

Monthly Labour Survey Misconduct since at Least the 1990s

Falsified Statistics in Japan

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Abstract

The Monthly Labour Survey, which is one of the major economic statistics published by the Government of Japan, has been under criticism since January 2019 due to its negligent survey conduct and misinformation regarding its results. This paper approaches this scandal from a viewpoint of how the indicators of the quality of the survey were falsified and misreported. Based on published information regarding sample size and sampling errors, the author outlines three problems. (1) Since at least the 1990s, the survey's sample size has been reported as larger than it actually was. (2) Since 2002, a significant portion of the sample has been secretly discarded. (3) Since 2004, the sampling error has been underreported by ignoring errors occurring in the strata of large establishments. These problems have escaped public attention as the government and academics are not critical of the falsification of basic information that determines the quality of the survey.

Keywords: labor statistics, sample size, sampling error, economic indicator, wage survey

1. Introduction

Since January 2019, the scandal regarding the “Monthly Labour Survey” (毎月勤労統計調査)* conducted by the Ministry of Health, Labour, and Welfare (MHLW) of Japan has been widely reported. Public attention has been centered on underestimation of average wages due to negligent statistical processing of data from large-scale business establishments in Tokyo as a result of their sampling scheme that deviated from the official regulation.

There is another aspect to this scandal that is rarely covered by the media. The MHLW has disguised the quality of the survey through misinformation about sample size and sampling error. Focusing on this aspect, this paper explains how the survey has deviated from official regulations, how the deviation has been concealed through falsification of published information, and when these misconducts began.

2. Sample Size Reduction since at Least the 1990s

2.1. Reduced sample and falsified figures

The most obvious problem is the fraudulent reduction of sample size and the untrue reporting of it. Based on the document [1] released by the MHLW on January 17, 2019, Table 1 shows the number of establishments surveyed by the Monthly Labour Survey since

* The Monthly Labour Survey consists of three parts: the National Survey (全国調査) the Prefectural Survey (地方調査), and the Special Survey (特別調査). This paper discusses only the National Survey, because it is the focus of the scandal.

2004. Despite the fact the real samples consisted of between 28,271 to 30,297 business establishments, the MHLW has constantly published larger figures. The official annual report of *The Annual Report on the Monthly Labour Survey* (毎月勤労統計要覧) (hereinafter *Annual Report*), has stated in every edition that the survey covered around 16,700 establishments with 30 or more regular employees and around 16,500 establishments with 5 to 29 regular employees, so that the total sample included roughly 33,200 establishments.

Table 1: Number of establishments surveyed by the Monthly Labour Survey and their published figures (2004–2018)

Survey year	Number of establishments actually surveyed (a)	Published figure (b)	Inflation rate (b/a)
2004	28,271	circa 33,200	1.17
2007	28,384	circa 33,200	1.17
2009	28,502	circa 33,200	1.16
2012	28,454	circa 33,200	1.17
2015	29,109	circa 33,200	1.14
2018	30,297	circa 33,200	1.10

Source: The Ministry of Health, Labour, and Welfare’s document dated January 17, 2019 [1: p. 4].

The *Annual Report* has therefore published inaccurate sample sizes. For example, whereas the MHLW surveyed only 28,271 establishments in 2004, it reported an inflated number of 33,200 establishments. It is a form of “falsification” to publish inauthentic information with manipulated figures.

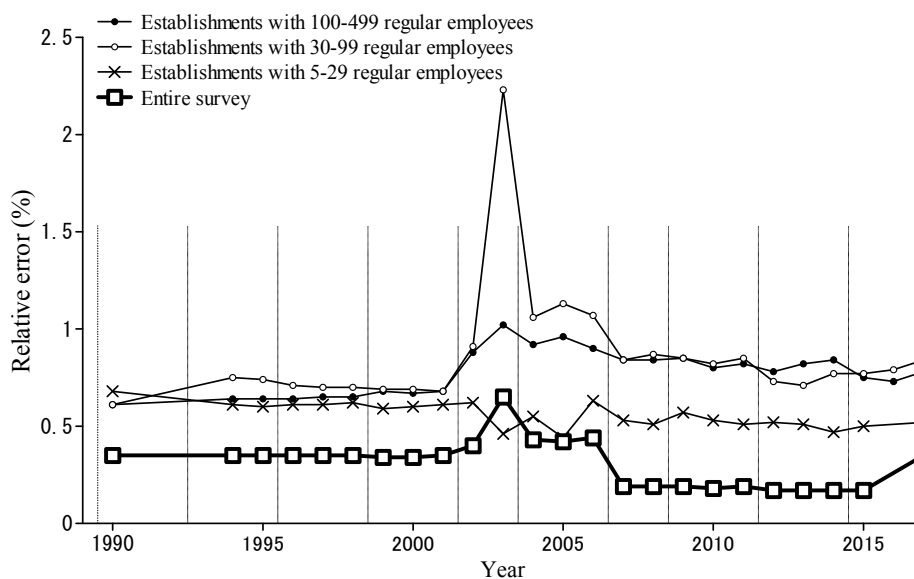
2.2. When did it begin?

The exact numbers regarding how many business establishments were actually surveyed are known only for 2004 and for some years after that, as shown in Table 1. Prior to 2003, the MHLW [2: p. 2] has only confirmed that the number of establishments actually surveyed was approximately 10% less than that shown in public documents since 1996. This simply means that it is not known how many establishments were surveyed before 1996. There has been no further information about the date when the falsification began.

Nevertheless, we have a clue regarding surveys conducted before 1996. The *Annual Report* contains a section about survey sampling errors. This section contains a table of “relative error,” an indicator of the size of error due to random sampling (see Appendix A.1 for its definition). It provides an estimation of the sampling error level for the average wage estimated based on survey results. This statistic has a mathematical relationship to the sample size, such that the relative error becomes $\sqrt{2}$ times when the sample size is halved. Suppose that the Monthly Labour Survey in the past had authentically surveyed 33,200 establishments, as was stated in the *Annual Report*. If the number started to decrease to around 28,300 from a certain period, the relative error should have risen by 1.08 times during that period. If so, it may be possible for us to specify the period of time by tracking the record of the values of relative errors.

However, there is no clear indication of the reduction of sample size, even tracking back the data in the 1990s. Figure 1 is a graph plotting the published values of relative errors from 1990 to 2017. It shows no conspicuous changes in relative errors around 1996. Before that, between 1990 and 1994, there was an increase in relative error for establishments with 30–99 regular employees. The sample size for this category of establishments may have decreased during that period. However, at the same time, the relative error went down for establishments with 5–29 regular employees. Surmising from the fact that this category showed a slightly larger relative error than the other categories in 1990, there is a possibility that the MHLW apportioned the sample predominantly to this category. Notwithstanding, the relative error of the entire survey was nearly constant between 1990 and 2001 at around 0.35%. It therefore seems likely that there was little change in the sample size for the entire survey during the 1990s.

Based on the aforementioned information, we can infer that the falsification of data on the number of establishments surveyed had already occurred by the first half of the 1990s. It may have started back in the 1980s or even earlier. Unfortunately, before 1989, the *Annual Report* arranged its contents in a different way from that used today and did not disclose the entire survey’s relative error. Furthermore, there are many years for which no information on sampling errors is available. For these reasons, the task of examining data before the 1980s is a problem to be tackled in the future.



Relative errors for “contractual cash earnings.” Source is the *Annual Report on the Monthly Labour Survey* except for the 2017’s value, which comes from a document of the MHLW [1: p. 4] in January 17, 2019. The 2008 edition of the *Annual Report on the Monthly Labour Survey* offers the table captioned as July 2008 [3: p. 289]. This data is judged to have been from 2007, with the year being recorded incorrectly. The values are incomparable between the period up to 2006 and the period since 2007 (see Appendix). Only in 1990 is the value for March. For all other years, the value is for July. Values from 1991 to 1993 are not recorded in the *Annual Report on the Monthly Labour Survey*. For 2016, the results for establishments with 5–29 regular employees are listed separately by rotation group, and the relative error of the entire survey is unknown [4: p. 294]. The vertical dotted lines indicate the replacement period of the establishments with 30–499 regular employees.

Figure 1: Changes in the relative error in the Monthly Labour Survey (1990–2017)

3. Sampling Rate Falsification since 2002

3.1. Sharp increase of sampling errors during 2002–2003

The relative error appeared to significantly change in 2002 and the following year. After stability up to 2001, throughout which the relative error was around 0.35% for the entire survey, the statistic sharply increased to 0.40% in 2002 and 0.65% in 2003. This resulted in the error increasing by 1.86 times in two years. The sharp increase in relative error suggests that there was some change in the survey method that brought about corresponding growth in the sampling error. However, there has been no explanation for this.

A clue for solving the mystery was found in the January 22 Special Inspection Committee Report [5: p. 15] from the MHLW. In the report, the Committee revealed that, until 2003, the Monthly Labour Survey had reduced the sample size for establishments with 30–499 regular employees. This sample reduction was done, as the Committee reported, after the official sampling procedure had decided the list of target establishments to survey. The MHLW inserted an illegal process to remove a half of the sample from some regions and industries with a large number of survey targets. The sampling rate was essentially halved in such cases.

The regulation for the Monthly Labour Survey entails selecting the survey targets randomly with the sampling rate determined for each stratum defined by the size of establishments and their industry classification. This sampling process is performed with a systematic sampling technique using an exhaustive register of establishments with 30–499 regular employees across Japan [1: p. 1]. The official sampling rates used in this procedure are published in the *Annual Report* every year.

Despite this regulation, some of the sampled establishments were discarded and were not actually surveyed. For example, imagine that the official sampling rate for a stratum was set to 1/100. From this stratum, business establishments should be randomly selected at this rate to include a certain number of them on the list of survey targets. If half of the selected establishments were not surveyed in the actual survey process, the real sampling rate was thereby reduced to 1/200. Notwithstanding, this reduction was not disclosed so that official documents and reports would report it as 1/100. The surveyors therefore pretended to have surveyed twice as many establishments as they actually did. That is, the reported sampling rate was falsified.

When such illegal methods started to be adopted has not been reported. Nevertheless, it can be inferred that this began in 2002, based on the fact that the relative error was stable until 2001, as we have already seen in Figure 1.

3.2. How many survey targets were illegally discarded?

Given that the relative errors have increased since 2002, another mystery arises here. The error increases too significantly if the sampling rates of some regions and industries are only reduced by half. The relative error is inversely proportional to the square root of the number of survey subjects. Therefore, even if the number of survey subjects decreased to

half, the increase in relative error should be by approximately 1.41 times. In reality, however, an even greater increase occurred in the relative error during the period. Between 2001 and 2003, the relative error increased by 1.86 times, from 0.35% to 0.65%. This rapid increase creates a question whether more than half of the samples were discarded in 2003.

We can answer this question based on the reported figures for the sampling rates and relative errors. The method, data, and results are shown in the Appendix.

Among the results, we first focus on the strata of establishments with 30–99 regular employees (see Appendix A.4.2). For these strata, the result suggests that roughly 90% were not actually surveyed among the establishments that were originally selected as the survey target. This percentage of discarded samples varies from industry to industry. The worst are industries such as “apparel” and “wholesale and retail trade, eating and drinking places.” In these industries, less than 5% were actually surveyed, as estimated in Table A.2. According to the Establishment Census of the time [6], there were more than 60,000 establishments nationwide classified as “wholesale and retail trade, eating and drinking places” with 30–99 regular employees. Along with the sampling rate of 1/128 described in the *Annual Report* for these businesses, the survey should therefore have targeted around 500 of them. However, the relative error figures suggest that only around 20 were actually surveyed in 2003.

For business establishments with 100–499 regular employees, the result is not quite as bad (see Appendix A.4.1). Regarding the total of the all strata of this category of establishments, the real sampling rate is estimated as around half that reported. Nevertheless, the result suggests that a greater proportion of the sample was discarded for some industries. In such industries as “apparel,” “wholesale and retail trade, eating and drinking places,” and “transport and communications,” the result suggests that at least 75% of the sample was discarded. The sampling rates officially reported for these industries seem to have been inflated by 4–5 times.

3.3. Further questions about the illegal sample discarding

The above estimation was for the 2003 survey as the relative error was particularly large in that year. However, the relative error was already quite large in 2002. It is likely that the real sampling rate had already been reduced in 2002. It is also likely that a further sample reduction was made for the 2003 survey.

This implies that there was a violation of the rule regarding the duration for which the same targets should continue to be surveyed, if the sample was altered between 2002 and 2003. In this period, target alteration was not officially recognized. For establishments employing 30–499 regular employees, the Monthly Labour Survey regulations required the sample to be replaced at regular intervals [3: p. 280]. The time periods for the sample replacements are marked with vertical dotted lines in Figure 1. Once a business establishment is covered, monthly surveys must continue until the next replacement. In the beginning of the 21st century, which is the time period our study focuses on, a new sample was covered in 2002, which replaced the previous ones. The next replacement was

scheduled in 2004. Nevertheless, as the trend in relative error indicates, the sample was likely to have been altered between 2002 and 2003.

This also creates doubt regarding the randomness of the sample selection process, because there would be an opportunity to remove some of the survey subjects after seeing the 2002 results. The surveyor would therefore have been able to reselect the target establishments of their choice.

Another question is how long the illegal sample reduction continued. The Special Inspection Committee Report [5: p. 15], as mentioned above, suggested that this only continued until 2003. However, this explanation does not match the trend of relative errors. Figure 1 reveals that, from 2004 onwards, the relative error of establishments with 30–499 regular employees was at the same level as in 2002. Contrary to the Special Inspection Committee’s account, it should be assumed that the sample thinning continued after 2004.

Furthermore, it is reasonable to assume that the current Monthly Labour Survey still includes the reduction of the sample of establishments with 30–499 regular employees. Looking at data from 2004 to 2017 in Figure 1, the relative error for establishments in this category remains at a high level, far exceeding that for establishments with 5–29 regular employees. It is therefore suggested that the sample size for establishments with 30–499 regular employees has not yet recovered to its pre-2001 level.[†]

4. Relative Error Falsification since 2004

Among the series of frauds involving the Monthly Labour Survey, the first misconduct that came to light at the end of 2018 was the problem of fraudulent sampling of business establishments with 500 or more regular employees in Tokyo Prefecture [7]. A sampling rate of 1 was officially applied to establishments with at least 500 regular employees. That is, all of them should be used as survey subjects. However, this was actually not the case and a considerable number of these establishments were not surveyed. It has been said that this fraudulent sampling began in the 2004 survey [1] [2] [5] [7]. The Monthly Labour Survey thus began to report false sampling rates for this category of establishments.

In addition, the reported relative error figures have also been falsified since then. In the relative error table of the *Annual Report*, there is no column for establishments with 500 or more regular employees. Instead, at the bottom of the table, there is an annotation that reads, establishments with 500 or more regular employees were under a complete survey. This implies that the relative error is zero for all strata of that category of establishments and that this is the reason errors for these are not reported.

Certainly, if all establishments are surveyed, the sampling error should be zero.[‡] However, since 2004, the survey has not been any more complete, so sampling errors must

[†] Here we should note the 2007 change in the method for calculating the relative error. Comparison of relative errors is thereby difficult to draw across the periods before and after the change (see Section 4 and Appendix).

[‡] See Equation (2) in Appendix A.1 to confirm $c_i = 0$ if $N_i = n_i$.

have occurred. Therefore, the relative error for establishments with 500 or more regular employees had to be reported in the table.

Falsification has also occurred for the value published as the relative error of the entire survey. This was another derivation from the assumption that strata of establishments with 500 or more regular employees yielded no sampling error. The reported figure was totaled based on this wrong assumption and naturally failed to provide a correct estimation. The value for the totaled error was smaller than the actual value.

Furthermore, the published figure of the relative error for the entire survey may have been further reduced in 2007 because of a change in the method of estimation. With this change, the process of summing the errors put a greater weight on strata with higher average wages (see footnote in Appendix A.1). It is well known that large establishments tend to pay high wages. The change in the calculation method may therefore result in the greater impact of the assumption of zero error for establishments with 500 or more regular employees. It can be hypothesized that the reported relative error for the entire survey became more inconsistent with the actual value.

This hypothesis is supported by the trend in relative errors in Figure 1. The data show a sudden decline in 2007. We can interpret this decline as reflecting the fact that the aforementioned methodological change applied from that year [3: p. 288].

The hypothesis is also supported by the sudden rise in the relative error for the entire 2017 survey (Figure 1), as reported in the document by the MHLW dated January 17, 2019 [1: p. 4]. This document was published in response to the suspicion arising from the scandal regarding the survey. The MHLW announced that the document contained re-calculated figures to reflect the actual sampling scheme accurately. According to the document, the relative error was 0.35% for the entire 2017 survey. This figure is roughly double that for the 2007–2015 surveys (around 0.18%) as published in the past *Annual Report*. That is, the published data on the relative error may have been falsified until 2015 to represent only half of the real sampling errors. This may be a result of the false assumption of zero error for establishments with 500 or more regular employees.

5. Japanese Authority Indulges in Data Falsification

Based on the above discussion, the following three issues can be identified regarding the Monthly Labour Survey scandal.

- Since at least the 1990s, the reported number of survey subjects has been greater than the actual number.
- Since 2002, reported sampling rates have also been higher than actual rates.
- Since 2004, the relative error has been reported to be lower than its actual value, falsely assuming that there was no sampling error among business establishments with 500 or more regular employees.

These exemplify how the survey has purported to be of higher quality than it actually was. For more than a quarter of a century, it has used falsified figures to give the impression of a survey with high reliability.

After the problem was discovered, the Special Inspection Committee of the MHLW, involving academics from a variety of fields, conducted an investigation to confirm the facts and responsibility for them. The result, reported on January 22, 2019, included an unacceptable opinion. On page 27 of the report [5], the Inspection Committee concluded that the above-mentioned issues were not cases of falsification, while accepting them as fundamentally true. That is, they concluded that it is not falsification to manipulate the number of surveyed subjects into a larger one or to manipulate the estimated value of sampling error into a smaller one. It was absolutely shocking that a committee including academic members would suggest to the government that this kind of conduct does not constitute falsification.

Data such as the number of surveyed subjects and estimated sampling errors are fundamental to determining a survey's quality. If the idea that it does not matter whether such data are falsified has permeated the government and the academic world, it could be argued that this scandal was destined to happen. We also suspect that this symptom is not restricted to the Monthly Labour Survey. Rather, it may be the case that a lot of government statistics and scientific research is distorted due to falsification.

Appendix

A.1. Relative sampling errors published in the *Annual Report*

The *Annual Report on the Monthly Labour Survey* has included a table of relative errors for July every year since 1994. Until 2006, the table included “標本誤差率” (relative sampling error) figures.

From the 2007 survey data, the *Annual Report* [3: p. 288] altered the index to evaluate sampling errors. The new index, referred to as “標準誤差率”,[§] has been used up to now. This new index is not compatible with the old one used until 2006. This alteration may also be a source of the underestimation of the sampling error due to the misreported sampling scheme of large establishments, as discussed in Section 4.

Here, we focus on the old index. It is calculated for each stratum broken down by the size of the establishment (5–29, 30–99, or 100–499 regular employees) and the industry to which it belongs (based on the Japan Standard Industrial Classification: JSIC). For strata of establishments with 5–29 regular employees, the method of calculation is more complex, reflecting their complex sampling method. We focus on the relatively simple version of the index applied to the strata of establishments with 30–499 regular employees because the illegal discarding of samples was reported as occurred in these strata [5].

[§] The Japanese term for the new index, “標準誤差率,” is usually translated as “relative standard error.” However, the English section of the *Annual Report* has continued to use the same translation as the old index, “relative sampling error” [4: p. 311].

According to the *Annual Report* [8: pp. 271–272], the relative sampling error (for strata of establishments with 30–99 or 100–499 regular employees) is defined as follows. Here, x denotes the total “contractual cash earnings” that an establishment paid for all of its employees. y denotes the number of regular employees in the establishment. These variables are determined with data from each establishment surveyed.

For a stratum i , defined by industry and the number of regular employees, let X_i and Y_i denote the coefficients of variation for x and y , respectively. Let ρ_i denote the correlation coefficient of x with y . The coefficient of variation for contractual cash earnings, φ_i , is determined by the following equation.

$$\varphi_i^2 = X_i^2 + Y_i^2 - 2\rho_i X_i Y_i \quad (1)$$

The relative sampling error for contractual cash earnings, c_i , is related to φ_i as

$$c_i^2 = \frac{N_i - n_i}{N_i - 1} \times \frac{\varphi_i^2}{n_i} , \quad (2)$$

where N_i denotes the number of establishments within stratum i in the population, while n_i denotes the number of establishments surveyed for stratum i .

The sampling error for a combination of multiple strata can be obtained by summing c_i^2 with weighting using the square of W_i to obtain the total relative error c as

$$c^2 = \sum_i W_i^2 c_i^2 , \quad (3)$$

where W_i denotes stratum i 's share of the estimated number of employees among the all strata to be combined.**

A.2. Estimation of the proportion of illegally discarded samples in 2003

In Figure 1, we observe a sharp increase in the value of relative sampling errors between 2001 and 2003. It may be due to illegal discarding of samples, as suggested by the Special Inspection Committee [5] of the MHLW. Here, we attempt to estimate the proportion of the discarded samples from the published information regarding the survey's sampling errors in this period.

Let q_{0i} denote the inverse number of the reported sampling rate for stratum i for the 2001 survey. Suppose that no samples were discarded in 2001, the number of establishments surveyed in the stratum should be equal to the number of establishments sampled according to its reported sampling rate:

$$n_i = \frac{N_i}{q_{0i}} . \quad (4)$$

** The weighting by W_i^2 applied until 2006. From 2007, the weight was replaced by $R_i^2 W_i^2$, where R_i denotes the ratio of the average of contractual cash earnings per employee for stratum i to that for all strata [3: p. 288]. See Section 4 for the effect of this change in the context of this paper.

Equations (2) and (4) provide the relative sampling error for 2001, c_{0i} , as follows.

$$c_{0i}^2 = \frac{N_i - N_i/q_{0i}}{N_i - 1} \times \frac{\varphi_i^2}{N_i/q_{0i}} = \frac{1 - 1/q_{0i}}{N_i - 1} \times \varphi_i^2 q_{0i} = \frac{q_{0i} - 1}{N_i - 1} \times \varphi_i^2 \quad (5)$$

For 2003, in the same manner, the relative sampling error c_{1i} is given by the equation

$$c_{1i}^2 = \frac{q_i - 1}{N_i - 1} \times \varphi_i^2, \quad (6)$$

where q_i denotes the inverse number of the real sampling rate for the 2003 survey.

It is possible that N_i and φ_i vary by year, but here we simply assume they were constant between 2001 and 2003. Equations (5) and (6) thereby imply the following for the 2003/2001 ratio of the sampling error:

$$\frac{c_{1i}^2}{c_{0i}^2} = \frac{q_i - 1}{q_{0i} - 1}. \quad (7)$$

In Equation (7), the values of c_{0i} , c_{1i} , and q_0 are available from the *Annual Report*. We therefore obtain the real sampling rate for the 2003 survey as follows.

$$q_i = 1 + (q_{0i} - 1) \frac{c_{1i}^2}{c_{0i}^2} \quad (8)$$

Comparing q_i with the reported value of the sampling rate for the 2003 survey, we can estimate the proportion of the discarded sample.

A.3. Data

The data on relative errors and sampling rates are drawn from the *Annual Report*. The relative errors are for the July 2001 [9: p. 258] and 2003 [8: p. 272]. The sampling rates are those for the surveys in 1999–2001 [10: p. 247] and 2002–2003 [8: p. 265].

Industry was classified in accordance with the JSIC 1993 edition [11]. For many industries, both the sampling rates and the relative sampling errors were given for the level of major classification such as “D. Mining” and “E. Construction” (beginning with the major JSIC code). Exceptionally, for “F. Manufacturing” and “L. Services,” which are large industries, the sampling rate was given for their sub-categories. For these exceptions, we prudently assign a small value, 1/9999, as the reported sampling rate. Including these cases, if the reported sampling rate is small enough and identical between the 2001 and 2003 surveys, the proportion of the discarded sample will depend almost solely on the ratio of the relative sampling errors between the two years.

A.4. Results

Tables A.1 and A.2 present the results. The values of “q” and “q1” are the inverse numbers of the real and reported sampling rate for the 2003 survey, respectively. The ratio q1/q indicates the ratio of the real sampling rate to the reported one. If the ratio exceeds 1, some establishments have been added as an extra sample. Otherwise, it provides an estimation of the proportion of the sample remaining after the illegal discarding.

A.4.1. Results for establishments with 100–499 regular employees

Results for establishments with 100–499 regular employees are presented in Table A.1. It shows that, in 2003, the MHLW surveyed only 24% of the sampled establishments in the “F15. Apparel” industry (a sub-category of “F. Manufacturing”). This stratum’s sampling rate was reported as 1/10, whereas 1/40.87 may be the real sampling rate. It is therefore estimated that about 76% of the sample was discarded. For the “H. Transport and communications” industry, the reported sampling rate was 1/24. However, the real sampling rate may be smaller, 1/117.37 by our estimation. This suggests that 80% of the sample was discarded. For “I. Wholesale and retail trade, eating and drinking places,” 77% of the sample may have been discarded.

Table A.1: Proportion of discarded sample (establishments with 100–499 regular employees)

Industry (JSIC)	Error (%)			Sampling rate (inverse)			
	2001	2003	Ratio	q0	q1	q	Ratio
D. Mining	3.67	4.30	1.17	1	1	1.00	1.00
E. Construction	2.10	2.20	1.05	16	16	17.46	0.92
F. Manufacturing	0.83	1.15	1.39	9999	9999	19194.43	0.52
F12-13. Food, beverages, tobacco, and feed	2.92	4.17	1.43	12	24	23.43	1.02
F14. Textile mill products	2.49	4.20	1.69	6	6	15.23	0.39
F15. Apparel	3.75	8.95	2.39	8	10	40.87	0.24
F16. Lumber and wood products	2.85	5.82	2.04	4	6	13.51	0.44
F17. Furniture and fixtures	3.93	4.76	1.21	6	4	8.33	0.48
F18. Pulp, paper, and paper products	2.70	3.88	1.44	8	12	15.46	0.78
F19. Publishing, printing, and allied industries	2.96	4.88	1.65	6	8	14.59	0.55
F20. Chemical and allied products	2.90	2.52	0.87	12	18	9.31	1.93
F21. Petroleum and coal products	2.66	3.10	1.17	2	6	2.36	2.54
F22. Plastic products, except otherwise classified	2.94	3.75	1.28	12	12	18.90	0.64
F23. Rubber products	2.54	3.49	1.37	6	4	10.44	0.38
F24. Leather tanning, leather products, and fur skins	5.94	7.89	1.33	2	2	2.76	0.72
F25. Ceramic, stone, and clay products	3.28	2.72	0.83	12	8	8.56	0.93
F26. Iron and steel	2.37	4.18	1.76	12	24	35.22	0.68
F27. Nonferrous metals and products	3.48	3.29	0.95	8	8	7.26	1.10
F28. Fabricated metal products	2.47	2.88	1.17	16	12	21.39	0.56
F29. General machinery	2.22	2.60	1.17	32	60	43.52	1.38
F30. Electrical machinery, equipment and supplies	2.21	2.11	0.95	24	36	21.97	1.64
F31. Transportation equipment	1.97	2.42	1.23	24	24	35.71	0.67
F32. Precision instruments and machinery	2.74	4.51	1.65	6	6	14.55	0.41
F33-34. Ordnance and accessories, Miscellaneous manufacturing industries	3.53	7.46	2.11	6	8	23.33	0.34
G. Electricity, gas, heat supply and water	1.81	2.87	1.59	8	24	18.60	1.29
H. Transport and communications	1.92	3.72	1.94	32	24	117.37	0.20
I. Wholesale and retail trade, eating and drinking places	2.08	4.46	2.14	18	18	79.16	0.23
J. Financing and insurance	5.32	3.89	0.73	16	12	9.02	1.33
K. Real estate	5.32	6.26	1.18	2	2	2.38	0.84
L. Services	1.30	1.29	0.99	9999	9999	9845.78	1.02
TL. Total	0.68	1.02	1.50	9999	9999	22496.50	0.44

Industry: Based on the Japan Standard Industrial Classification.

Error: Relative sampling error from the *Annual Report on the Monthly Labour Survey* [8: p. 272] [9: p. 258]. “Ratio” is for 2003/2001.

Sampling rate: The inverse number of the reported sampling rate for the sample replacement in 1999 (q0) [10: p. 247] and in

2002 (q1) [8: p. 265]. If the value is unknown, “9999” is assigned. Equation (8) gives estimation for 2003 (q). “Ratio” is q1/q.

It is true that there are some strata where the ratio of the remaining sample is estimated as more than 1. This holds for industries such as “F20. Chemical and allied products,” “F21. Petroleum and coal products,” and “F30. Electrical machinery, equipment and supplies.” It is therefore probable that the MHLW added extra samples for these strata to contribute toward the reduction of errors.

Notwithstanding, it may also be true that the effect of the extra samples was marginal when totaling the error for all industries. In contrast, the effect of discarded samples may have had a greater magnitude of increasing error. Indeed, growth was observed in the sampling error for the total of all industries. The growth was by 1.5 times, from 0.68% in 2001 to 1.02% in 2003. This is equivalent to reducing 56% of samples in cases with simple random sampling from an infinite population.

Table A.2: Proportion of discarded sample (establishments with 30–99 regular employees)

Industry (JSIC)	Error (%)			Sampling rate (inverse)			
	2001	2003	Ratio	q0	q1	q	Ratio
D. Mining	3.49	3.83	1.10	6	4	7.02	0.57
E. Construction	2.22	2.38	1.07	96	96	110.19	0.87
F. Manufacturing	1.00	1.30	1.30	9999	9999	16897.62	0.59
F12-13. Food, beverages, tobacco, and feed	3.73	5.16	1.38	64	64	121.57	0.53
F14. Textile mill products	4.08	4.10	1.00	12	18	12.11	1.49
F15. Apparel	2.85	9.17	3.22	72	32	736.03	0.04
F16. Lumber and wood products	3.55	3.68	1.04	16	16	17.12	0.93
F17. Furniture and fixtures	2.71	3.56	1.31	24	16	40.69	0.39
F18. Pulp, paper, and paper products	2.57	2.76	1.07	24	16	27.53	0.58
F19. Publishing, printing, and allied industries	3.77	3.78	1.00	32	24	32.16	0.75
F20. Chemical and allied products	3.52	3.46	0.98	32	12	30.95	0.39
F21. Petroleum and coal products	5.19	5.76	1.11	4	2	4.70	0.43
F22. Plastic products, except otherwise classified	3.43	2.63	0.77	36	12	21.58	0.56
F23. Rubber products	2.92	2.57	0.88	8	4	6.42	0.62
F24. Leather tanning, leather products, and fur skins	4.61	3.94	0.85	4	4	3.19	1.25
F25. Ceramic, stone, and clay products	3.01	2.34	0.78	36	16	22.15	0.72
F26. Iron and steel	2.22	3.09	1.39	32	24	61.06	0.39
F27. Nonferrous metals and products	3.74	2.51	0.67	12	4	5.95	0.67
F28. Fabricated metal products	2.85	3.98	1.40	96	96	186.27	0.52
F29. General machinery	3.46	2.36	0.68	64	48	30.31	1.58
F30. Electrical machinery, equipment and supplies	3.44	4.00	1.16	48	48	64.55	0.74
F31. Transportation equipment	2.82	2.16	0.77	48	16	28.57	0.56
F32. Precision instruments and machinery	4.07	4.15	1.02	12	12	12.44	0.96
F33-34. Ordnance and accessories, Miscellaneous manufacturing industries	5.01	4.55	0.91	16	12	13.37	0.90
G. Electricity, gas, heat supply and water	2.31	2.90	1.26	24	24	37.25	0.64
H. Transport and communications	2.27	2.63	1.16	84	96	112.41	0.85
I. Wholesale and retail trade, eating and drinking places	1.73	9.14	5.28	108	128	2987.65	0.04
J. Financing and insurance	5.48	3.66	0.67	64	48	29.10	1.65
K. Real estate	4.39	5.42	1.23	8	8	11.67	0.69
L. Services	1.08	1.31	1.21	9999	9999	14710.85	0.68
TL. Total	0.68	2.23	3.28	9999	9999	107524.91	0.09

See the legend below Table A.1.

A.4.2. Results for establishments with 30–99 regular employees

For establishments with 30–99 regular employees (Table A.2), two industries, “F15. Apparel” and “I. Wholesale and retail trade, eating and drinking places,” exhibit a large proportion of sample discarding. In these strata, 96% of the sampled establishments were discarded.

In a few strata of establishments with 30–99 regular employees, such as “F29. General machinery” and “J. Financing and insurance,” the MHLW would have added extra samples. However, the effect of discarded samples is overwhelming. The sampling error for the total of all industries grew by 3.28 times (from 0.68% to 2.23%) between 2001 and 2003. This error growth is equivalent to a 91% reduction of samples in cases of simple random sampling from an infinite population.

A.5. Script

Below is the Perl script used for the analysis. The data of sampling rates and relative errors for 2001 and 2003 appear at the end of the script.

```
#!/usr/bin/perl

$" = $, = "\t";
$\ = "\n";

sub size {
    return '30-99' if $_[0] == 1;
    return '100-499' if $_[0] == 0;
}

sub real_q {
    my ( $q0, $q1, $c0, $c ) = @_ ;
    warn ( "Invalid RE 2001: $c0.\n" ) unless $c0;
    warn ( "Invalid RE 2003: $c.\n" ) unless $c ;
    my $C = $c * $c;
    my $C0=$c0 * $c0;

    1 + ($q0 - 1) * $C / $C0 ;
}

print qw( _size industry RE2001 RE2003 RE_ratio q0 q1 q q_ratio );

while(<DATA>){
    chomp;
    ($ind, @q0[0,1], @q1[0,1], @c0[0,1], @c[0,1]) = split ;
    foreach( 0..1 ) {
        $q0[$_] = 9999 if $q0[$_] eq '.' ;
        $q1[$_] = 9999 if $q1[$_] eq '.' ;
        my $q = real_q( $q0[$_], $q1[$_], $c0[$_], $c[$_] );
        print size($_) , $ind, $c0[$_], $c[$_], $c[$_]/$c0[$_], $q0[$_], $q1[$_], $q,
        $q1[$_]/$q,;
    }
}

# Below are data from the Annual Report on the Monthly Labour Survey
# Industry is according to Japan Standard Industrial Classification, 1993
__END__
TL      .      .      .      .      0.68  0.68  1.02  2.23
D       1       6       1       4       3.67  3.49  4.30  3.83
E      16      96      16      96      2.10  2.22  2.20  2.38
F       .       .       .       .       0.83  1.00  1.15  1.30
F12-13 12      64      24      64      2.92  3.73  4.17  5.16
F14     6       12      6       18      2.49  4.08  4.20  4.10
F15     8       72     10      32      3.75  2.85  8.95  9.17
```

F16	4	16	6	16	2.85	3.55	5.82	3.68
F17	6	24	4	16	3.93	2.71	4.76	3.56
F18	8	24	12	16	2.70	2.57	3.88	2.76
F19	6	32	8	24	2.96	3.77	4.88	3.78
F20	12	32	18	12	2.90	3.52	2.52	3.46
F21	2	4	6	2	2.66	5.19	3.10	5.76
F22	12	36	12	12	2.94	3.43	3.75	2.63
F23	6	8	4	4	2.54	2.92	3.49	2.57
F24	2	4	2	4	5.94	4.61	7.89	3.94
F25	12	36	8	16	3.28	3.01	2.72	2.34
F26	12	32	24	24	2.37	2.22	4.18	3.09
F27	8	12	8	4	3.48	3.74	3.29	2.51
F28	16	96	12	96	2.47	2.85	2.88	3.98
F29	32	64	60	48	2.22	3.46	2.60	2.36
F30	24	48	36	48	2.21	3.44	2.11	4.00
F31	24	48	24	16	1.97	2.82	2.42	2.16
F32	6	12	6	12	2.74	4.07	4.51	4.15
F33-34	6	16	8	12	3.53	5.01	7.46	4.55
G	8	24	24	24	1.81	2.31	2.87	2.90
H	32	84	24	96	1.92	2.27	3.72	2.63
I	18	108	18	128	2.08	1.73	4.46	9.14
J	16	64	12	48	5.32	5.48	3.89	3.66
K	2	8	2	8	5.32	4.39	6.26	5.42
L	1.30	1.08	1.29	1.31

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Notes

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