academic, internationally recognised standards. Statistical information is produced in Neuchâtel with the required professional and methodological competence in transparent, accountable processes. Official statistics should deliver unbiased, high-quality facts that enable the political sphere to define measures in a future oriented and targeted way. As statistics are interpreted, they are also of political relevance. Of course, statistics are not event-predicting prophets, but the monitoring of trends and developments in the topical areas of public debates does mean that issues can be recognised at an early stage. Statistical information should generate added value in shaping the future.

The results of statistical surveys are then measured with regard to whether they correspond to the need for information. This means that a high outcome orientation is required from official statistics. The results are not measured against their entertainment value but must satisfy the requirement of being relevant for monitoring. This requirement presupposes prospective thinking and action which anticipates possible developments.

The growing need from politics, the economy and society for a comprehensive monitoring system increasingly calls for statistics. Because in addition to the conventional analyses limited to certain topics, there is also a demand for wider, cross-sectional analyses.

From collecting data to statistical information

Statistics should be real, neutral and above all reliable. Collecting and evaluating data is a very complex process. When a census was carried out in Helvetia for the first time in 58 BC, the only tools needed were a stylus and wax tablet. The validity of the results can no longer be verified. In order to fulfil today's requirements, the production of valuable statistical information presumes a wide scope of theoretical and practical knowledge.

From data collection to the delivery of the statistical results, there is quite a lot to consider. Nowadays, special attention should be given to reducing the burden on respondents as far as possible, something which can be controlled by choosing the right data collection method.

The FSO is familiar with various methods such as direct surveys, where an interview may be conducted as part of a classic survey. Furthermore, more or less automated observation is used; transport censuses are an example of this. Another increasingly important statistical survey method includes the evaluation of existing data, mostly administrative data (registers) that can considerably reduce the number of direct surveys and the costs associated with these. But collecting data is, of course, only one stage of statistical surveys. After this, data need to be recorded, analysed and interpreted by specialists and then made easily accessible to the public in a suitable way. This requires ongoing interaction with all interest groups.

Switzerland's "statistical hub" serves today's needs, creates transparency and lays the foundations for society's further development. It is also an immeasurable resource for the social description of past times and phenomena. The FSO's communication service's utmost task is to impart factual knowledge on developments, contexts and modes of action in a comprehensible way. This process takes place in close cooperation with the production departments. The transversal thinking and action fostered and promoted by the new Director General Georges-Simon Ulrich serves as the basis for this. We should remember that statistics are a universal language. Yet communication habits and needs are constantly changing. Current topics such as big data and social media are influencing our work. Through innovation and consistency, the FSO wants to ensure that it continues to be seen as a national centre of excellence and creates benefit in the future. Our philosophy is to keep a sense of tradition while being open to innovation.

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What's certain is that nothing is certain

By using complex methodology, statistics make statements on the most diverse topics. Sometimes statistics look to the past, sometimes to the future. They often deal with probabilities, scenarios and simplifying models. For the layman and expert alike it is not always easy to find one's way around. Beat Hulliger, Professor of Economic and Social Research at the University of Applied Sciences and Arts Northwestern Switzerland, examines the communication of statistical findings as well as statistical literacy. Professor Beat Hulliger interviewed by Caroline Schnellmannn

Professor Hulliger, what problems do people have with statistics?

People have a strong desire for unambiguous, clear and reliable statements that can guide their actions. Statistics are often unable to fulfil this desire because both the reality that statistics are supposed to reflect as well as the statistics themselves, are complex. People therefore have to deal – against their own wishes –with issues that are uncertain and complex. They often do this only when they find themselves in a tight corner and are directly concerned. For example when the financial crisis threatens their money on the stock exchange or they need to catch a plane and have a fear of flying. Also the fact that statistical methods are often constructed around one or more scenarios can present problems. This entails leaving the real world behind and being able and willing to imagine another one. The fact that this world has to be mathematically formulated in order to be manageable makes access to such abstractions more difficult. This is something that has to be learnt and practiced.

Although we cannot live without the ability to understand numbers, in order to comprehend statistical information, this ability has to be well-honed. What is meant by the statement "the number of person-kilometres covered by train has increased by 2.3%"? A whole series of interpretations are necessary to understand these numbers in context. And when a quantification of uncertainty is also included – for example in a prediction that over the next five years annual growth of 0.8% to 2.7% is expected – it becomes very challenging to extract information in order to gain insight into a problem or to make a decision. Therefore it is extremely important that a basic understanding of numbers is taught in primary and secondary schools.

Which factors influence the perception of statistical findings?

Personal experience has a big influence on how a person reacts to statistical findings. On the one hand it can make a topic more accessible. A finding about the prevalence of borreliosis is of more interest to me if I have been bitten by a tick in the past. On the other hand too much value can be attached to personal experience. Many people draw conclusions from their own experiences that are not statistically representative and thus only valid to a limited extent. Or the opposite can happen and scientifically proven facts can be rejected on the basis of contrary personal experience.

The intellectual effort or time involved is also very important. If someone has to spend ten minutes pondering over information in order to integrate it into their own personal experience, it is possible that they are not prepared to make the effort. Trained users of statistics have reduced this time to a few seconds and can deal with the complexity of statistical information.

Another important consideration is the overall esteem in which statistics are held in a given society. The historical background and mentalities come into play here. It appears that there are societies that are more relaxed about uncertainty and which include uncertainty in their decision making whereas other societies have a strong need for clear rules and certainty.

Originally statistics was purely about providing a description of facts important to statesmen and women. The Latin "statisticum" means "concerning the state". The calculus of probability and the exploration of random or uncertain phenomena came later. An interesting cultural controversy regarding this change of perspective began in 1895 at the Conference of International Statistical

Institutes in Bern when the Norwegian Anders Kiaer presented the idea of a random sample. The opponents of this approach argued that only a complete population census could provide valid statistics. It took almost thirty years to acknowledge that random samples can provide sound information despite being tainted by a degree of uncertainty.

This swaying between certainty and uncertainty can be seen throughout the whole history of statistics. In the English speaking world the probability theory had long been considered an indispensable tool whereas in Switzerland, statistics relied for a long time on the numerical description of facts.

For example, in contrast to English speaking countries, weather forecasts in Switzerland rarely come with details of probability. In Switzerland, preference is given to a statement that appears to be unequivocal, although it isn't really, rather than one where the probability is quantified.

There has been a lot of hype lately about data journalism. What are the reasons for the new popularity of data?

Basically it's to do with the new possibilities created by information technology. One reason is that parts of the economy have realised that their business is essentially dependent upon their being able to identify at an early stage, signals and structures in a deluge of data. An example is the analysis of large companies' client data or the analysis of stock exchange data. Providers of statistics and in particular IT providers have reacted to this phenomenon, wishing to exploit this market potential. This gave rise to the "data mining", "big data" and "data scientist" hype.

There have always been journalists who have communicated statistical information. Against the background of the Big Data hype, however, a new awareness has arisen that data journalism is now a journalistic discipline of its own. The heightened appreciation of statistical information is probably also related to the desire to understand the increasing complexity of our world. Environmental problems, the financial crisis and diverse conflicts, such as the one currently waging in Ukraine, make it clear to people that the world is less certain and predictable than they would like it to be. Discussions on the financial crisis in particular are unconceivable without figures and at the same time the financial crisis had a noticeable effect on many people. Environmental problems too, are hard to grasp without statistical information. The interest in statistical information is there. Statisticians have always been team players because as method-oriented scientists they have to, and wish to, work together with other scientists and IT specialists. Data journalists are a welcome addition to such a team as they can reinforce the transfer of knowledge and know how to render complex content comprehensible.

What do statisticians need to do in order to be understood?

There is a certain amount of awareness as to how to communicate statistical findings. Storytelling and visualisation are perhaps the most important elements. Statisticians must talk about the findings, shed light upon them, set them in a context use pictures to tell them, in order to make them accessible. The problem is simple: to attract attention. At the same time, not only must the findings be communicated but also the complex background of statistical information has to be explained in passing as it were. That is a great challenger for statistical writers. They have to gain the attention of readers while not overstretching them; otherwise they will lose interest and move on to another topic.

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Caroline Schnellmann is a freelance writer

The new population census: from the comprehensive survey to the extensive system of household and person statistics

The only thing that is constant is change, in both everyday life and in politics. In the course of the rapid process of economic and social change, the demands made on official statistics have also increased. Official statistics need to provide information more quickly and frequently. They must also be able to flexibly pick up on issues and topics and provide answers. The new population census is part of the answer to these challenges. Markus Schwyn

In June 2007, the Swiss Parliament passed a completely revised Federal Act on the Federal Population Census which came into force on 1 January 2008. With the new act, the Federal Council and the Parliament decided to modernise official statistics. The new population census also brings a complete change of system: the comprehensive survey every ten years has been replaced by an integrated statistical system. The system combines the use of existing, harmonised registers of persons with sample surveys that are conducted and evaluated on an annual basis. At the heart of the new statistical information system is the resident population of Switzerland, in other words, the people and their households. For every person, a link is formed with the dwellings and residential buildings.

Four key elements of the population census

The population census act states that data on the population composition and social development in Switzerland must be surveyed either annually, quarterly or every five years depending on the topic. The life situations and cultural areas concerned are as follows: "status, structure and development of the population"; "families, households and housing conditions"; "employment and income"; "education and training"; "migration"; "language, religion and culture"; "transport and the environment"; "buildings, dwellings and location of work and school". The areas are covered by four survey types: register survey, structural survey, thematic survey and CH omnibus survey.

Harmonised register

The annual register survey is based on communal and cantonal population registers, the principal federal registers of persons as well as the Federal Register of Buildings and Dwellings (RBD). This means that basic information on the population and buildings and dwellings is available annually at even the smallest spatial resolution. The Federal Act on the Harmonisation of the Register of Residents[1] fulfilled one of the central requirements for the easy and efficient use of register data. The act specifies the identifiers and the variables which the registers must include, determines the content and form of the registers and controls the exchange of data between them.

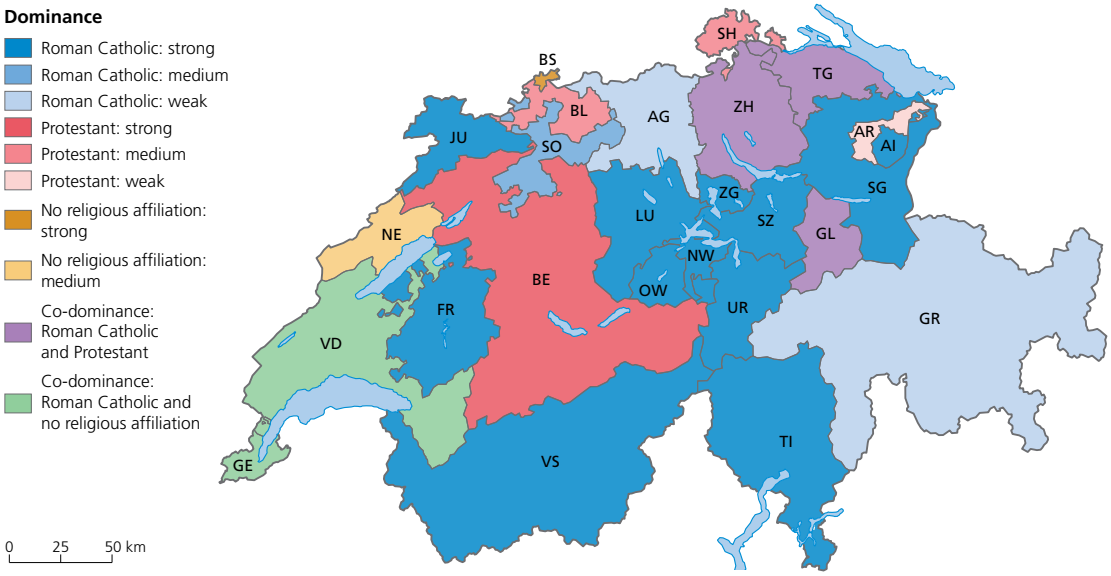
The samples have been taken since 2010 based on information from the population register and the RBD. Population statistics also have a key role in supplying reference values for sample surveys: for the planning, weighting and extrapolation of efficient sample testing, information about the population as a whole, its population groups and dwellings and residential buildings is very important.

Additional sample surveys

The Structural Survey and the thematic sample surveys provide other important variables that cannot be obtained from registers. The Structural Survey is designed as an annual sample survey of 200,000 people. Persons aged 15 and over in private households are questioned. The respondents provide information about themselves and their households. A sample survey of 200,000 people allows statistical analyses to be carried

The population census has provided important data on Switzerland's structure for more than 160 years. From 1850 to 2000, the entire Swiss population was recorded every ten years on a reference day using a questionnaire. This survey was supplemented by a number of adaptations to the questionnaire and the ongoing further development of analysis techniques. The 2000 Population Census was the last of its kind: 2010 marked the greatest break with this tradition. By way of the Federal Act on the Harmonisation of the Register of Residents and the Federal Act on the Population Census, the legal prerequisites for a new population census were created in 2006 and 2007. Instead of a comprehensive survey in which every household and all household members must take part once a decade, the information has been obtained from register surveys and additional sample surveys since 2010.

Dominant religious affiliation in 2012



Source: FSO – Structural Survey (SS) 2012

out for all the cantons and for groups of 15,000 people. After five years, it will be possible to make assertions about specific groups of 3000 people using data pooling. Within these groups, units of 140 people after one year and groups of 28 people after five years can be detected. Cantons use the opportunity to supplement the survey in their own area at their own expense. This means that cantons can improve their results both easily and sustainably according to their needs.

Thematic sample surveys are also carried out annually using a sample size of 10,000 to 40,000 people. The following topics alternate on a five-yearly cycle: "mobility and transport", "education and training", "health", "families and generations" and "language, religion and culture". The existing health survey and the transport micro-census are incorporated into this system. Because of the size of the samples, the thematic surveys allow conclusive results to be produced for the whole of Switzerland and the seven major regions. The "Mobility and Transport" Microcensus can provide results for the agglomeration (large urban) areas with a sample size of 40,000 people. Cantons also regularly make use of the opportunity to supplement the sample plan at their own expense for these surveys.

Flexible Omnibus survey

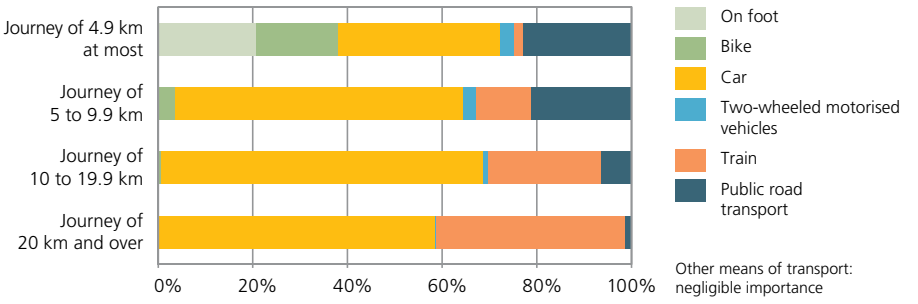
Omnibus surveys are a new, flexible tool that provides rapid answers to current questions. The annual sample survey of around 300 people offers interested parties the opportunity to get involved in the survey with specific questions. The survey provides results for Switzerland that can be quickly reviewed and published.

The census as part of an integrated system

The new focus of the population census has transformed it into the backbone of a new integrated system for household and person statistics (SHAPE) and part of a system that combines the systematic use of existing administrative registers with sample surveys of people and households. The content, method and organisation of the various surveys are linked and coordinated with one another. The different areas that make up the population census thus supplement other FSO surveys in the areas of "work" and "income, consumption and living conditions". The Swiss Labour Force Survey (SLFS) provides data about the labour market and about working life in general in the process. The Household Budget Survey (HBS) provides regular information about the consumption habits and income of private households in Switzerland and the new survey on income and living conditions introduced in 2007 (SILC: Statistics on Income and Living

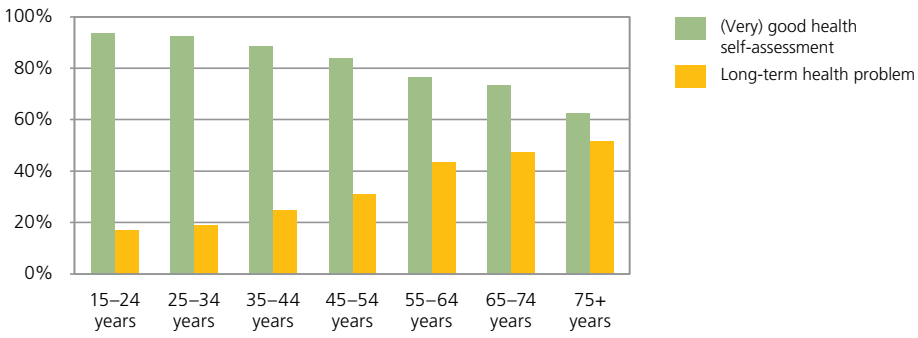
Principal means of transport by length of journey to go to work in 2012

Proportion of commuters using a certain means of transport as their principal means of transport to go to work



Source: FSO – Structural Survey (RS)

Self rated health and long-term health problems, 2012



Source: Suisse Health Survey 2012

Conditions) covers a wide area including income, education, work, childcare, the composition of households, the housing situation and health.

The four different surveys and their data are combined and the results of this integrated system shown in four types of statistics with a different thematic and spatial depth of focus:

- basic annual statistics on the population, households and housing on the basis of the nationwide register surveys at commune and meter coordinate level;
- annual structural statistics based on the structural survey and the register surveys. These also include the "traditional" topics of the population census. They provide additional information to the basic statistics and form the basis for the analysis of the topics at cantonal level;
- every year, in-depth statistics on the topics of "work" and "income, consumption and living conditions" on the basis of the thematic surveys and register surveys for Switzerland's seven major regions;
- every year, in-depth statistics on one of the other topics on the basis of the relevant thematic survey and register surveys for Switzerland's seven major regions;
- annual statistics on current issues on the basis of the Omnibus survey and the register surveys at nationwide level.

The system integrates basic statistics, structural statistics and detailed thematic statistics as well as information about persons, households and housing.

These cross-sectional perspectives and the integration of the results from the various surveys allow the seven topic areas to be covered comprehensively.

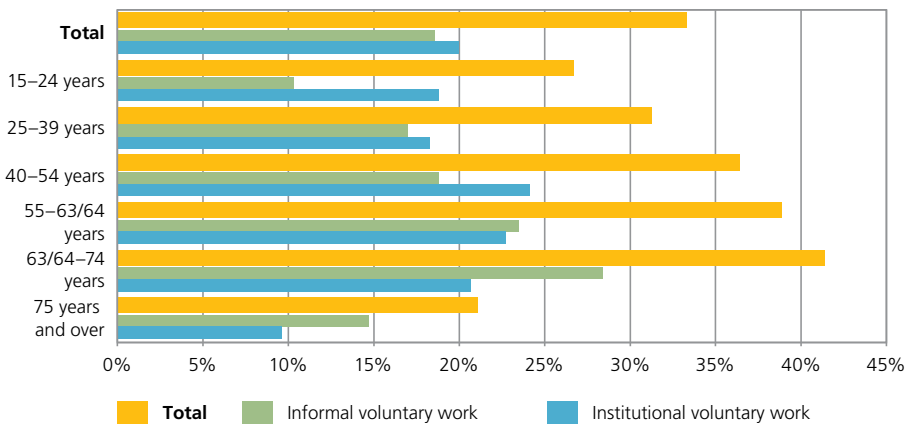
Greater than the sum of its parts

The new census can only exploit its full potential if it takes the form of a well-functioning integrated system. It is more than the sum of the various individual statistics. In order to create an integrated system, integration components are needed which will bring together surveys based on different data sources. This function is assumed by the following integration components:

- the social security (AHV/AVS) number which as a personal identifier enables a person to be clearly identified in various data sources;
- the building and dwelling identifiers which enable the household formation and the allocation of persons and households to the buildings and dwellings;
- the key variables which ensure the comparability of results and the mutual definition of the population groups.

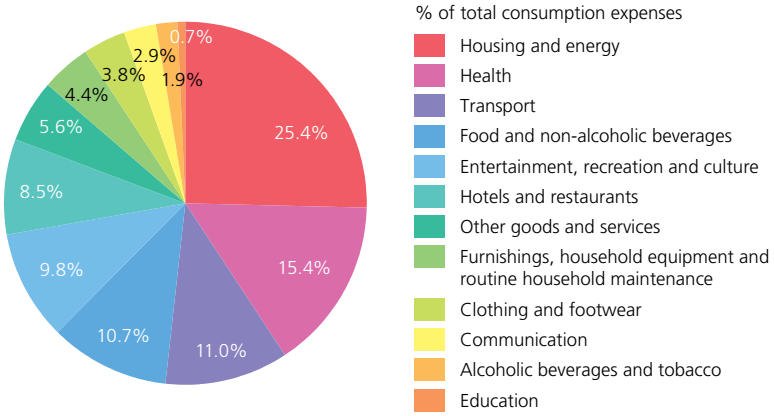
The key variables allow population groups to be defined and identified in a standardised way. They also generate a lowest common denominator which guarantees that the results of the different statistics and the statistical monitoring of specific population groups are comparable. This means that is possible to make assertions about groups according to the highest completed level of education, or with regard to mobility and travel behaviour, preventive healthcare, the use of cultural offerings, language skills or religious practice and much more. This means that definable groups of people (e. g. people with a university degree) can be described and analysed in the context of topic areas.

Participation of the permanent resident population in voluntary work by type of activity and age group in 2013



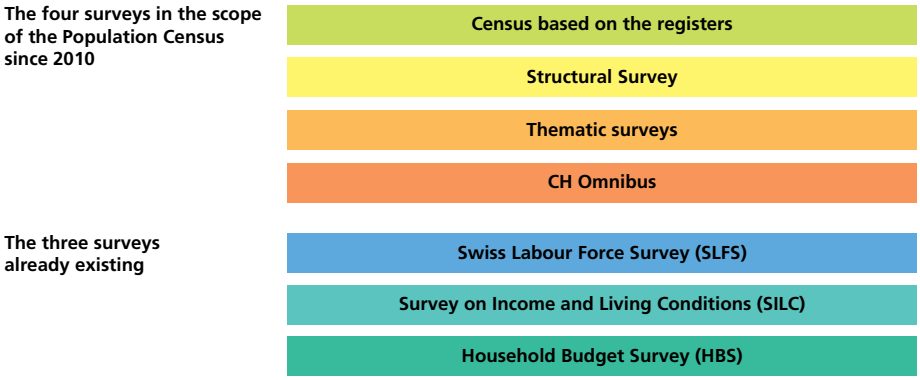
Source: Swiss Labour Force Survey (SLFS), "Unpaid work" module

Overall structure of the standard consumption basket in 2013



Source: HBS

System of household and person statistics (SHAPE)



Topicality, flexibility and spatial precision

The new system was introduced in 2010 and offers various advantages. The population census has become more topical, flexible and spatially precise. Information is more frequent, thematically wider and quickly available. The availability of data updated on an annual basis means that regular, systematic monitoring of important and politically relevant topics is now possible. The new system can also be updated and further developed as needed. Finally, there is an optimal cost-benefit ratio. Improved coordination and greater synergy effects result in a significantly lower financial and administrative outlay and considerably relieve the burden on respondents, communes and the cantons.

Further, continuously updated information can be found in the 2010 Population Census: www.VZ2010.bfs.admin.ch

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1
Register harmonisation: www.register-stat.admin.ch

The world in figures: indicators reveal complex interrelationships

Indicators make it possible to infer complex interrelationships from simple data. Such quantified insights often serve as a basis impacting highly diverse social spheres of activity – from healthcare and education to the economy. A study by the TA-SWISS Centre for Technology Assessment has shed light on the opportunities and risks of indicator-based decision-making systems. Lucienne Rey

Good news for Switzerland: in May 2014, the country was once again a frontrunner in a study of the world's most innovative cities. Three Swiss cities (Zurich, Geneva and Basel) feature on the list of the world's top ten smartest cities published by the University of Navarra's Instituto de Estudios Superiores de la Empresa (IESE) management school. Economists explored ten different dimensions, each based on a range of parameters to rank the 135 cities included in the study. Besides economic data, such as average output per employee and gross domestic product, the survey also took into account social indicators, such as unequal distribution of income and information on the state of the environment, the city's technical facilities and the efficiency of its public administration.

The IESE's ranking attracted attention both in Switzerland and worldwide. The survey not only featured in the *Schweizer Handelszeitung*, the *Basler Zeitung* and the *Tribune de Genève*, it was also reported in the UK Guardian, *The Baltimore Sun* and Warsaw's *Gazeta*. The hit parade of the "smartest cities" is revealing in several respects. It not only indicates regional successes and shortcomings from an economic planning perspective, it also shows just how popular rankings are. Whether it's about the regions with the highest quality of life, the best universities or the most corrupt countries – rankings that are backed up by data stand a good chance of attracting the public's attention and appearing particularly credible.

Evidence forms the basis

Data play an increasingly important role in our day-to-day lives. This is not least due to technology, with giant data storage systems, powerful communication networks and sophisticated statistical processes allowing huge quantities of information to be collected, managed and processed.

But it doesn't stop at data analysis: the initial call in the field of medicine for decisions and related measures to be based on evidence is increasingly gaining currency in politics. Evidence-based policy means that the effectiveness of political actions must be backed up by scientific studies – the thinking behind this being that quantitative effectiveness analyses will help make politics and policy making more transparent. The increasing international integration also favours the use of indicators. On the one hand, international collaboration requires comparable benchmarks between the partners involved, and on the other, the globalised economy calls for comparison with competitors in other countries. Globalisation is therefore one of the strongest drivers for indicators.

Focus on education and sustainable development

Against this backdrop, the TA-SWISS Centre for Technology Assessment commissioned a study on indicator-based decision-making systems. The study was based on a total of four case studies: two from the field of education and two from the area of sustainability. MONET, which stands for "Monitoring der Nachaltigen Entwicklung" (sustainable development monitoring) is supported by three federal offices: the Federal Statistical Office FSO, the Federal Office for Spatial Development ARE and the Federal Office for the Environment FOEN and is split into twelve topic areas – e. g. healthcare, employment, mobility and transport – which are measured using more than 70 indicators. The other case study, the Circle Indicators (CI) was developed at regional level. The CI measures sustainability using the three dimensions of environment, economy and society. Both indicator systems on sustainability are based on data collected anyway by various federal offices at federal, cantonal or communal level.

Regarding the education case studies, however, the required data were collected specifically for the two indicator systems in the study: PISA[1] and HarmoS[2]. *HarmoS corresponds to a set of stand*ards describing the minimum level of skills that school children should acquire. HarmoS was still in progress when the TA-SWISS study got underway. It therefore provided illustrative material in order to investigate the development process for standards that are closely related to indicators. The case studies provided the empirical basis on which to challenge the assumptions derived from the theoretical preparatory work.

Characteristics of indicators

One of the primary aims of indicator systems is to make complex social or environmental processes more readily understandable. But there may sometimes be a fine line between the necessary reduction

in complexity and an unacceptable level of simplification. The study also recognises this ambivalence between helpful simplification and unacceptable generalisation as characteristic of indicators.

A further characteristic of indicators is what is known as decontextualisation. Once social occurrences are captured in figures, they become substantially more abstract. The issue at stake is taken out of context and considered in isolation. It is therefore unavoidable for this decontextualised form of reality to mask references to other issues, which may potentially also be important to gain a proper understanding of the issue in question.

Indicators also allow us to reflect on our own behaviour. They define parameters to align decisions that need to be made with previously set goals. One potential drawback, however, may be the delayed reaction speed if the indicators first have to be evaluated before action can be modified. The fact that indicators may have a delayed impact on processes of social change should not only be regarded as negative, however, since self-reflection can often prevent jumping to hasty conclusions.

What makes a good indicator

The TA-SWISS study sheds light on various aspects of indicators. From a social science point of view, their operationalisation should initially be considered in an appropriate manner, in other words the relationship between the indicator and the issue being investigated should be as close and unambiguous as possible. The measurement per se should be conducted professionally; it is also advantageous if indicators are based on available data collected over longer periods with a minimum amount of effort, as this is the only way to ensure that the collection of data is cost-efficient and that the indicators are updated regularly. Furthermore, the indicators must be recognised, collected at the right time and widely accepted.

From a political science perspective, it is initially important that indicators are recognised and legitimised. This means that their use must be shown to be justified – both concerning the problem area and with regard to the organisations working with these indicators. One way of increasing legitimacy and acceptance is to involve the organisations and individuals affected by the indicatorisation early on (participation). Another key factor is communication: information about the actual indicators and the indicatorisation process must be accessible. In addition, there must be an exchange of thoughts and ideas between the various parties involved.

Finally, another highly important factor is ensuring the indicators are applied in the right frame of reference. If they are being used to check whether particular target values are being achieved (controlling), they have to fulfil different requirements than if they are being used to monitor a development or to evaluate the impact of specific measures. These frameworks should be clarified from the outset when the indicators are defined and should remain constant over time.

Dynamic planning, clear responsibilities and open communication are the keys to success

In its conclusions, the TA-SWISS study cites the most important factors on which the success or failure of an indicator system depends. It states, for example, that an indicator project is never fully complete because indicators for political decision-making systems always relate to social processes, which in turn are subject to constant change: the economy's demands on schools are evolving, the appearance of new harmful substances are making new measurements necessary. The scientific basis is developing, too – for example measurement methods for indicators. Indicator (systems) should therefore be considered dynamic projects, which must be constantly reviewed and updated.

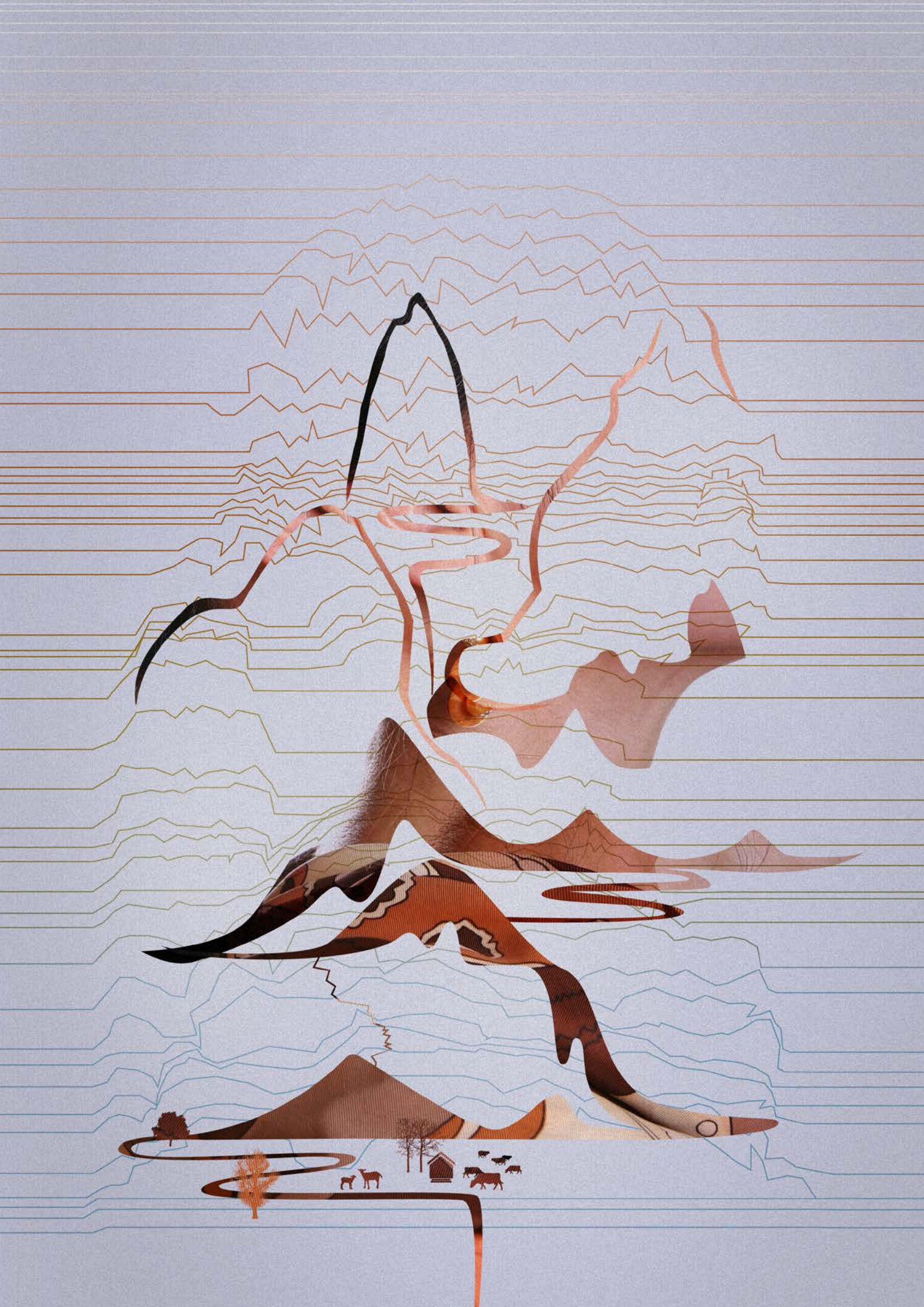
It is also important to plan information relating to indicators carefully and early on and to record it in a concept. In particular, responsibilities with regard to communication must be clarified, the context of the indicators must be disclosed, e. g. their frame of reference and any potential shortcomings, individuals or organisations must be entrusted with mediation and interface tasks and the media should be supplied proactively with regular information.

This text refers to the following TA study: *Messen, werten, steuern. Indikatoren – Entstehung und Nutzung in der Politik* (Measure, Rank, Control. Indicators – their Development and Use in Politics), Centre for Technology Assessment, Berne, 2010.

Lucienne Rey is a freelance science journalist

1
Programme for International Student Assessment; international study conducted periodically by the OECD.

2
Harmonisation of compulsory schooling



From official statistics to forecasts – the model world of BAK BASEL Economics

As an independent economic research institute, BAKBASEL has provided substantiated analyses on an empirical but practice-based level for more than 30 years. In the beginning the focus of the forecasts was mainly on classic macroeconomic variables such as private consumption or exports. The forecasting process was soon expanded to cover various sectors and regions, with special forecasts also being compiled, for example, for the retail sector, tourism and the construction industry. The forecasts are based on an overarching model architecture. In many cases, the data basis and projected variables are supported by surveys and statistics from the Federal Statistical Office (FSO).

Alexis Bill-Körber, Markus Langenegger and Jonas Stoll

Model philosophy and architecture

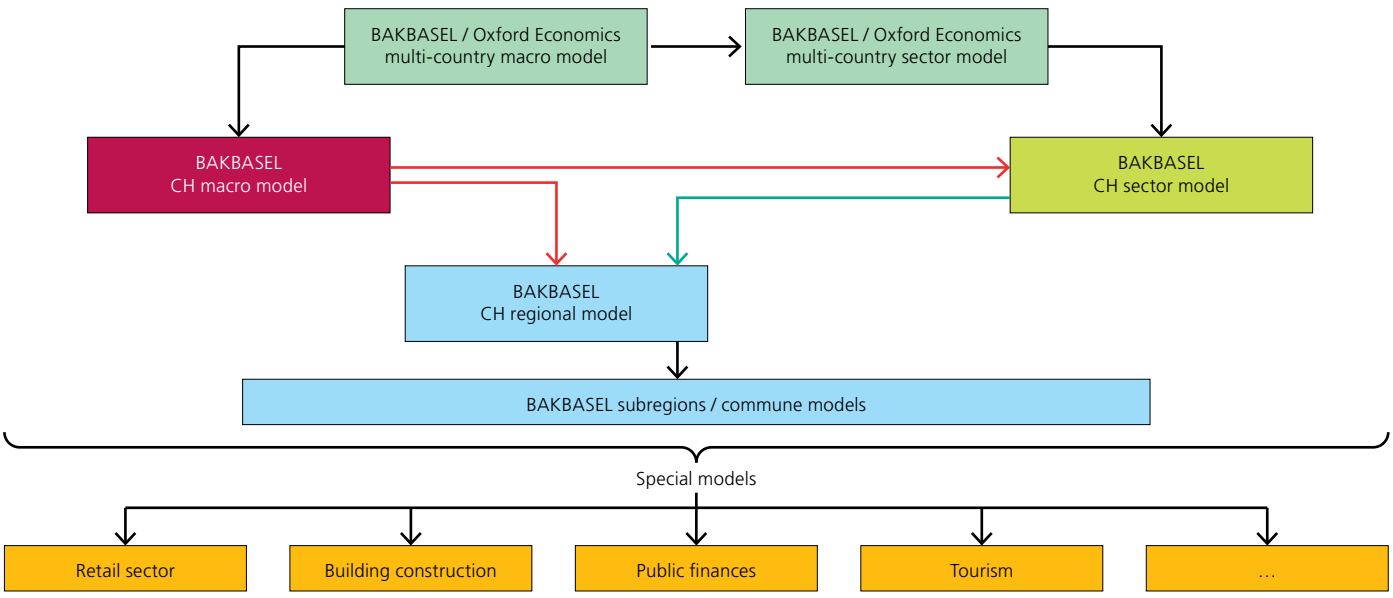
To forecast and simulate different variables such as the US base rate, Swiss consumption expenditure, the pharmaceutical industry's work volume, the aggregate income of Aargau or value added in the energy sector and water supply in the commune of Trimmi, BAKBASEL does not simply rely on a single model but instead on an array of models which are consistently linked with each other (see diagram). The model hierarchy follows a top-down approach which can best be described starting from the biggest (multi-country model) and ending with the smallest. There are also a number of special models.

From the world economy to the Swiss commune

The *multi-country macro model* and the *multi-country sector model* – which are both operated in close cooperation with BAKBASEL partner institute Oxford Economics – form the starting point of the model world. Seen separately, both model families represent a pool of individual country models which are, however, linked with each other through foreign trade interrelations and relative prices (deflators, interest, foreign exchange rates, unit labour costs). The Swiss macro and sector model make up two very comprehensive country models for Switzerland.

The macro country models contain the expenditure side components of the national accounts, supply variables such as production potential, prices, costs as well as capital and labour markets. For Switzerland, there are currently more than

BAKBASEL model philosophy and model architecture



Source: BAKBASEL

300 macroeconomic variables that are connected to each other and internationally linked. These variables can be forecast and analysed using simulated calculations.

Based on the production account, the sector models depict economically relevant sector variables such as the gross value added or employment development (for more than 80 individual sectors in Switzerland pursuant to NOGA2008).

Keynesian in the short-term, neoclassical in the long-term

The model philosophy follows that of the econometric structural models. These consider both empirically determined relationships and the theoretical foundation. In the case of macromodels, for example, short-term economic, mainly demand-driven factors dominate the model results. In the long-term, however, structural elements such as workforce potential gain the upper hand over dynamic adjustment processes. For the short-term and long-term analyses, great importance is also attached to the financial markets and their non-monetary repercussions such as via the explicit consideration of liquidity level parameters.

Sector demand via input/output networks

The multi-country model forecasts find their way into the sector models via the elements of final demand and relative price competitiveness. However, as most sectors produce both goods and services for the end consumer market and for the upstream sectors, additional interim demand elements are considered via international input/output networks. Within this broad-based demand approach, a global investment boom thus directly has a positive effect on the manufacturers of investment goods and the external suppliers of these sectors.

Export basis approach for regions

For the economic development of a region, first and foremost it is the export basis which is crucial with regard to model structure. The export basis is calculated based on both the regional economic shares of the individual export sectors (structural effect) as well as their region-specific competitiveness (international competitiveness in the region).

In addition to the value-added effects which are directly connected with regional export successes, an additional demand effect emanates from the export sector income onto the other sectors. In the terminology of the export basis approach, these sectors are also called derivative sectors due to their dependency on the export basis. The migration of labour between the regions is also considered across domestic commuter networks and cross-border commuter structures in this process. Accordingly, for example, the local trade and industry in the canton of Basel-Landschaft also benefits from income generated in the canton of Basel-Stadt.

Example 1: Retail sector forecasts

The retail sector has been a key focus point for BAKBASEL from the very start. From an early stage, a forecast model was developed for the Swiss retail sector on a national level which has been further developed on an ongoing basis over the years. Today it plays a key part in analyses and forecasts for the Swiss retail sector. The forecasts for the Swiss retail sector are published every quarter under the title *"Perspektiven Detailhandel Schweiz"* (Retail sector forecasts Switzerland). Its clients are mainly large retail sector companies which use the forecasts to monitor the overall market and carry out their business planning.

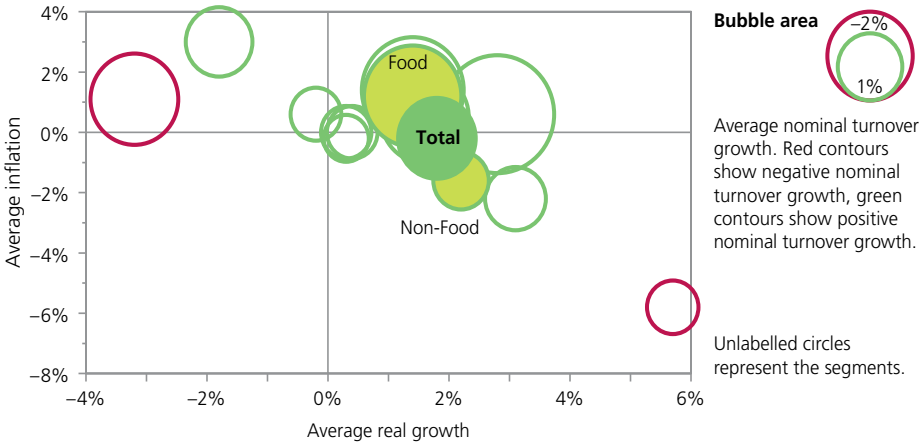
Consistent market assessment

At present, a distinction is made between two sectors in the retail sector model (food and non-food) with a total of twelve segments. Forecasts for nominal and real turnover development and inflation are compiled for each of these. The retail trade turnover statistics published every month by the FSO are a key data basis for this model. The retail sector model is based on econometrically valued equations and is incorporated into the BAKBASEL model family. This ensures that the forecasts for the Swiss retail sector can be consistently aligned with the current macroeconomic forecasts. The following (projected) variables in particular are integrated in this process:

- Real final household consumption expenditure
- Primary income
- Permanent resident population
- Consumer prices
- Commodity prices.

Apart from the retail sector model, the forecasts are also based on the expert appraisals of BAKBASEL's economists.

Developments in the Swiss retail sector 2014–2020



Source: BAKBASEL – Perspektiven Detailhandel Schweiz, May 2014

Demand as a turnover driver in the Swiss retail sector

The grap on page 17 shows an extract from the May 2014 forecast. Overall, BAKBASEL is expecting an average nominal increase in turnover per year of 1.6% for the forecast horizon from 2014–2020. The driving force here should be the development in demand measured against real turnover growth, whereas a small decrease in the price level should be expected.

Additional application areas

The retail sector model is the starting point for a number of additional analyses of the Swiss retail sector. This includes, for instance, the following categories: development and supervision of specific forecast models for the turnover growth of large retail sector companies, preparation of forecasts for the regional demand growth to support companies in their expansion strategy or in the implementation of scenario analyses.

Example 2: Civil engineering forecast

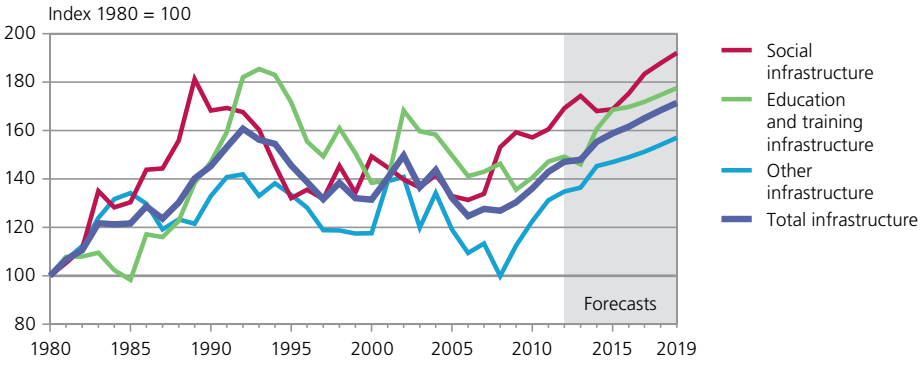
The civil engineering forecast is one of BAKBASEL's oldest regular forecasting services. In addition to the main and ancillary construction trades, the civil engineering forecast is also increasingly demanded by building suppliers due to its high degree of differentiation. The public sector is also another important source of clientele.

FSO statistics as a data basis

The FSO's annual "construction and housing statistics" makes up the historic data basis of the civil engineering forecast. Various investment categories from the infrastructural, residential and industrial building areas on a nationwide level are projected based on this data.

Per category, a difference is also made between new, modification and renovation expenditure. In addition to forecasts of the investment volumes, a forecast of the actual newly created units, divided into single-family and multi-family houses, also exists for the residential building area.

Civil engineering development Infrastructural building expenditure by construction



Source: FSO – Construction and housing; BAKBASEL – Hochbauprognose 2013

Regional differences

At a regional level, the construction expenditure for seven Swiss regions is projected by the three main categories: the infrastructural, residential and industrial building areas. The forecast horizon is seven years from the last historical FSO value.

Heavily indicator-based in the short-term

The short-term forecast is heavily supported by preparatory indicators such as construction projects according to the FSO statistics or building permits and building applications from the Swiss *Baublatt*. In particular, these indicators cover the one to three year forecast horizon. In calculating the probability of realisation, macroeconomic variables such as interest or employment development are, however, already considered.

Based on essential influencing factors in the mid-term

In the mid-term forecast, fundamental influencing factors which explain the investments in construction prevail in the model. In the case of the general macroeconomic influencing factors, the interest development should first and foremost be considered here. In the case of the specific parameters of the individual construction categories, for instance, demographic structural changes (infrastructural civil engineering), development of disposable income (residential building) or the development of office intensive occupation (office construction) should be considered.

Infrastructural construction as an important pillar

At present, the Swiss residential building boom is a hot topic in particular. According to last year's civil engineering forecast, however, infrastructural civil engineering offers the best growth prospects in the mid-term (see grap). As shown by the numerous large projects planned in hospitals, the intensified competition during the forecast period until 2019 will especially spur on investment expenditure in social housing construction. In this area, an upward trend can be seen in all Swiss regions.

Additional application areas

The extensive civil engineering forecast also offers a promising starting point for further special projects and publications. These include the second home study on behalf of the State Secretariat for Economic Affairs (SECO) or the subregional construction forecasts for the *Graubündnerischer Baumeisterverband*.

Example 3: Tourism forecasts

Since 1999, BAKBASEL has compiled forecasts on behalf of SECO for the Swiss Tourism Statistics. The number of overnight stays at hotels, the value added in the restaurant and hotel sector, the transport revenues of the Swiss mountain railways and tourism exports are projected. In the process, overnight stays at hotels are estimated at both national and regional level. The forecasts are compiled twice a year at the start of the winter and summer season (in November and May). Tourism forecasts show stakeholders in the tourism sector the developments in demand that can be expected. As a result of this, they improve the planning of companies involved in the tourism industry and public expenditure and thus provide decision-making bases to align the tourism sector to the global market's future challenges in an even more targeted way.

Error correction approach

Put more simply, it could be said that tourism demand is defined by the relative offer prices, the economic situation in the home markets, guests' preferences and the quality of what is offered. BAKBASEL bases its forecasts on the statistical-econometric model in error correction form. This enables both long-term balancing relationships and future (economic) deviations therefrom to be considered. The explanatory variables to evaluate tourism demand firstly come from BAKBASEL's forecast models and secondly from the Federal Statistical Office (Statistics on tourist accommodation (HESTA). Tourism demand is estimated separately for every country of origin and every tourist region. The following (projected) indicators – to some extent also as lagged variables – are also used in particular here:

- Overnight stays – Real consumption expenditure in the countries of origin
- Registered unemployment rate and level in the countries of origin
- Foreign exchange rates
- Various deflators as indicators for the price development
- Real investment in construction in hotels and restaurants as an indicator for the quality of the offer.

Slightly weaker growth in the summer season

As an example, the diagram above shows BAKBASEL's current tourism forecast from June 2014 for the development of overnight stays: After a clear catch-up was seen in summer 2013 with a 3.5% growth in the demand for overnight stays in hotels, the increase in the current 2014 summer season is expected to slow down again. Thanks to the continued improvement of the global economy and a stable Euro exchange rate, the growth should, however, be slightly above the long-term growth trajectory of 1.0–1.5% with a plus of 1.7%.

Additional application areas

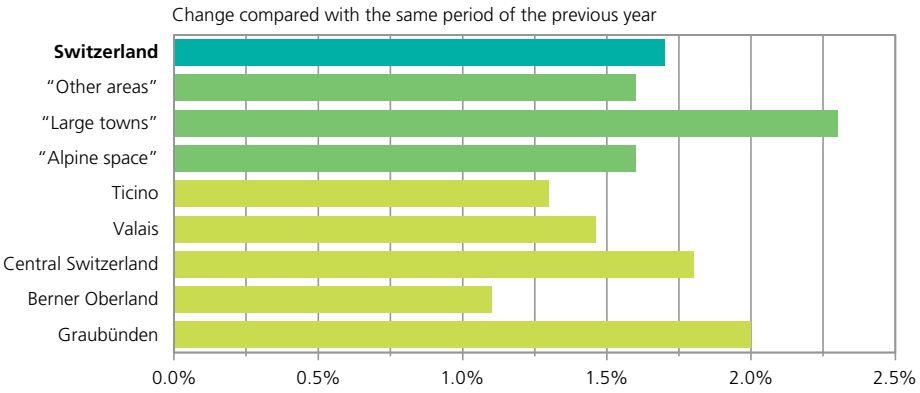
In addition to compiling economic forecasts, BAKBASEL's analysis spectrum on Swiss tourism also includes structural analyses which deal with the central issue of which factors determine a tourist destination's success. At the level of the individual destinations, for example, a strategic information and decision-making instrument was developed which is based on a comprehensive international database. The web-based tool enables the destinations independent, comprehensive and international benchmarking of the economic success and of the decisive competitive factors.

Alexis Bill-Körber, Head of Forecasting Department, BAK Basel Economics AG

Markus Langenegger, Project Manager, BAK Basel Economics AG

Jonas Stoll, Project Manager, BAK Basel Economics AG

Overnight stays forecast, summer season 2014



Source: BAKBASEL

The Art of Conjecturing

Jakob Bernoulli, a mathematician and physicist from Basel, developed the first statistical attempts to deal with complex questions of probability as early as the 17th century. Delving deep into theories on gambling, he proved what is known as "the weak law of large numbers" calling it his golden theorem, which he viewed as more important that the squaring of the circle. However, *Ars Conjectandi* containing Bernoulli's various findings was only published eight years after his death.

Caroline Schnellmann

Although *Ars Conjectandi* was never completed and is not as well formulated as Jakob Bernoulli's other texts, it is considered his most prominent work. Among other things, it contained the first mathematical proof of the weak law of large numbers, making it possible to say something about the probability of events. Jakob Bernoulli had spent 20 years trying to prove this law, and was aware of its practical usefulness. In his scientific diary *Meditationes he wrote: "The theorem means more to me than if I had discovered how to square the circle*[1]*. That would indeed be nice, but it would be of no practical use".*

A priori and a posteriori

What was new about *the weak law of large numbers* was that it made it possible to estimate the probability of events in the future through the evaluation of similar circumstances in the past. It enabled Jakob Bernoulli to address such complex and not at all banal questions such as the probability of death resulting from a particular disease, or the air quality in a given month or year, when the probability was not yet known a priori. Bernoulli proposed a method for solving such problems which can be considered the foundation of the theory of probability, and of statistics. *"But there is another approach possible in seeking a solution that cannot be found a priori, for it can at least be determined a posteriori, i. e. from the successes that in many cases can be determined on the basis of similar examples"*. The relevant observations of Bernoulli can be found in part four of *Ars Conjectandi*.

In the first three parts of the work, Bernoulli concentrated in particular on games of chance such as dice, in which the probability of an event occurring is even known *a priori*. The probability that one of the six sides of the cube will be found at the top is already clear from its geometry.

Problems of this kind provided enough scope for Bernoulli's combinatorial considerations. Although they served mainly for derivation of the fourth part of *Ars Conjectandi*, the explanations were so thorough that they could still be used as a combinatorics textbook today.

The weak law of large numbers

Bernoulli needed *the weak law of large numbers* in order to determine probability *a posteriori* or even empirically. This law states that the relative frequency of a random outcome converges towards its expected value. A simple example, given by Bernoulli himself, is the ratio of black to white tokens in an urn. This can be determined by repeatedly drawing a token, noting its colour, recording this statistically and replacing it. With the increasing number of withdrawals, the ratio of white and respectively of black tokens converges towards the actual number in the urn.

In other words, the greater the number drawn, the more reliable the prognosis. Bernoulli realised that to many people this was a matter of intuition. *"Sometimes even a simple-minded person has experienced the fact – quite independently, as a result of some natural instinct and without any prior instruction (which is truly a wonder) – that the greater the number of such observations, the less risk there is of erring…"*

The certainty of the future

Other observations made by Bernoulli in the fourth part of *Ars Conjectandi show just how fundamental his development of probability theory was at this time: "Everything that exists or is created under the sun – the past, the present and the future – can be known with the greatest degree of certainty. In so far as the past and present are concerned this is self-evident… But even with regard to future things there can be no doubting*

1
The squaring of the circle is one of the best known problems in mathematics. For centuries mathematicians, together with an ever greater number of uninitiated, have searched in vain for the solution. The challenge is to construct from a given circle, in a finite number of steps, a square having the same area (it is equivalent to the so-called rectification of the circle, i. e. the construction of a straight line corresponding to the circumference of the circle). To square the circle using only a ruler and a compass has now been proven impossible. This was established as recently as 1882 by the German mathematician Ferdinand von Lindemann.

that they will occur, if not through the unavoidable necessity of some fateful event, then by means of divine foresight and predestination. … All other things, in so far as we know, have an incomplete degree of certainty – greater or lesser in accordance with the greater or lesser probability – that any thing is, will be or has been. The probability is thus a degree of certainty and differs from it as does a part from the whole".

Post mortem

What ultimately prevented the perfectionist Jakob Bernoulli from completing and publishing in his lifetime *Ars Conjectandi*, with its proof of *the weak law of large numbers*, was a lack of data. He wanted to test his discovery by means of a suitable example, having in mind marriage contracts and inheritance expectations. His intention was to determine expected values in a table of inheritance expectations based on the life expectancies (young-old, healthy-sick) of those listed in his sample. To make this approach possible he would have needed death dates. But in the 17th century no town kept statistics on deaths. And even if these had existed, Jakob Bernoulli would have had no access to them.

It was not until 1713, eight years after his uncle's death, that Niklaus Bernoulli published the treatise, with Jakob's commentary and reflections on the theories of such mathematicians as Christian Huygens, Gerolamo Cardano, Pierre de Fermat and Blaise Pascal, as well as his own contributions on combinatorics and permutation analysis or for example on what we now know as Bernoulli numbers and expected values.

The passages quoted from *Ars Conjectandi* are taken from the translation of Robert Haussner, published by Wilhelm Engelmann, Leipzig, 1899.

Caroline Schnellmann is a freelance writer

The Bernoulli family

The Bernoulli family of Basel were one of the most celebrated families of mathematicians and scholars of the 17th and 18th centuries. The progenitor of the family was Leon, a Protestant doctor from Antwerp. The most famous members are Jakob, Johann and Daniel Bernoulli. Jakob and his younger brother Johann were bitter rivals. It was Jakob's nephew Niklaus I who eventually published *Ars Conjectandi*. Nikolaus II, Daniel and Johann II, the three sons of Johann, were also keen mathematicians. So great was the rivalry between Johann and his son Daniel that on the publication of Daniel's main opus *Hydrodynamica* (1738) the father himself wrote a book under the title *Hydraulica* and backdated it to 1732. In doing so, he committed a fraud that brought him into much ridicule. The best known family members in modern times are Hans Bernoulli, an architect who designed various residential complexes and buildings in Basel and Zurich, and the photographer Maria Bernoulli, who was the first wife of Hermann Hesse.

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