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Gathering economic data on fish processing companies

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Tiivistelmä

Euroopan Unionin kalanjalostusteollisuuden taloudellisen tilanteen seuraamista koskeva asetus (No 1543/2000) määrää selvittämään vuosittain jalostusyritysten käyttämän kalan määrän kokonaisuudessaan ja lajikohtaisesti sekä yritysten liikevaihdon, tuotantokustannukset, kiinteät kustannukset, rahoitusaseman, investoinnit, hinnat tuotteittain sekä henkilöstön määrän.

Tässä tutkimuksessa selvitetään, miten vaaditut tiedot saadaan estimoitua yhdistämällä RKTL:n kalanjalostustilaston tietoja tuotantomääristä ja Tilastokeskuksen yritysrekisterin taloudellisia tietoja. Tutkimuksen kehikkoperusjoukko muodostettiin yhdistämällä RKTL:n kalanjalostuskehikot yritysrekisterin kanssa. Alan yritykset näyttävät olevan heterogeeninen ryhmä, jossaa tapahtuu jatkuvasti muutoksia. Kehikoiden muodostamiseen ja päivittämiseen tulisikin jatkossa panostaa entistä enemmän.

RKTL:n kalanjalostuskysely tehdään vain joka toinen vuosi. Yritysten käyttämän kalamäärän arvioimiseksi käytettiin vuosina 1999 ja 2001 Horvitz-Thompsonin estimaattia, yleistettyä regressio-estimaattia ja synteettistä estimaattia. Vuonna 2000, jolloin jalostuskyselyä ei tehty, raaka-ainemäärälle laskettiin synteettinen estimaatti. Luotettavien estimaattien saamiseksi välivuosina tarvitaan parempaa lisäinformaatiota yrityksistä.

Asiasanat

kyselykehikko, malliavusteinen estimointi, malliperusteinen estimointi, lisäinformaatio

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Abstract

According to Council Regulation of the European Communities (No 1543/2000) the member countries shall collect data to evaluate the economic state of the fish processing industry. The information required is the volume and value of production, total income, financial position, investment, employment and production costs.

Economic data are available in the Financial statement statistics maintained by Statistics Finland. The Finnish Game and Fisheries Research Institute has carried out the data of volume of used raw materials every other year.

This study concentrated on the construction of a combined population frame and estimating the information demanded. Some modeling techniques were applied concerning years, when FGFRI didn't collect the processing survey. A linear model was fitted for data from a survey year and an estimate was calculated using auxiliary data for the target year taken from the Financial Statement Statistics. For a comparison of estimation approaches three different estimators – a Horvitz-Thompson estimator, a synthetic estimator and a generalized regression estimator – were calculated for the survey years 1999 and 2001. For the non-survey year 2000, a synthetic estimator was the only option, and the aim was to examine the reliability of this estimation approach.

The study showed that the group of processing companies was dynamic and heterogeneous. Thus the updating and constructing of frame should be done more delicately in future. In these years, the FGFRI does not carry out the processing survey, the estimation of volume of production requires more detailed auxiliary information.

Key words

Frame population, model-dependent estimation, model-assisted estimation, auxiliary information

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Abstract

According to the Council Regulation of the European Communities (No 1543/2000 Article 4) the member countries shall collect data to evaluate the economic state of the fish processing industry. These data are: production (expressed in volume and value), the number of enterprises, the number of jobs, and changes in production costs. This study concentrated on the construction of a combined population frame for survey sampling purposes, on a review on, and evaluation of, the existing register data bases possibly usable as sources of information on economic and related issues and on selected estimation approaches for sample surveys.

A combined population frame was compiled by combining the sampling frame maintained by the Finnish Game and Fisheries Research Institute (FGFRI) and the Business Register maintained by Statistics Finland. The combined sampling frame includes companies that have processed fish in different main branches of industry. The Business Register includes companies that have operated without a break more than six months and whose turnover is more than a defined limit. The study showed that in 1999, about 37 percent of the fish processing companies and in 2001, about 19 percent did not meet this limit. It was also observed that there was a slight under-coverage in the sampling frame of FGFRI. In 1999, there were 37 companies in this frame whose main branch was either fish processing, fish wholesale trade or fish retail store, and who were included in the Business Register but were not included in the FGFRI frame. In 2001, this figure was 21 companies. For a more detailed examination the combined frame was divided into three mutually exclusive subgroups: 1) the companies outside of the FGFRI frame (Block 1), 2) the companies in the intersection of the FGFRI frame and the Business Register (Block 2) and 3) the companies outside of the Business Register (Block 3). The demography of businesses was examined based on this division of companies.

The study showed that the group of fish processing companies was dynamic; only 65 percent of the companies in the 1999's frame were included in the 2001's frame. Thus, it would be very useful if the combined frame were updated regularly; each year as the most favorable option. This would be especially useful for two related purposes: to obtain the necessary economic data and to estimate the requested totals for years when a sample survey with direct data collection is not launched. In addition, it would be useful if the combined frame would be compiled as a joint effort of Finnish Game and Fisheries Research Institute and Statistics Finland, to assure a frame which is as reliable as possible and uses all the available information on fish processing companies.

Economic data (total income, production costs, fixed costs, financial position, investment and employment) by main branch are available in the Financial Statement statistics maintained by Statistics Finland. These data are included in the non-public part of the Business Register. The study showed that the share of turnover of the companies that were not included in the Business Register was negligible. In 1999, it was about 0.3 percent of the total turnover and in 2001, less than 0.1 percent.

The total volume of the used raw material has been estimated by a sample survey every second year. The Finnish Game and Fisheries Research Institute has carried out this survey since 1993. In non-survey years, the volume can be estimated using modeling techniques. In this study, a linear model was fitted for data from a survey year and an estimate was calculated using auxiliary data for the target year taken from the Financial Statement Statistics. For a comparison of estimation approaches, three different estimators - a Horvitz-Thompson estimator, a synthetic estimator and a generalized regression estimator - were calculated by main branch for the survey years 1999 and 2001. For the non-survey year 2000, a synthetic estimator was the only option, and the aim was to examine the reliability of this estimation approach. Because

of the data availability, a Horvitz-Thompson estimator was an option for companies in the FGFRI's sampling frame (Block 2 and 3). A synthetic estimator was an option for companies in the Business Register (Block 1 and 2) and the generalized regression estimator for the companies in the intersection of the FGFRI sampling frame and the Business Register. The study indicated that the estimators produced results that differed to some extent. This is probably because of technical differences, different use of the auxiliary data, possible imperfections in the sampling frames and the possible strong dynamics in the area of fish industries. Therefore, it is difficult to assess the reliability of synthetic estimation for the non-survey years based on the results obtained this far. Thus, more research is needed to improve the estimation for the non-survey years.

Contents

1. Introcuction

1.1 Background

The member countries of the European Union have collected for a long time primary fishery data to support common fishery policy. Since 1995 the European Union has funded projects, which have supported the development of common fishery policy, in order to certify the continuation of primary data collection in member countries. In 1999, the Commission informed the member countries that the Commission will formulate a single data collection contract between each member state and the Commission for next five to six years. A member state should define a national program for the collection and management of data needed to evaluate the situation in the fishery resources and fisheries sector. Therefore, it was necessary to define the minimum program to cover the information needed for the scientific evaluations. (Ministry of Agriculture and Forestry and Finnish Game and Fisheries Research Institute, 2002).

The Council Regulation of the European Union No 1543/2000 defines the minimum program that includes the economic monitoring of the fishing enterprises and the processing industry. According to this minimum program the member countries of the European Union shall report every year the following economic information: income, production costs, fixed costs, financial position, investment, prices per product, employment and capacity utilisation. Moreover, the amount of raw fish by species should be reported annually. (Ministry of Agriculture and Forestry and Finnish Game and Fisheries Research Institute, 2002).

The Finnish Game and Fisheries Research Institute has produced statistics for fish production every second year since 1993. These reports are published in the Agriculture, Forestry and Fishery -Series of the Official Statistics of Finland. For the purposes of these statistics, fish processing covers both products and processed fish. In Fish processing -statistics the total quantity of processed fish by species and by province, and the number of fish processing companies, are reported. In 1997 and 1999 the employment impact of fish processing was also studied. These reports are based on data collected by a sample survey. However, in Fish processing -statistics, economics of the fish processing companies was not studied.

1.2 Study tasks

This study was launched to develop a method to gather the requested economic variables for the companies, which have processed fish. Because the total amount of processed fish should also be reported every year, a suitable estimating method was also examined. The material for this study is based on the survey data collected by the Finnish Game and Fisheries Research Institute (FGFRI) in 1999 and in 2001 and the economic data extracted from the financial statement statistics of the Business Register of Statistics Finland. A part of the study was executed in the Research Laboratory of the Business Structures Unit of Statistics Finland.

The study tasks are formulated in the following way: 1) specification of target population and construction of population frame, 2) inventory of information resources available, 3) gathering economic information from fish processing industry and 4) estimating the total amount of raw material.

The target population includes all companies in the fish processing industry. The population frame was constructed by linking together two separate registers of fish processing companies, the register maintained by FGFRI and the Business Register of

Statistics Finland. All companies in the FGFRI's sampling frame were not in the Business Register, because their turnover was less than 52 000 FIM in 1999 and 8914 € in 2001. Thus, there was different kind of information available to the subgroups.

The possible information resources were FGFRI's own statistics, Business Register and Financial Statement -statistics of Statistics Finland. The economic information by main branch from the financial statement statistics is not available for the companies outside of Business Register. Furthermore, the survey data gathered by FGFRI is available only for a part of the population.

This study examines the possibilities to gather the economic information for the fish processing companies from the financial statement -statistics maintained by Statistics Finland. Furthermore, the study examines to develop method to estimate the total amount of the raw material. In 1999 and in 2001, the total amount of used raw material is estimated using 1) a Horvitz-Thompson estimator, 2) a synthetic estimator and 3) a generalized regression estimator. A synthetic estimator is also calculated for the non-survey year 2000. The study examines possibilities to estimate the total amount of the raw material based on the previous year study in the years, when the sample survey is not carried out.

In this report, the Fish processing statistics made by Finnish Game and Fisheries Research Institute are first presented and evaluated. Second, the Business Register of the Statistics Finland is described. The methods and the results of the gathering economic data on fish processing companies are reported in chapter 4. Conclusions of are presented in the final chapter.

2. Processed fish production surveys

The Finnish Game and Fisheries Research Institute (FGFRI) has produced statistics on fish processing every second year since 1993. The studies are based on sample surveys and the results are published in Agriculture, Forestry and Fishery Series of Official Statistics of Finland. In the following the methods used in the surveys for years 1999 and 2001 are described and evaluated. For statistics production, fish processing is defined to cover both fish products and processed fish. Fish products are obtained through a mechanical treatment of fish, e.g. cutting into pieces or filleting. Processed fish is obtained through a chemical or physical treatment of fish. (Finnish Game and Fisheries Research Institute, 2001 and 2003).

2.1 Target and frame populations

The target population of the Fish processing statistics covers all companies, which have processed fish during the study year. The sampling frame was constructed by using an address register of the companies, which process fish, maintained by FGFRI. The register was updated by linking with the Business Register of Statistics Finland and with the lists of addresses maintained by the fisheries units of regional Employment and Economic Development Centres and the National Veterinary and Food Research Institute. (Finnish Game and Fisheries Research Institute, 2001 and 2003). The fisheries units of regional Employment and Economic Development Centres (TE-centres) are responsible for maintaining registers in this field. ("Services for farming and fisheries". TE-centre's www-page, 25.8.2003). The National Veterinary and Food Research Institute of Finland (EELA) operates under the supervision of the Ministry of Agriculture and Forestry offering services to veterinarians, food industry, authorities, consumers and animal owners. The aim of EELA is to promote both animal health and welfare as well as to safeguard the safety and quality of livestock products. ("Safe food from healthy animals". EELA's www-page, 26.8.2003).

The frame population consisted of 418 companies in 1999 and 312 companies in 2001. In 1999, the population was divided into three strata for sampling purposes. The first stratum included companies that had processed over 20 000 kg of fish in 1997 and also all companies located in the areas of the fisheries units of the Employment and Economic Development Centers of Southeastern Finland, South Savo, North Karelia, North Savo or Central Finland or in the region of Åland. The second stratum consisted of all companies processing lampreys and the third of all other companies. There were 124 companies in stratum 1, six companies in stratum 2 and 288 companies in stratum 3. (Finnish Game and Fisheries Research Institute, 2001).

In 2001, the population was stratified into five strata. The first stratum included companies freezing Baltic herring for food. The second stratum was made up of the biggest companies on the basis of turnover or previous quantities of fish processed. The third stratum was made up of the smallest companies in terms of turnover. The fourth stratum included companies for which there was no data on turnover or previous quantities of fish processed. The fifth stratum included companies which processed small quantities of fish in 1999. There were four companies in stratum 1, 64 companies in stratum 2, 159 companies in stratum 3, twenty companies in stratum 4 and 65 companies in stratum 5. (Finnish Game and Fisheries Research Institute, 2003).

2.2 Sampling design

In 1999, a stratified sampling design was used where the sampling unit was a company. All companies in stratum 1 and 2 and one out of three companies in stratum 3 were included in the survey. Thus the sample size was 255 companies. Information was collected mainly by telephone interviews. However, the questionnaire was sent in paper format to companies that preferred to reply by mail. Table 1 displays the response rate by stratum. Out of the target companies, 78 percent responded either to the telephone interview or to the mail questionnaire. (Finnish Game and Fisheries Research Institute, 2001).

In 2001, stratified sampling was also used and the sampling unit was a company. All companies in stratum 1, 2 and 4 were included in the survey. In stratum 3, the inclusion probability was proportional to the income of the company in 2001 and in stratum 5 the inclusion probability was proportional to the quantity of fish processed in 1999. The sample size was 168 companies. Information was collected mainly by telephone interviews. Table 2 displays the response rate by stratum in 2001. Complete responses were obtained from 148 companies (88 %) (Finnish Game and Fisheries Research Institute, 2003).

Table 1. Response rate by stratum in 1999.

Stratum	Population	Sample	Responses	Response %
1	124	124	101	81
2	6	6	5	83
3	288	96	69	72
All	418	255	175	78

Table 2. Response rate by stratum in 2001.

Stratum	Population	Sample	Responses	Response %
1	4	4	4	100
2	64	64	55	86
3	159	50	42	84
4	20	20	19	95
5	65	30	28	93
All	312	168	148	88

2.3 Adjustment for non-response

In 1999, telephone interviews were started with the largest companies. Response probability tended to be larger for large companies than for small companies. Poststratification was used to adjust for the possible bias due to nonresponse. Based on the volume of fish processed in 1997 the first stratum was poststratified into companies handling more than 500 000 kg and to those handling less than 500 000 kg. Thus, there were four strata for the computation of results. (Finnish Game and Fisheries Research Institute, 2001).

In 2001, the sample was also poststratified. Data on the company's fish processing operations in 2001 and data on turnover were used for poststratification. The five original strata were divided into 13 poststrata. (Finnish Game and Fisheries Research Institute, 2003).

2.4 Summary of results of the surveys

The amount of domestic and imported fish used for processing was estimated by fish species, raw-material groups and end-product groups. A Horvitz-Thompson estimator was used. In 1999, the total amount of fish processed in Finland was about 37 million kg, of which domestic species accounted for about 30 million kg. Almost half of the companies were located in the province of Western Finland. In 1999, employment in the area of fish processing companies was also studied. In 2001, the fish processing companies used raw material about 43 million kg, of which domestic fish accounted for 36 million kg and imported fish 7 million kg. Employment in the area of fish processing companies was not studied. (Finnish Game and Fisheries Research Institute, 2001 and 2003).

As a quality measure, the sampling error was reported by 95 % confidence intervals of estimated totals. In addition, a slight measurement error could be expected, because the processed volumes of many companies were not based on bookkeeping but were estimates given by the respondents. This aspect has been studied separately and the results are reported in publications of FGFRI. (Finnish Game and Fisheries Research Institute, 2001 and 2003).

3. The business register of statistics Finland

In this study, one of the aims was to examine the usability of register sources for supplementary sampling frames. The statutory duties of Statistics Finland include the maintaining of a Register of Enterprises and Establishments. The register covers all enterprises, corporations and self-employed persons that are liable to pay value added tax or have paid employees. The criteria to be included in the register for a company is that a company has operated without a break more than six months and the company's turnover is larger than a defined limit. In 1999, this limit was 52000 FIM in a year and 8914 € in 2001. Public authorities are not included in the Business Register. The register is updated continuously. The data are derived from Statistics Finland's own surveys and from various administrative records. (Statistics Finland, 2003).

The Business Register includes about 259 000 operating enterprises and corporations and about 291 000 establishments. The Business Register contains the following public information: 1) Business ID 2) name 3) address 4) municipality 5) region and province 6) telephone number 7) industry 8) size category of personnel 9) size category of turnover 10) date of establishment 11) legal form 12) type of owner 13) language 14) number of establishment 15) importer 16) exporter. The data can be sorted by branch of industry, by location, or by size of unit. (Statistics Finland, 2003).

Statistics Finland gathers also information about the financial statement of a company. The data are collected from the companies, which have at least 20 employees. The financial statement information is imputed for the companies with less than 20 employees using data from trade tax materials. The Financial Statement statistics cover about 95-99 percent of companies in the Business Register. This information is non-public. The variables of the financial statement statistics are listed in Appendix 1. (Nurmi, 2003).

The units of Business Register can be classified e.g. by branch of industry. The classification is based on the Standard Industrial Classification (SIC 2002) of Statistics Finland. The industrial classification categorises enterprises, other organisations and individual enterprises into industry groups according to the principal activity. Similar functions or activities are grouped into each industry group. The activities are similar when they are alike by commodities they produce, their production inputs and the process. The principal activity is an activity, which increases most the value added of a company. The main branch of a company, which has several activities, is determined by the highest value added activity. ("Economic classification". www-page of Statistics Finland, 25.8.2003). In this study the main branches are mainly fish processing, fish wholesale trade and fish retail store.

4. Gathering economic data on fish processing companies

The council regulation of the European Union No 1543/2000 defines a minimum program for economic monitoring of fishing companies and fish processing industry. According to the minimum program the following data should be gathered every year: used raw material, total income, production costs, fixed costs, financial position, investment, prices per product, employment and capacity utilisation. In this study, possibilities to gather the economic data on the fish processing companies from the Financial Statement statistics of the Business Register of Statistics Finland are examined. This report focuses on a part of these economic data (income, labour costs, other running costs, value of used raw material and employment situation).

4.1 Materials

A combined population frame was created by using the register of the fish processing companies maintained by Finnish Game and Fisheries Research Institute and the Business Register of Statistics Finland. The fish processing data from the Finnish Game and Fisheries Research Institute was linked to the firms in the Business Register. All companies in the register of the FGFRI were selected into the population frame. Furthermore, it was observed that the Business Register included companies whose main branch was fish processing, fish wholesale trade or fish retail store and which were not in the register of FGFRI. These firms also were selected into the population frame. Figure 1 describes the structure of the combined population frame. A further examination indicated that only a part of this frame could be used for the estimation of the economic totals.

The population frame was dived into three mutually exclusive subpopulations: Block 1, Block 2 and Block 3. Block 1 contains companies which were not included in the list of FGFRI. Block 2 contains the companies in the intersection of the list of FGFRI and the Business Register, and Block 3 contains the companies that were not included in the Business Register.

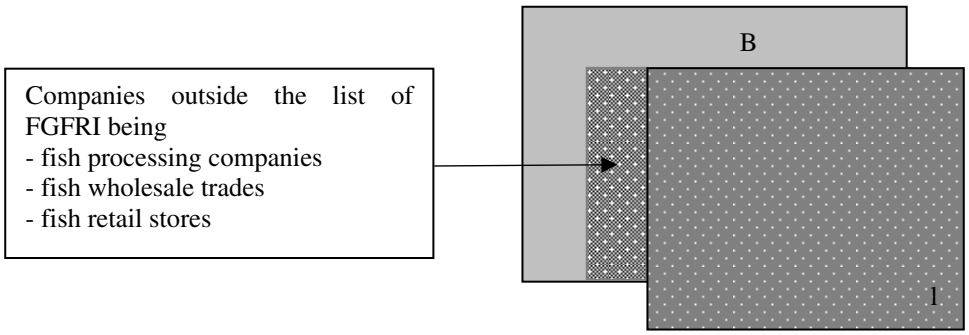

Figure 1. The selection of the companies for the combined population frame. The dotted area refers to the combined frame.

In 1999, the combined population frame consisted of 455 companies. There were 37 companies in Block 1, 251 companies in Block 2 and 167 companies in Block 3. In 2001, the total number of companies in the population frame was 331. There were 21 companies in Block 1, 246 companies in Block 2 and 64 companies in Block 3. Figure 2 shows the number of companies in the different parts of the population frames in 1999 and 2001.

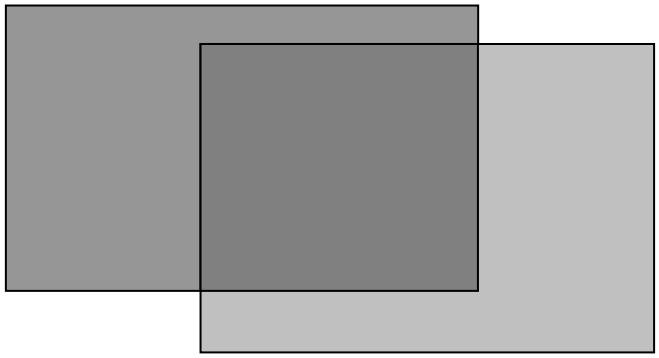

Figure 2. The number of companies in the different parts of the combined population frame in 1999 and 2001.

Table 3 displays the number of companies in the population frame by block and by main branch in 1999 and in 2001. In 1999, the number of companies in Block 3 was about 37 percent of all companies in the population frame. In 2001, this share was about 19 percent.

Table 3. The number of companies in the population frame by block and main branch in 1999 and 2001.

Main branch	Block 2 Intersection		Block 1 Business Register		Block 3 FGFRI	
	1999	2001	1999	2001	1999	2001
Fishery	21	17	-	-	10	8
Fish culture	25	16	-	-	-	1
Fish processing	107	137	35	13	13	28
Wholesale trade of fish	38	42	-	3	2	1
Retail store of fish	28	23	2	5	5	7
Other	31	11	-	-	-	-
Unknown	1	-	-	-	137	19
All	251	246	37	21	167	64

The main branch 'other' includes companies, which were processing fish in 1999 or 2001, in the following branches: fur farming, meat processing, fruit, berries and vegetables processing, traveling trade and so on. The subgroup 'unknown' includes the companies, which main branch was not available.

The FGFRI's frame contains companies that can have several branches of activity. Unfortunately, the number of these companies was not available in this study. The princi-

pal activity is the activity, which increases most the value added of the company. The main branch of a company, which has several activities, is determined by the highest added value activity. For example, if a company has three types of activity and fish processing is the main branch, the turnover from the fish processing might be only 35 percent of the total turnover. Furthermore, if a company has two types of activity and the fish processing is not the main branch, the turnover from the fish processing might be even 49 percent of the total turnover. Thus, in this study the proportion of the turnover that comes exactly from fish processing was impossible to be defined due to non-availability of information. The economic totals are defined by main branch: fish processing, fish wholesale trade, fish retail store and 'other'.

4.2 Methods

4.2.1 Research Laboratory of Business Structures Unit of Statistics Finland

To have access to micro-level economic data, the empirical part of the study was carried out in the premises of the Research Laboratory of the Business Structures Unit of Statistics Finland. Because of data confidentiality reasons, there was however not an access to detailed company identification data and therefore, a unique identification of target companies was not possible. Due to this the reported figures might include a contribution of companies, which are processing Baltic herring for the feed and thus, do not belong to the target population.

4.2.2 Gathering economic information

The economic information was available in the Business Register for companies belonging to blocks one and two. Block 3 includes companies whose income is less than 52 000 FIM (about 8746 €) in 1999 and under 8914 € in 2001. Therefore, an upper limit of the total income Block 3 companies in 1999 is 167*8746 € = 1 460 582 € and in 2001 64*8914 € = 570 496 €. Using these figures the estimated total is only 0.3 percent of the total income of the entire fish processing industry in 1999. In 2001 the total income of the companies the Block 3 is even less than in 1999. The proportion of the Block three companies from the total incomes of the entire fish processing industry was about 0.09 percent in 2001. Accordingly, the companies in Block 3 do not constitute an economically significant group of companies in this context. Thus, the economic data on fish processing industry is gathered only for the companies belonging to blocks one and two.

The cumulative distribution of the turnover shows the same picture (see figure 3). The group of companies with a small turnover is not significant when the total turnover is considered.

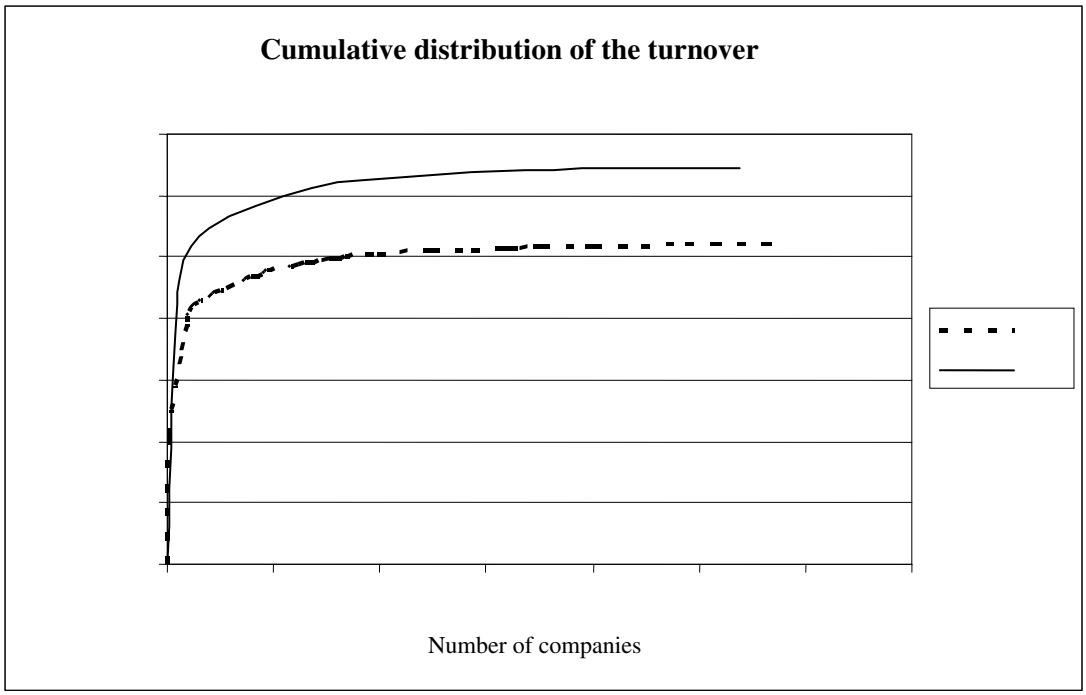

Figure 3. The cumulative distribution of the turnover in Block 1 and 2 in 1999 and in 2001.

The branches of fishery and fish culture were also left out of the population frame. The economic data for fisheries are reported in a separate annually report, Economic Performance of selected European Fishing Fleets. However, while some fishery and fish culture companies do process fish, it is not possible to estimate the proportion of the turnover, which comes from fish processing in this group of companies. Anyway, the share of this group owing to fish processing can be expected to be nonsignificant.

The value of the used raw material in 2001 was determined by using the estimated total of raw material by species and species-spesific prices. The price per kilogram by species was ascertained from the FGFRI's own sources of information, Producer price for fish -statistics. Then, the total value of used raw material was determined for the companies, which were in the sample in 2001, by multiplying the price per kilogram by the estimated amount of used fish. The total value of the used raw material was determined by the Horvitz-Thompson (HT) estimator.

More technically, the Horvitz-Thompson estimator of the total t is given by

$$\hat{t}_{HT} = \sum_{k \in S} \frac{y_k}{\pi_k} = \sum_{k \in S} a_k y_k \ ,$$

where y_k is the value of the variable of interest for unit k and a_k is the sampling weight. The inclusion probability for unit k is denoted by π_k. The corresponding sampling weights are $a_k = 1/\pi_k$. This unbiased HT estimator has the variance

$$V(\hat{t}_{HT}) = \sum_{k \in U} \sum_{l \in U} \left(\frac{a_k a_l}{a_{kl}} - 1 \right) y_k y_l \ ,$$

where $a_k = 1/\pi_k$ and $a_{kl} = 1/\pi_{kl}$. An unbiased estimator of this variance is

$$\hat{v}(\hat{t}_{HT}) = \sum_{k \in S} \sum_{l \in S} (a_k a_l - a_{kl})\, y_k y_l \text{ . (Särndal, Swensson \& Wretman, 1992).}$$

The estimators for domains, for example the totals by branch, are given by replacing y_k by y_{dk}, which is the value of the study variable in domain d and zero otherwise. Then, the HT estimator for domain d is given by

$$\hat{t}_{yd,HT} = \sum_{k \in S} a_k y_{dk} \text{ . (Särndal, 2001).}$$

4.2.3 Estimating the total of raw material

The total amount of the used raw material was estimated in three different ways for the survey years 1999 and 2001. The methods were 1) a design-based Horvitz-Thompson estimator (HT), 2) a model-dependent synthetic estimator (SYN) and 3) a model-assisted generalized regression estimator (GREG). These estimators for the study variable were calculated by block and by main branch. In 2000, when the survey was not carried out, the total amount of raw material was estimated by the synthetic estimator.

For the synthetic and GREG estimators a linear model $y_k = \mathbf{z}_k'\mathbf{b} + \varepsilon_k$ was used, where y_k is the amount of the used raw material of company k and $\mathbf{z}_k = (1, z_{1k})'$ are measurements of an auxiliary z-variables and ε_k is the residual. The best auxiliary variable was found by investigating the correlations between the study variable and the auxiliary variables. The economic variable with the highest correlation was selected into the final model. The correlations between the study variable and the auxiliary economic variables by branch are reported in Appendix 2. The model parameter $\mathbf{b} = (b_0, b_1)'$ was estimated by weighted least squares and the fitted values $\hat{y}_k = \mathbf{z}_k'\hat{\mathbf{b}}$, where $\hat{\mathbf{b}} = (\hat{b}_0, \hat{b}_1)'$ and $\mathbf{z}_k = (1, z_{1k})'$, were computed for all elements $k \in U$, where $U = \{1,..,N\}$ denotes. To examine the stability of estimates, both the previous year and the next year model parameter estimates were used for the year 2000.

The model-dependent synthetic estimator of domain total t_d of y is given by

$$t_{yd,SYN} = \sum_{k \in U_d} \hat{y}_k \ , \ d = 1,...,D,$$

where U_d are mutually exclusive subgroups of the population (Lehtonen & Pahkinen, 2003). In this study the main branches and the blocks were used as the subgroups. An alternative estimator is introduced in section 4.3.5.

The model-assisted generalized regression estimator of domain total t_d of y is given by

$$\hat{t}_{yd,GREG} = \hat{t}_{yd,SYN} + \sum_{k \in S_d} a_k (y_k - \hat{y}_k),$$

where $\hat{t}_{yd,SYN} = \sum_{k \in U_d} \mathbf{z}_k'\hat{\mathbf{b}}$ and S_d denotes the sample from the domain d. (Lehtonen & Pahkinen, 2003).

4.3 Results

4.3.1 Income of fish processing companies in 1999 and 2001

According to the minimum program the total income of the fish processing companies and income per product should be reported annually. The income per product is not available, but the total income is gathered from the Financial Statement -statistics of the Business Register of Statistics Finland.

Figure 4 and 5 show the distribution of turnover for the companies in blocks one and two. In 1999 and 2001, the turnover of most of the fish processing companies was less than one million euros. In 1999, even 73 percent of companies had a turnover under 500 000 €. This was 70 percent in 2001. The total of turnover of fish processing companies has increased annually about 11 percent from the year 1999 to the year 2001.

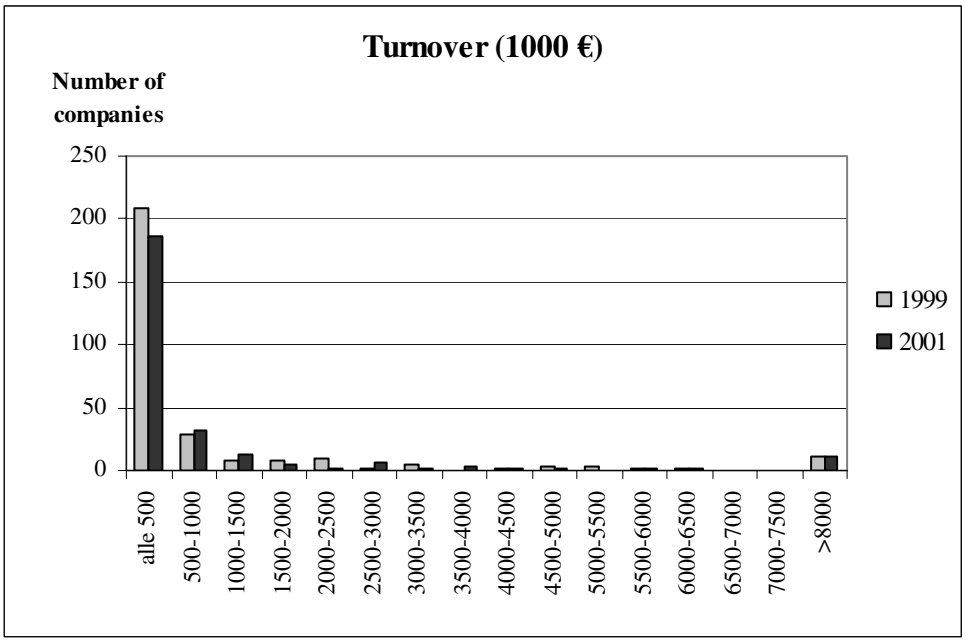

Figure 4. Distribution of turnover (1000 €) of fish processing companies in blocks 1 and 2 in 1999 and 2001.

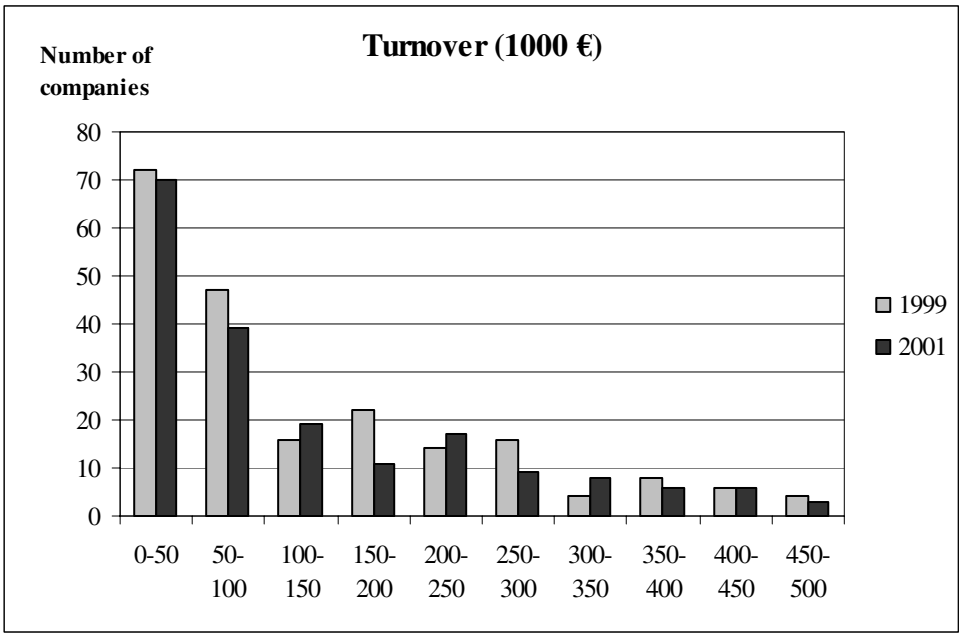

Figure 5. Distribution of turnover (1000 €) of fish processing companies whose income was under 500 000 € in blocks 1 and 2 in 1999 and 2001.

Table 4 displays the total turnover by main branch in 1999 and 2001. In 1999, there were only two fish retail stores in the population frame. Economic data is confidential information and thus, this information is not allowed to be reported for groups of companies containing less than three units. Therefore, the turnover of fish retail stores has been added to the turnover of the fish processing. The main branch 'other' includes companies, which were processing fish in 1999 or 2001, in the following branches: fur farming, meat processing, fruit, berries and vegetables processing, traveling trade and so on. Thus, for these companies the main part of the turnover obviously comes from another activity than fish processing.

The main branch 'other' dominates the total economic figures. Table 4 shows that the turnover of the subgroup 'other' is even more than half of the whole turnover of the population frame. Because there is no information about the proportion of the fish processing in these companies, it is impossible to estimate the proportion of the turnover, which comes from fish processing, even when it is known that a company has processed fish to some (but unknown) extent. Thus, for future statistics the economic total figures from these companies probably will not be reported.

Table 4. Total turnover (1000 €) of fish processing companies by main branch in 1999 and 2001.

Year	Main branch	N_1	Block 1	N_2	Block 2	Total
1999	Fish processing	35	7 162	107	106 640	113 802
	Fish wholesale trade	0	-	38	88 043	88 043
	Fish retail store	2	(combined to turnover of fish processing)	28	31 246	31 246
	Other	0	-	32	276 514	276 514
	All	**37**	**7 162**	**205**	**502 443**	**509 605**
2001	Fish processing	13	9 484	137	69 672	79 156
	Fish wholesale trade	3	3 789	42	182 891	186 680
	Fish retail store	5	4 716	23	11 563	16 279
	Other	0	-	11	353 087	353 087
	All	**21**	**17 989**	**213**	**617 213**	**635 202**

Table 5 displays selected statistics for turnover by main branch for the fish processing companies. In 1999, the branch of fish retail store has the highest coefficient of variation, about 0.59, and the branch 'other' about 0.56. In 2001 the branch 'other' has a large coefficient of variation, about 0.81. A large coefficient of variation indicates heterogeneity of a subgroup. If subpopulations were internally more homogeneous, the total amount of raw material would be more accurately estimated. Thus, more extensive auxiliary information about the operations of the companies would be useful for this purpose.

Table 5. Minimum, maximum, mean, standard error and coefficient of variation of turnover (1000 €) in fish processing companies by branch in 1999 and 2001 in Block 2.

1999						
Main branch	N_2	Min	Max	Mean	s.e.	cv
Fish processing	107	1	27 301	997	306	0.3068
Fish wholesale trade	38	14	15 878	2 317	583	0.2515
Fish retail store	28	10	18 523	1 116	655	0.5868
Other	32	9	139 787	8 641	4 811	0.5568
All	**205**	**1**	**139 787**	**2 043**	**650**	**0.3182**

2001						
Main branch	N_2	Min	Max	Mean	s.e.	cv
Fish processing	137	0	8 611	501	110	0.2201
Fish wholesale trade	42	9	50 079	4 355	1 374	0.3154
Fish retail store	23	16	3 452	503	155	0.3086
Other	11	38	287 854	32 099	26 067	0.8121
All	**213**	**0**	**287 854**	**2 525**	**1 204**	**0.4769**

4.3.2 Production costs of fish processing industry in 1999 and 2001

According to the minimum program the total of the production costs of fish processing industry should be reported by cost items. The costs items are labour, energy, raw material, packing and other running costs. Labour costs are available from data on financial statements by the Business Register. Table 6 displays the total labour costs by main branch in 1999 and 2001. Labour costs have been reduced about 18 percent from the year 1999 to the year 2001. At the same time interval, the full-time labour force in fish processing companies reduced about 19 percent (see table 11).

Table 6. Total of labour costs (1000 €) in fish processing companies by branch in 1999 and in 2001.

Year	Main branch	N_1	Block 1	N_2	Block 2	Total
1999	Fish processing	35	900	107	12 995	13 895
	Fish wholesale trade	0	-	38	5 982	5 982
	Fish retail store	2	(combined to labour costs of fish processing)	28	3 799	3 799
	Other	0	-	32	33 293	33 293
	All	**37**	**900**	**205**	**56 069**	**56 969**
2001	Fish processing	13	1532	137	10 380	11 912
	Fish wholesale trade	3	139	42	16 743	16 882
	Fish retail store	5	390	23	1 462	1 852
	Other	0	-	11	16 135	16 135
	All	**21**	**2 061**	**213**	**44 720**	**46 781**

Table 7 selected statistics for labour costs in the fish processing companies. In 1999 the highest labour costs were in the branch 'other'. The average labour costs in this branch were even 8.5 times higher than in the branch fish processing. In 2001 the highest labour costs were also in the branch 'other'. The coefficients of variation are high as they were in the case of turnover.

Table 7. Minimum, maximum, mean, standard error and coefficient of variation of labour costs (1000 €) in fish processing companies by branch in 1999 and 2001 in Block 2.

			1999			
Main branch	N_2	Min	Max	Mean	s.e.	cv
Fish processing	107	0	2 322	121	31	0.2518
Fish wholesale trade	38	0	691	157	29	0.1868
Fish retail store	28	0	2 313	136	82	0.6045
Other	32	3	13 306	1 040	513	0.4931
All	**205**	**0**	**13 306**	**231**	**69**	**0.3012**
			2001			
Main branch	N_2	Min	Max	Mean	s.e.	cv
Fish processing	137	1	1 423	75	16	0.2180
Fish wholesale trade	42	0	3 784	399	127	0.3194
Fish retail store	23	0	514	64	23	0.3618
Other	11	2	8 114	1 467	896	0.6110
All	**213**	**1**	**8 114**	**187**	**49**	**0.2598**

According to the minimum program energy and packing costs should be also reported. The study showed that this information can not be obtained directly from the financial statements statistics of the Business Register. Energy and packing costs are evaluated in the statistics on the structure and commodities of industry made by Statistics Finland. Unfortunately, this information was not available for this study.

The other running costs are gathered directly from the Business Register. Table 8 shows the totals of the other running costs by branch. The other running costs cover the company's other costs than raw materials and consumables, external services and staff expenses. Table 9 selected statistics for other running costs in the fish processing companies.

Table 8. Totals of other running costs (1000 €) in fish processing companies by branch in 1999 and in 2001.

Year	Main branch	N_1	Block 1	N_2	Block 2	Total
1999	Fish processing	35	883	107	14 111	14 994
	Fish wholesale trade	0	-	38	5 142	5 142
	Fish retail store	2	(combined to other running costs of fish processing)	28	3 462	3 462
	Other	0	-	32	61 192	61 192
	All	**37**	**833**	**205**	**83 907**	**84 740**
2001	Fish processing	13	555	137	10 032	10 587
	Fish wholesale trade	3	130	42	18 130	18 260
	Fish retail store	5	320	23	1 068	1 388
	Other	0	-	11	46 401	46 401
	All	**21**	**1 005**	**213**	**75 631**	**76 636**

Table 9. Minimum, maximum, mean, standard error and coefficient of variation of other running costs (1000 €) in fish processing companies by branch in 1999 and 2001 in Block 2.

			1999			
Main branch	N_2	Min	Max	Mean	s.e.	cv
Fish processing	107	0	3 078	132	40	0.3052
Fish wholesale trade	38	10	663	135	26	0.1958
Fish retail store	28	2	2 103	124	74	0.5974
Other	32	3	31 176	1 912	1 099	0.5746
All	**205**	**0**	**31 176**	**341**	**145**	**0.4240**

			2001			
Main branch	N_2	Min	Max	Mean	s.e.	cv
Fish processing	137	0	2 103	72	20	0.2792
Fish wholesale trade	42	0	8 774	432	213	0.4930
Fish retail store	23	0	206	46	11	0.2318
Other	11	16	30 557	4 218	2 941	0.6971
All	**213**	**0**	**30 557**	**311**	**141**	**0.4526**

4.3.3 Value of raw material in 2001

The value of the used raw material in 2001 was determined by using the estimated total of raw material by species and species-spesific prices. The price per kilogram by species was ascertained from the FGFRI's own sources of information, Producer price for fish -statistics. Then, the total value of used raw material was determined for the companies, which were in the sample in 2001, by multiplying the price per kilogram by the estimated amount of used fish. The total value of the used raw material was determined by the Horvitz-Thompson (HT) estimator.

Table 10 displays the HT estimators of the value of the used raw material by branch in 2001. The fish processing companies used approximately (70 769 ± 15 921) *1000 € for the raw material. On average, this is about 264 000 € for a single company. HT estimators were calculated for blocks 2 and 3, although the other economic data was defined for blocks 1 and 2. The value of the used raw material was impossible to

define for Block 1, because the survey is taken for Block 2 and 3 only. The value of the used raw material in Block 3 was 6 percent from the value of all the used material.

Table 10. HT estimates of the total value (1000 €) of the used raw material by branch in 2001.

Branch	N	n	$\hat{t}_{yd,HT}$	$s.e(\hat{t}_{yd,HT})$	$cv(\hat{t}_{yd,HT})$
Fish processing	165	53	32 594	6 603	0.2026
Fish wholesale trade	43	33	30 159	7 436	0.2466
Fish retail store	30	12	4 441	1 594	0.3590
Other	30	13	3 575	1 753	0.4902
All	**268**	**111**	**70 769**	**8 123**	**0,1209**

4.3.4 Employment in fish processing industry in 1999 and 2001

According to the minimum program the employment situation in the fish processing industry should be reported. The number of employees should be reported as full-time equivalents. Table 11 displays these figures by branch in 1999 and 2001. The totals were estimated in a similar way as for the total turnover and production costs.

The number of the employees was also investigated in a sample survey in 1999. In that case the estimated total number of full-time equivalent employees was 1432. The estimates in Table 11 include also employees outside the fish processing industry, because the proportion of fish processing in the companies, which have several lines of activities, is not known.

Table 11. The number of the full-time equivalent employees in fish processing companies by branch in 2001.

Year	Main branch	N_1	Block 1	N_2	Block 2	Total
1999	Fish processing	35	53.7	107	587.4	641.1
	Fish wholesale trade	0	-	38	254.6	254.6
	Fish retail store	2	(combined to number of the employees of fish processing)	28	177.4	177.4
	Other	0	-	32	1 047.5	1 047.5
	All	**37**	**53.7**	**205**	**2 066.9**	**2 120.6**
2001	Fish processing	13	77.4	137	468.6	546.0
	Fish wholesale trade	3	6.9	42	599.5	606.4
	Fish retail store	5	20.2	23	62.8	83.0
	Other	0	-	11	474.9	474.9
	All	**21**	**104.5**	**213**	**1 605.8**	**1 710.3**

According to these figures, there are less than two thousand workers in the fish processing companies in Finland. The employment has declined about 20 percent from 1999 to 2001. Table 12 shows that in 1999 there were 8.7 full-time equivalent employees on average in fish processing companies and about 6.8 in 2001. In 1999, there were 5.5 full-time equivalent employees on average in companies, whose main branch was fish processing. In 2001, this figure was 3.4.

Table 12. Minimum, maximum, mean, standard error and coefficient of variation of the number of full-time equivalent employees in fish processing companies by branch in 1999 and 2001 in Block 2.

		1999				
Main branch	N_2	Min	Max	Mean	s.e.	cv
Fish processing	107	0	74	5.5	1.1	0.2081
Fish wholesale trade	38	0	29	6.7	1.2	0.1765
Fish retail store	28	0.1	98	6.3	3.4	0.5429
Other	32	0.1	386	32.7	15.1	0.4617
All	**205**	**0**	**386**	**8.7**	**2.1**	**0.2415**

		2001				
Main branch	N_2	Min	Max	Mean	s.e.	cv
Fish processing	137	0	68	3.4	0.7	0.1992
Fish wholesale trade	42	0.1	137	14.3	4.4	0.3117
Fish retail store	23	0.1	16	2.7	0.7	0.2589
Other	11	0.3	227	43.2	25.6	0.5921
All	**213**	**0**	**227**	**6.8**	**1.5**	**0.2180**

Figure 5 shows that most of fish processing companies employ less than five full-time equivalent workers. Even 76 percent of companies in 1999 and 79 percent in 2001 had less than five full-time equivalent employees. Only four companies in 1999 and three companies in 2001 had more than a hundred full-time equivalent employees.

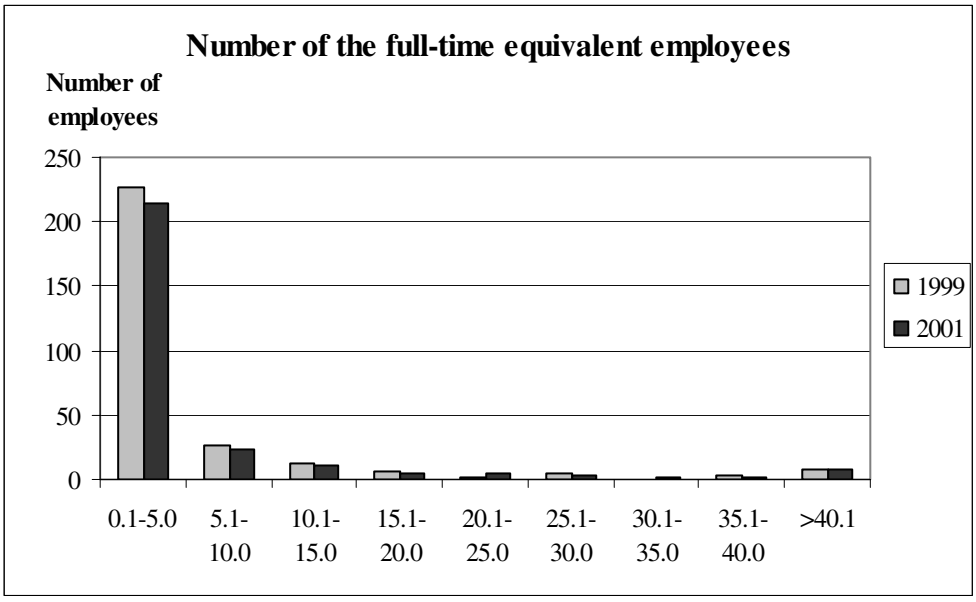

Figure 5. The number of full-time equivalent employees in fish processing companies in 1999 and 2001.

4.3.5 The estimated total of raw material by different estimators

According to the minimum program the member countries of the European Union should report economic information as well as the amount of the total used raw material and the raw material by species every year. The total amount of material used and the material by species are available from the survey data for every second year. But in the years when the sample survey is not carried out the amount of the raw material has to be estimated based on data from the previous year. In the study an option to use a synthetic estimator based on a linear regression model was investigated. The selected auxiliary variables, correlations and the estimated model parameters are displayed in the Appendix 3.

For 1999 and 2001, Horvitz-Thompson (HT), estimators, model-dependent synthetic estimators (SYN) and model-assisted generalized regression estimators (GREG) by main branch and by block were computed by using methods introduced in section 4.3.3. HT estimators were calculated for Blocks two and three, SYN estimators for Block one and two and GREG estimators for Block two. It was impossible to calculate HT estimators for Block 1, because the sample was drawn from the list of FGFRI and Block 1 companies were not included in that list. Furthermore, SYN and GREG -estimators were not estimated for Block 3, because the necessary auxiliary data was not available for the companies outside of the Business Register. In 2000, when the survey was not executed, a synthetic estimator was the only option, because there was no survey data for that year.

Table 13 displays HT estimates of total amount of raw material by block in 1999 and 2001. Table 14 displays the SYN and GREG estimates by block. The figures in Table 13 include also a contribution of companies that have processed fish in main branches fishery and fish culture. Thus, the figures in Table 13 are almost equal to those in Fish Production -statistics. However, the SYN and GREG estimates are larger than the reported figures. An explanation might be that in 2001, the figures for turnover used for PPS sampling were different to those used for the GREG and SYN estimators. The SYN and GREG estimates are reported both without and with the fisheries' and fish cultures contribution.

Table 13. HT estimates of the total amount of raw material (1000 kg) by block in 1999 and 2001.

	1999			2001		
	Block 1	Block 2	Block 3	Block 1	Block 2	Block 3
$\hat{t}_{yd,HT}$	-	37 274	4 726	-	40 316	3 269
$s.e(\hat{t}_{yd,HT})$	-	5 272	2 072	-	5 991	1 669
$cv(\hat{t}_{yd,HT})$	-	0,1415	0,4384	-	0,1486	0,5105

Table 14. SYN and GREG estimates of the total amount of raw material (1000 kg) by block in 1999 and 2001.

With fishery and fish culture	1999			2001		
	Block 1	Block 2	Block 3	Block 1	Block 2	Block 3
$\hat{t}_{yd,SYN}$	7 930	62 025	-	4 020	57 868	-
$s.e(\hat{t}_{yd,SYN})$	163	9 675	-	660	10 976	-
$cv(\hat{t}_{yd,SYN})$	0,0206	0,1560	-	0,1641	0,1897	-
$\hat{t}_{yd,GREG}$	-	54 281	-	-	53 452	-
$s.e(\hat{t}_{yd,GREG})$	-	5 224	-	-	4 857	-
$cv(\hat{t}_{yd,GREG})$	-	0,0962	-	-	0,0909	-
Without fishery and fish culture	1999			2001		
	Block 1	Block 2	Block 3	Block 1	Block 2	Block 3
$\hat{t}_{yd,SYN}$	7 930	59 308	-	4 020	56 007	-
$s.e(\hat{t}_{yd,SYN})$	163	8 542	-	660	10 043	-
$cv(\hat{t}_{yd,SYN})$	0,0206	0.1440	-	0,1641	0.1793	-
$\hat{t}_{yd,GREG}$	-	51 766	-	-	51 187	-
$s.e(\hat{t}_{yd,GREG})$	-	5 224	-	-	4 857	-
$cv(\hat{t}_{yd,GREG})$	-	0.1009	-	-	0.0949	-

For a comparison for the non-survey year 2000, the synthetic estimator of the total was computed based on estimates of regression coefficients from both the survey data in 1999 and the survey data in 2001. This means that the model parameter **b** was estimated both from the 1999's survey and from 2001's survey. Table 15 displays the synthetic estimators for Block 1 and 2 in 2000. Figures are reported both without and with the fisheries' and fish cultures contribution.

Table 15. SYN estimators of the total amount of raw material (1000 kg) by block in 2000.

Without fishery and fish culture	2000		2000	
	Block 1_{99}	Block 2_{99}	Block 1_{01}	Block 2_{01}
$\hat{t}_{yd,SYN}$	16 906	53 621	9 210	45 667
With fishery and fish culture	2000		2000	
	Block 1_{99}	Block 2_{99}	Block 1_{01}	Block 2_{01}
$\hat{t}_{yd,SYN}$	16 906	56 338	9 210	47 700

The results indicate that the standard synthetic estimator can produce much larger estimates than the HT estimator and the GREG estimator. There can be several reasons

for this property. Large estimates can be obtained if the estimator is very unstable. Other reasons are for example a badly fitting model, a large temporal variation in the composition of the frame registers which include the auxiliary variables, or different measurement of the auxiliary data between the years of interest. Further, different measurement of the auxiliary data in different parts of the combined frame register can cause difficulties. Basically, however, the auxiliary data used for this exercise should be useful because the correlations between the study variable and the auxiliary variables are at least modest. Selected correlations are displayed in Appendix 3. In 1999, the correlation between the amount of the raw material and the turnover was 0.43 in the fish processing branch. In 2001, this correlation was 0.48, but the correlation between operating margin and the amount of the raw material was higher, 0.62. Thus the operating margin was selected into the model as a covariate in this exercise. The covariates correlated more strongly in the other branches (see Appendix 2).

As an alternative, a simple synthetic estimator for 1999 could be computed by formula

$$\hat{t}_{yd,SYN} = \sum_{k=1}^{N_{1(r)}} \frac{N_1}{N_{1(r)}} y_{1k} + \sum_{k=1}^{N_{2(r)}} \frac{N_2}{N_{2(r)}} y_{2k} + \sum_{k=1}^{N_3} \hat{y}_{3k} = \sum_{k=1}^{N_{1(r)}} \frac{N_1}{N_{1(r)}} y_{1k} + \sum_{k=1}^{N_{2(r)}} \frac{N_2}{N_{2(r)}} y_{2k} + \sum_{k=1}^{n_{3(r)}} y_{3k} + \sum_{k=1}^{N_3 - n_{3(r)}} \hat{y}_{3k}$$

where $N_{h(r)}$ and $n_{h(r)}$ denote the number of responding population and sample units in stratum h and y_{hk} and $\hat{y}_{hk}$ are the observed and predicted value for unit k in stratum h, respectively. This estimator could be expected to be more stable than the standard SYN estimator. It would be useful to examine this simple method in more detail for future estimation purposes.

5. Conclusions

The target population of this study includes the fish processing companies in Finland. The population frame was compiled by combining two frames: the sampling frame maintained by the Finnish Game and Fisheries Research Institute and the Business Register of Statistics Finland. All the companies from the sampling frame of the FGFRI's Fish Production -statistics in 1999 and in 2001 did not include to the Business Register, because the Business Register covers companies who have operated without a break six months and whose yearly turnover is more than a defined limit. The study showed that in 1999 about 37 percent of the companies, which have processed fish, and 19 percent in 2001, did not meet this limit. Thus, the sampling frame of FGFRI contains more companies than there are fish processing companies in the Business Register. The study showed also that the Business Register included companies whose main branch was fish processing, fish wholesale trade or fish retail store and which were not in the register of FGFRI. These firms were also selected into the population frame. Thus, the population frame was divided into three mutually exclusive subgroups: 1) the companies outside of the list of FGFRI (Block 1), 2) the companies in the inter section of the list of FGFRI and the Business Register (Block 2) and 3) the companies outside of the Business Register (Block 3).

As a conclusion of a detailed inspection of the frames, it would be useful if the frame would be updated every year. This study showed that the group of fish processing companies is very dynamic; only 298 companies from the 1999's frame were included in the 2001's frame. New companies begin operations and some companies go out of business. Probably, a regular census study would be useful to update the frame. However, because of response burden a census study would not be feasible for every year, perhaps a 3-5 years interval would be suitable.

In the future it would be useful to compile the combined frame more carefully. It would be useful if Statistics Finland and the Finnish Game and Fisheries Research Institute would work closer together to build a frame as reliable as possible. Competence of the experts of the FGFRI and the knowledge about the processing work of companies would be necessary to ascertain that the frame would not include companies with "wrong kind of processing".

The second study task was to find out the available information sources. The Financial Statement -statistics maintained by Statistics Finland includes companies' balancing of the accounts figures. Thus, the data for economic monitoring of the fish processing companies is available from these statistics. However, these figures are for the companies in the Business Register only (Block 1 and 2). In addition, the survey data gathered by FGFRI are available for the companies in Block 2 and 3.

The FGFRI's frame contains companies that can have several branches of activity. The main branches of these companies are determined by the highest added value activity. Thus, in this study the proportion of the turnover that comes exactly from fish processing was impossible to define due to non-availability of information. The economic totals were defined by main branch: fish processing, fish wholesale trade, fish retail store and 'other'. The 'other' main branch included companies, which were processing fish in 1999 or 2001, in the following branches: fur farming, meat processing, berries and vegetables processing, travelling and so on. The study showed that 'other' main branch dominated the total economic figures although there were only few companies and the used raw material was of a minor amount in this branch. Thus, in the future the economic total figures from these companies probably will not be reported.

The third study task was to gather economic information from the fish processing companies. This study managed to find out a method to ascertain most of the required economic totals for these companies. Turnover, labour costs, other running costs,

fixed costs, financial position, investments and employment are possible to be gathered annually directly from the Financial Statement -statistics in Business Register of the Statistics Finland. These economic totals were determined by main branch for blocks 1 and 2. The turnover of the companies in Block 3 was under 0.5 percent of the total turnover of the whole industry and was ignored. Thus, it was decided that the economic data in the Business Register is accurate enough to describe the total economy of the fish processing industry. The totals of turnover, labour costs, other running costs and employment of the fish processing companies are reported in this study. However, the total packing and energy costs of the fish processing companies are not reported in this study because of lack of information. Energy and packing costs are evaluated in the statistics on the structure and commodities of industry made by Statistics Finland. Unfortunately, this information was not available for this study. In this study it was not possible to estimate the prices per products. Further research could also explore the sources of this information.

The financial statements are based on data collected by Statistics Finland. Data are based on corporate balance sheets and profit and loss account data. Statistics Finland checks the validity of these data. In this study, the reported figures might include the contribution of the companies, which are processing Baltic herring for the feed and thus, do not belong to the target population. According to the regulation the purpose was to declare economic information from the companies, which are processing fish for food. Because of legislation Statistics Finland could not give access to economic information relating to a specific company. Therefore, companies' business identity code was not available during this study and due to this, it was not possible to determine exactly the group of eligible companies.

The total value of the used raw material was estimated by the Horvitz-Thompson estimator. The price per kilogram by the species was ascertained from Producer price for fish -statistics. The value of used raw material was determined for the companies, which were in the sample in 2001, by multiplying the price per kilogram by the estimated amount of used fish. The total price of the used raw material was calculated by main branch in the Blocks 2 and 3. Standard errors and coefficients of variation were also calculated for the estimated totals.

The final study task was to examine an estimating method for the total amount of raw material in the years when the sample survey is not carried out. In 1999 and in 2001 the amount of the used raw material (1000 kg) was defined by three ways: 1) by Horvitz-Thompson -estimator (HT), 2) by synthetic estimator (SYN) and 3) by generalized regression estimator (GREG). The estimators, standard errors and the coefficients of variation were calculated by main branch. HT-estimators were possible to be calculated for Blocks 2 and 3, SYN-estimators for Blocks 1 and 2 and GREG-estimators for Block 2. In 2000, when the survey was not executed, synthetic estimators by main branch were calculated. The standard model-dependent SYN-estimators were somewhat unstable probably because of badly fitting model and a large temporal variation in the composition of the frame registers. The different measurement of the auxiliary data in different parts of the combined frame register can also cause difficulties. In this study figures for turnover used for PPS sampling were different to those for the GREG and SYN estimators. The extra difficulty for estimation for the year 2000 using a synthetic estimator was the changes in the structures of populations between years, as reflected in the structure of the yearly frame populations. An alternative synthetic estimator was proposed for future evaluation.

Future research in the estimation of amount of the used raw material would be useful. This study showed that an overall linear model $y_k=\mathbf{z}_k'\mathbf{b}+\varepsilon_k$, where $\mathbf{z}$ is one of the economic variables, might not be sensitive enough for reliable estimation. For example, the coefficients of variation of turnover by main branch are more than 25 percent. Thus, these subgroups are not internally homogeneous and the division of companies by main branch is not probable accurate enough for the use of the economic information from these subgroups in the estimation of the amount of raw material. As an

alternative, the model could be fitted for other types of subgroups of the population, where the operations of the companies are more similar, for example fish smoking, ready-to-eat food making or deep frozen. In that case the material, supply and the operation place needed would be the same, and the economic auxiliary variable in the model would be stronger. More auxiliary information is needed to construct these subgroups. However, this study showed that fish processing companies are very dynamic; new companies begin operations and some companies go out of business. The operation of a company can also change from year to another. Thus, the division of fish processing companies into sub-populations according to the operations of the companies can be difficult. In addition, alternative estimators could be examined.

Another future research could consider the possibility to estimate the total amount of the used raw material by using declarations of the sales of the allocation fishing. A fishmonger has a duty to give a declaration of the sale of the allocation fishing. These fishes are salmon, cod, sprat and Baltic herring. Future research could also explore the connection between the amount of catch of fish and the processed fish. Because the Fish Processing -statistics have published every second year since 1993, it would also be possible to study the possible trends in the total amount of raw material.

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Appendix 1. The variables of Financial Statement - statistics in the Business Register of Statistics Finland

Net turnover

Other operating income

Total operating income

Raw materials and consumables

External services

Staff expenses

Operating profit

Variation in stocks of finished goods and work in progress

Operating profit

Depreciations according to plan

Reduction in value of goods held as non-current assets

Reduction in value of current assets

Business result

Financial income

Financial expenses

Income taxes

Other direct taxes

Net profit

Extraordinary income

Extraordinary expenses

Proceeds from sales of fixed assets

Total profit

Change in depreciation reserve

Change in untaxed reserve

Result for the financial year

Income before extraordinary items

Group contributions received

Group contributions paid

Intangible assets

Tangible assets

Investments

Stocks

Non-current debtors

Current debtors

Investments held as current assets

Cash in hand and at banks

Total assets

Capital and reserves

Appropriations

Provisions

Non-current creditors

Current creditors

Total liabilities

Creditors

Liabilities subject to interest

Dividend distribution agreed / proposed

Increases in intangible assets

Decreases in intangible assets

Increases in tangible assets

Decreases in tangible assets

Increases in fixed asset shares

Decreases in fixed asset shares

Returns on business operations, total

Value added

Staff total

Tangible net investments

Appendix 2. Correlations between the used raw material and the economic data

Correlations in 1999:

	Total kg	Materials and supplies	Other expenses	Added value	Turnover	Operating margin
Total kg	1.00000	-0.28312 0.0017	-0.05091 0.5792	0.21639 0.0171	0.23171 0.0105	0.32476 0.0003
Materials and supplies	-0.28312 0.0017	1.00000	0.43841 <.0001	-0.93774 <.0001	-0.97001 <.0001	-0.90427 <.0001
Other expenses	-0.05091 0.5792	0.43841 <.0001	1.00000	-0.67294 <.0001	-0.64198 <.0001	-0.39819 <.0001
Added value	0.21639 0.0171	-0.93774 <.0001	-0.67294 <.0001	1.00000	0.98563 <.0001	0.92139 <.0001
Turnover	0.23171 0.0105	-0.97001 <.0001	-0.64198 <.0001	0.98563 <.0001	1.00000	0.88938 <.0001
Operating margin	0.32476 0.0003	-0.90427 <.0001	-0.39819 <.0001	0.92139 <.0001	0.88938 <.0001	1.00000
Employees	0.23408 0.0098	-0.86241 <.0001	-0.79963 <.0001	0.95986 <.0001	0.95200 <.0001	0.78771 <.0001
Income	0.23177 0.0105	-0.85543 <.0001	-0.25599 <.0001	0.84138 <.0001	0.81041 <.0001	0.97863 <.0001
Profit/ loss	0.06650 0.8711	-0.83250 <.0001	-0.49506 <.0001	0.90867 <.0001	0.85635 <.0001	0.97606 <.0001
Net income	0.01491 0.8711	-0.79177 <.0001	-0.66708 <.0001	0.92513 <.0001	0.86668 <.0001	0.91958 <.0001
Returns of financial year	0.01083 0.9061	-0.82295 <.0001	-0.60797 <.0001	0.93119 <.0001	0.87746 <.0001	0.94639 <.0001

Correlations in 1999 by branch in the Block 2:

Fish processing

	Total kg	Materials and supplies	Other expen-ses	Added value	Turn-over	Opera-ting margin	Emp-loyees	Profit/ loss	Net income
Total kg	1.000	-0.4182 0.0015	-0.4067 0.0021	0.4234 0.0013	0.4262 0.0012	0.2901 0.0317	0.4486 0.0006	0.1155 0.4013	-0.0301 0.8272

Fish wholesale trade

	Total kg	Materials and supplies	Other expen-ses	Added value	Turn-over	Opera-ting margin	Emp-loyees	Profit/ loss	Net income
Total kg	1.000	-0.5549 0.0060	-0.6910 0.0003	0.7855 <.0001	0.5811 0.0036	0.8011 <.0001	0.7041 0.0002	0.6304 0.0013	0.5655 0.0049

Fish retail store

	Total kg	Materials and supplies	Other expen-ses	Added value	Turn-over	Opera-ting margin	Emp-loyees	Profit/ loss	Net income
Total kg	1.000	-0.8465 <.0001	-0.8558 <.0001	0.8506 <.0001	0.8483 <.0001	0.8252 <.0001	0.8513 <.0001	0.7455 0.0006	0.7505 0.0005

'other'

	Total kg	Materials and supplies	Other expen-ses	Added value	Turn-over	Opera-ting margin	Emp-loyees	Profit/ loss	Net income
Total kg	1.000	-0.1886 0.5786	-0.0553 0.8716	0.1944 0.5669	0.1683 0.6209	0.44913 0.1658	0.2662 0.4288	0.1490 0.6620	0.0934 0.7847

Correlations in 2001:

	Total 1000 kg	Total value	Materials and supplies	Other expenses	Added value	Turnover
Total 1000 kg	1.00000	0.59254 <.0001	-0.10306 0.2908	-0.13310 0.1717	0.39635 <.0001	0.11894 0.2224
Total value	0.59254 <.0001	1.00000	-0.24645 0.0105	-0.28674 0.0027	0.62167 <.0001	0.26722 0.0054
Materials and supplies	-0.28312 0.0017	-0.24645 0.0105	1.00000	0.98792 <.0001	-0.8367 <.0001	-0.99950 <.0001
Other expenses	-0.13310 0.1717	-0.28674 0.0027	0.98792 <.0001	1.00000	-0.87693 <.0001	-099135 <.0001
Added value	0.39635 <.0001	0.62167 <.0001	-0.8367 <.0001	-0.87693 <.0001	1.00000	0.85459 <.0001
Turnover	0.11894 0.2224	0.26722 0.0054	-0.99950 <.0001	-099135 <.0001	0.85459 <.0001	1.00000
Operating margin	0.58544 <.0001	0.79691 <.0001	-0.47508 <.0001	-0.53873 <.0001	0.81477 <.0001	0.49802 <.0001
Employees	0.38478 <.0001	0.62687 <.0001	-0.77785 <.0001	-0.81328 <.0001	0.97571 <.0001	0.79458 <.0001
Income	0.55693 <.0001	0.77955 <.0001	-0.11902 0.2221	-0.18547 0.0558	0.54677 <.0001	0.14320 0.1412
Profit/ loss	0.50487 <.0001	0.73217 <.0001	-0.04994 0.6095	-0.11479 0.2391	0.46206 <.0001	0.07267 0.4570
Net income	0.42472 <.0001	0.59707 <.0001	-0.47888 <.0001	-0.47620 <.0001	0.66075 <.0001	0.49026 <.0001
Returns of financial year	0.37156 <.0001	0.53449 <.0001	-0.60323 <.0001	-0.58585 <.0001	0.69765 <.0001	0.61078 <.0001

Correlations in 2001 by branch in the Block 2:

Fish processing

	Total 1000 kg	Materials and supplies	Other expen-ses	Added value	Turn-over	Opera-ting margin	Emp-loyees	Profit/ loss	Net income
Total kg	1.000	-0.4274 0.0020	-0.3576 0.0108	0.6065 <.0001	0.4796 0.0004	0.6180 <.0001	0.5332 <.0001	0.5502 <.0001	0.5206 0.0001
Total value	0.4830 0.0004	-0.7810 <.0001	-0.6986 <.0001	0.7683 <.0001	0.7808 <.0001	0.78455 <.0001	0.7144 <.0001	0.8449 <.0001	0.6513 <.0001

Fish wholesale trade

	Total 1000 kg	Materials and supplies	Other expen-ses	Added value	Turn-over	Opera-ting margin	Emp-loyees	Profit/ loss	Net income
Total kg	1.000	-0.7384 <.0001	-0.5811 0.0004	0.7915 <.0001	0.7389 <.0001	0.7940 <.0001	0.7087 <.0001	0.6814 <.0001	0.5682 0.0006
Total value	0.8610 <.0001	-0.8357 <.0001	-0.6272 <.0001	0.8493 <.0001	0.8291 <.0001	0.8356 <.0001	0.8023 <.0001	0.7528 <.0001	0.6445 <.0001

Fish retail store

	Total 1000 kg	Materials and supplies	Other expen-ses	Added value	Turn-over	Opera-ting margin	Emp-loyees	Profit/ loss	Net income
Total kg	1.000	0.03867 0.9213	-0.0236 0.9519	-0.0776 0.8427	-0.034 0.9303	0.1831 0.6373	-0.1334 0.7322	0.3483 0.3584	0.3156 0.4080
Total value	0.3725 0.3236	-0,3634 0.3364	-0.4845 0.1863	0.2629 0.4942	0.3500 0.3558	0.5668 0.1116	0.0741 0.8497	0.84078 0.0045	0.8420 0.0044

'other'

	Total kg	Materials and supplies	Other expen-ses	Added value	Turn-over	Opera-ting margin	Emp-loyees	Profit/ loss	Net income
Total kg	1.000	-0.9890 0.0014	-0.9891 0.0014	0.9896 0.0013	0.9890 0.0014	0.9926 0.0008	0.9890 0.0014	-0.9452 0.0153	0.9941 0.0005
Total value	0.9908 0.0011	-0.9978 0.0001	-0.9980 0.0001	0.9987 <.0001	0.9978 0.0001	0.9992 <.0001	0.9987 <.0001	-0.9787 0.0037	0.9991 <.0001

Appendix 3. The auxiliary variables, correlations and the estimated model parameters

Table 1. The auxiliary variables, correlations and the estimated model parameters by main branch in the Block 2 in 1999.

Main branch	*n*	Auxiliary variable	Correlation between the study variable and auxiliary variable	$\hat{b}_0$	$\hat{b}_1$
Fish processing	55	turnover	0.42618	261180.446 0.0072	75.050 <.0001
Wholesale trade of fish	23	Operating profit	0.80112	31892.5613 0.3218	1706.064 <.0001
Retail store of fish	17	Other operating charges	-0.85579	100695.434 0.0678	-625.735 <.0001
Other	11	Operating profit	0.44913	80968.2499 0,0524	590.1994 <,0001

Table 2. The auxiliary variables, correlations and the estimated model parameters by main branch in the Block 2 in 2001.

Main branch	*n*	Auxiliary variable	Correlation between the study variable and auxiliary variable	$\hat{b}_0$	$\hat{b}_1$
Fish processing	50	Operating profit	0.61800	94.7901 0.1516	2.5312 0.0343
Wholesale trade of fish	33	Operating profit	0.79399	84.4508 0.1222	1.5338 <.0001
Retail store of fish	9	-	-	- -	- -
Wholesale trade of fish and retail store of fish	42	Operating profit	-	138.0039 0.0688	1.4879 <.0001
Other	5	Operating profit	0,99256	16.0087 0.4411	0.4956 <.0001