# STABILITY OF VARIATION PATTERNS*

BY

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## I

Since the very beginning of systematic uses of sampling methods for data collection in Yugoslavia, which falls in the years following immediately the Second World War, the survey statisticians have become concerned about the practical meaning of sampling errors. In surveys with a considerabe rate of non-response, refusals, listing errors, response errors, etc. it is not easy to decide as to what the right amount of attention to sampling errors should be. In sample surveys with the effect of all these sources of errors reduced to a reasonable level the meaning of sampling error is of course much clearer. However, even in this type of situations the questions arose, such as : (1) is the knowledge of sampling errors essential for the utilization of sample survey results and (2) should an information about sampling errors be included in each report of sample surveys along with the related estimate of aggregates, averages, proportions, etc. ? In eonnection with answering these questions our hesitation was primarily due to the widely spread practice all over the world of presenting users with sample survey results alone and disregarding entirely the related sampling errors. An insisting on the need for sampling errors would thus be in conflict with a good part of the existing practice. However, after years of experience with a variety of surveys we have come to a firm opinion that *sampling errors have an essential orientational value*. Data from a sample survey might be, at least in principle, anything between "excellent" and "useless". An inspection of the magnitude of sampling errors for various characteristics at the level of the country as a whole and its subdivisions as well is the first step in passing the judgement about the place of a survey in between

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these extremes. Therefore, in order to establish the ground for the evaluation process of sample survey data an information about the magnitude of sampling errors should be considered as an *indispensable* part of each sample survey report.

Needless to say, the knowledge of sampling errors is not more than a part of the information needed for the evaluation process. At its subsequent stages this process is to go into non-sampling errors as well. However, all these additional steps have a very limited value unless they are combined with an information about sampling errors.

## II

How to satisfy the requirement from Section I and provide sampling errors ?

In the first years after the Second World War we used to compute sampling errors with the help of desk calculators and/or tables of squares and square roots. In order to reduce the amount of the related work in large scale surveys it was customary to sub-sample the available data. However, in spite of this, the time needed to carry out the computations was considerable. As a result, we used to restrict the computation of sampling errors to basic characteristics only and, in the best case, for some subdivisions of the country. The extension of the work to more characteristics and all the subdivisions would increase the cost of surveys and delay the release of results. The latter was particularly prohibitive in more recent surveys where the essential constraint on the work was a prompt release of data.

The practice of calculating errors for a few characteristics only leads to a difficult problem of choice. In fact, there is no satisfactory solution to this problem. It is almost impossible to overcome the arbitrariness in any choice. In a general survey of agriculture users' interest in data will be distributed over a very large range of characteristics. Whatever choice is made in this case it will reduce the amount of calculation at the expense of the amount of information offered.

A considerable step forward was made with the introduction of punch card equipment. In principle this has made possible the computation of errors for all the characteristics on the survey programme and for all the subdivisions. However, the new technology did not solve the problem of either the cost or the time needed for the computation. Even in the ideal situation of an immediate access to

the equipment, the work on coding, punching, verification, and tabulation of a large scale survey used to take months. Therefore, in case of more urgent needs for survey results we used to release data in several stages. The first of them referred to the provisional aggregates only as based on the summation of data for elementary units by the field personnel direct from questionnaires. The second stage related to the aggregates resulting from punch cards. The third stage represented the final report that normally involved a large number of sampling errors and the corresponding explanatory text.

Obviously, the utilization of the punch card equipment has greatly facilitated the survey work. However, it has also created new problems. The most important of them was the presentation of sampling errors. If sampling errors become available for many characteristics and for all the subdivisions their presentation together with the associated estimates of aggregates does not come into account as it would double the size of publications, with all the related consequences.

The introduction of computers has again changed the situation. In the beginning of the computer age in survey practice there were many difficulties that used to delay the work, such as the limited capacity, lack of experience on the part of staff, inadequate programming, etc. However, after some time the stage was reached, at least in better survey organizations, that it was possible to get from computers, in a shorter time than ever before, a large number of sampling errors. However, the cost of computation remained considerable. In Yugoslavia, survey estimates have to be made available separately for, at least, each of the eight republics and autonomous provinces. It meant the number of sampling errors that went into thousands. In order to reduce the cost of computation we were obliged to compromise with the requirements from Section I. The outcome was usually a reduced programme of computations and the related loss of information. Thus, the problem of how to get sampling errors at a reasonable cost has remained on the agenda.

The presentation of sampling errors was equally cumbersome as before. In order to arrive at some solution to this problem the following procedures were considered :

(*i*) Publish the estimated aggregates without errors with a remark in the text of the report that the users interested in sampling errors can get the necessary information from the statistical office concerned where the errors are kept available to those who might wish to know them.

The value of this procedure is based on the assumption that current users of data are mostly interested in the order of magnitude of the estimated aggregates. A small number of those who might be facing operational decisions or are in need for sampling errors for other reasons have a possibility of getting them.

(*ii*) Provide a summarized presentation of the appropriate magnitude of errors based on empirical studies of the following type:

(*a*) examine, for each characteristic separately, if there is any reasonable relationships between the estimated aggregates (for the country as a whole and its subdivisions) and the related sampling errors. If the answer is in positive prepare a table or a chart that exibits these relationships and thus eliminates a separate presentation of errors for each aggregate at each level of aggregation;

(*b*) examine if there is any similarity in the established relationships for different characteristics. If so establish groups of characteristics that have similar relationships, average the respective sampling errors is each group and thus reduce the amount of figures to be presented.

The procedure in (*i*) has the merit of simplicity and it might justified if the uses of data in a country have not yet reached a more refined level, such as those related to research. The research will lead to comparisons that often require sampling errors.

The procedure in (*ii*) takes time. Such studies are not likely to give quick results. In addition, sampling errors and the related aggregates for some characteristics may not follow any clear relationships. In such a case other alternatives need to be examined. One of them might be the groupment of sampling errors in classes of magnitude designated as $A, B, C, \ldots$ and the subsequent association of these characters to each of the published aggregates.

In this situation the interest obviously arises in other approaches to both the calculation and the presentation of sampling errors if they are likely to provide more efficient solutions to any aspect of the related problems.

The purpose of this paper is to illustrate some possibilities along this line that follow from the stability of variation patterns. The concept of the stability of variation patterns refers to the fact that the relative variances of the estimated aggregates of the various characteristics in successive surveys remain frequently constant over

longer periods of time. It the variation patterns are stable in this sense a fresh calculation of sampling errors is not needed in a new survey. The existing information about errors can be used instead. It also means that the summarized presentation of errors as arrived at after the first calculation can be used in subsequent surveys as well so that all the related studies are eliminated altogether.

In this connection the survey statistician will be interested in following question: to what extent the stability of variation patterns is a reasonable assumption in statistical surveys ?

In the subsequent parts of this paper some data will be presented in order to illustrate the validity of that assumption and some uses thereof.

## III

The first illustration refers to the quarterly pig surveys in Yugoslavia. These surveys are taken in six republics and autonomous provinces that are more important from the point of view of pig growing. The total sample consists of 200 statistical districts selected from the group of rural and mixed districts. In 1971 the total number of districts in this group was 42.228 with an average size of 69.4 households. The sample of districts was selected with equal probabilities. The total size of the sample was distributed roughly proportionally over the republics and autonomous provinces. The information on the programme of the survey was collected from all the households in the sample districts so that district aggregates were available for all the characteristics. These aggregates were used for the purpose of this study to estimate the respective aggregates for the country as a whole and its subdivisions and the variances of these estimates as well. All the estimated aggregates thus obtained for the period 1964-74 are presented in Table 1. Within each year the estimates are given for each quarter separately. Data for each quarter are collected in the field on the first day of the respective quarter, *viz.* 1st January, 1st March, etc. It is seen that, in addition to the variations from year to year, the table shows clear seasonal variations of aggregates within each year.

Table 2 exhibits the coffiecients of variation of the aggregates in Table 1.

Table 2 shows the stability of the coefficients of variation over the whole ptriod covered. This makes possible a simple summarization of all the errors presented in Table 2 by averaging the errors for the same quarter within each item. This leads to the results in

TABLE 1

**Estimated aggregates of the number of pigs in Yugoslavia by years, quarters, age, and sex (in thousands)**

| *Item* | *Quarter* | *1964* | *1965* | *1966* | *1957* | *1968* | *1969* | *1970* | *1971* | *1972* | *1973* | *1974* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total | 1 | 6 102 | 6 465 | 4 579 | 5 302 | 5 434 | 4 507 | 5 186 | 6 052 | 5 650 | 5 339 | 6 480 |
| | 2 | 7 183 | 6 795 | 5 440 | 5 941 | 5 865 | 5 117 | 5 967 | 6 645 | 6 047 | 6 060 | 7 077 |
| | 3 | 8 502 | 7 298 | 6 283 | 6 896 | 6 396 | 6 027 | 7 237 | 7 510 | 6 789 | 7 144 | 7 819 |
| | 4 | 5 315 | 3 913 | 4 264 | 4 416 | 3 849 | 4 061 | 4 911 | 4 552 | 5 329 | 6 215 | 5 280 |
| Less than 2 months | 1 | 2 119 | 2 294 | 1 544 | 1 942 | 2 052 | 1 678 | 1 973 | 2 414 | 2 327 | 2 182 | 2 544 |
| | 2 | 1 985 | 1 821 | 1 571 | 1 729 | 1 695 | 1 454 | 1 831 | 2 200 | 1 953 | 1 871 | 2 242 |
| | 3 | 2 420 | 1 978 | 1 719 | 1 979 | 1 710 | 1 784 | 2 381 | 2 433 | 2 151 | 2 268 | 2 416 |
| | 4 | 1 009 | 588 | 853 | 912 | 766 | 841 | 1 183 | 1 059 | 1 238 | 1 549 | 1 424 |
| 2-6 months | 1 | 1 893 | 1 670 | 1 078 | 1 219 | 1 216 | 942 | 1 186 | 1 360 | 1 190 | 1 036 | 1 506 |
| | 2 | 2 364 | 1 879 | 1 471 | 1 635 | 1 534 | 1 396 | 1 547 | 1 633 | 1 479 | 1 571 | 1 759 |
| | 3 | 2 176 | 1 593 | 1 432 | 1 521 | 1 357 | 1 294 | 1 347 | 1 500 | 1 304 | 1 398 | 1 546 |
| | 4 | 1 975 | 1 409 | 1 389 | 1 457 | 1 207 | 1 378 | 1 526 | 1 364 | 1 766 | 2 136 | 1 500 |
| 6-12 months | 1 | 1 258 | 1 580 | 1 234 | 1 363 | 1 339 | 1 159 | 1 250 | 1 356 | 1 281 | 1 307 | 1 464 |
| | 2 | 1 732 | 1 941 | 1 494 | 1 588 | 1 624 | 1 342 | 1 560 | 1 688 | 1 594 | 1 637 | 1 953 |
| | 3 | 2 473 | 2 395 | 2 006 | 2 180 | 2 178 | 1 893 | 2 253 | 2 308 | 2 234 | 2 335 | 2 580 |
| | 4 | 1 425 | 1 169 | 1 267 | 1 219 | 1 132 | 1 091 | 1 289 | 1 225 | 1 420 | 1 532 | 1 403 |
| 12 months and over | 1 | 832 | 920 | 723 | 778 | 827 | 728 | 776 | 922 | 882 | 815 | 966 |
| | 2 | 1 102 | 1 154 | 904 | 989 | 1 012 | 925 | 1 029 | 1 123 | 1 020 | 981 | 1 123 |
| | 3 | 1 432 | 1 333 | 1 126 | 1 216 | 1 151 | 1 056 | 1 257 | 1 269 | 1 100 | 1 143 | 1 277 |
| | 4 | 908 | 747 | 755 | 828 | 744 | 751 | 913 | 904 | 905 | 997 | 953 |
| Sows | 1 | 765 | 817 | 654 | 682 | 740 | 652 | 701 | 853 | 788 | 741 | 873 |
| | 2 | 942 | 941 | 754 | 802 | 818 | 753 | 860 | 959 | 854 | 831 | 950 |
| | 3 | 867 | 761 | 646 | 723 | 666 | 645 | 806 | 833 | 739 | 774 | 862 |
| | 4 | 757 | 594 | 606 | 661 | 594 | 605 | 762 | 722 | 751 | 829 | 808 |

TABLE 2

**Coefficients of variation of estimated aggregates of number of pigs in Yugoslavia by years, quarters, age and sex**

| *Item* | *Quarter* | *1964* | *1965* | *1966* | *1967* | *1968* | *1969* | *1970* | *1971* | *1972* | *1973* | *1974* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total | 1 | 5.24 | 5.23 | 5.10 | 5.01 | 5.39 | 6.11 | 5.58 | 5.38 | 5.93 | 6.35 | 5.56 |
| | 2 | 4.22 | 4.27 | 4.25 | 4.34 | 4.51 | — | 5.52 | 4.75 | 4.01 | 5.15 | 4.74 |
| | 3 | 4.44 | 4.20 | 4.46 | 4.33 | 6.53 | 6.21 | 4.50 | 4.62 | 4.92 | 3.78 | 4.59 |
| | 4 | 5.84 | 5.53 | 5.53 | 5.59 | 6.46 | 6.29 | 5.87 | 6.06 | 6.45 | 6.47 | 6.41 |
| Less than 2 months | 1 | — | 7.14 | 7.57 | 7.68 | 8.21 | 9.16 | 8.76 | 7.57 | 8.45 | 9.51 | 7.76 |
| | 2 | 5.73 | 6.09 | 7.18 | 6.20 | 7.09 | — | 7.48 | 7.40 | 8.98 | 8.14 | 6.79 |
| | 3 | 7.10 | 6.90 | 7.06 | 7.25 | 9.02 | 9.18 | 7.49 | 7.20 | 8.30 | 7.32 | 7.36 |
| | 4 | 8.76 | 8.26 | 8.41 | 8.92 | 9.44 | 9.68 | 8.68 | 8.76 | 9.80 | 8.34 | 9.95 |
| 2-6 months | 1 | — | 6.01 | 6.66 | 5.97 | 6.66 | 7.37 | 6.59 | 6.81 | 7.44 | 7.03 | 6.88 |
| | 2 | 5.07 | 5.35 | 4.93 | 5.23 | 5.86 | — | 6.48 | 6.35 | 5.76 | 7.41 | 7.40 |
| | 3 | 5.38 | 5.73 | 5.88 | 5.54 | 8.48 | 7.54 | 6.13 | 7.25 | 7.68 | 4.53 | 7.75 |
| | 4 | 6.21 | 6.07 | 6.11 | 5.65 | 8.48 | 7.75 | 6.25 | 7.28 | 8.04 | 5.14 | 6.90 |
| 6-12 months | 1 | — | 6.10 | 5.65 | 6.25 | 5.95 | 6.65 | 5.26 | 5.93 | 5.88 | 6.91 | 6.40 |
| | 2 | 5.52 | 6.34 | 5.30 | 5.95 | 5 34 | — | 6.65 | 4.83 | 4.45 | 5.43 | 5.57 |
| | 3 | 5.35 | 4.95 | 4.83 | 4.92 | 6.57 | 6.06 | 4.81 | 4.59 | 4.75 | 4.66 | 4.68 |
| | 4 | 6.82 | 6 82 | 7.11 | 7.03 | 7.74 | 7.56 | 7.30 | 7.23 | 7.89 | 6.38 | 8.59 |
| 12 months and over | 1 | — | 6.30 | 6.92 | 6.48 | 7.15 | 7.45 | 7.21 | 6.31 | 7.83 | 8.67 | 7.09 |
| | 2 | 5.46 | 6.39 | 6.46 | 6.93 | 7.09 | — | 7.88 | 6.91 | 7.39 | 8.06 | 7.56 |
| | 3 | 6.26 | 6.59 | 6.62 | 6.93 | 8.54 | 8.16 | 7.12 | 7.17 | 8.18 | 8.83 | 7.46 |
| | 4 | 6.37 | 7.15 | 6.83 | 7.18 | 7.75 | 8.40 | 6.79 | 7.49 | 7.99 | 6.97 | 7.44 |
| Sows | 1 | — | 6.25 | 6.68 | 6.32 | 6.91 | 7.37 | 7.06 | 6.70 | 7.32 | 6.57 | 6.56 |
| | 2 | 5.48 | 6.09 | 6.08 | 6.36 | 6.80 | — | 7.38 | 6 59 | 6.72 | 7.31 | 6.75 |
| | 3 | 5.88 | 6.48 | 6.39 | 6.53 | 8.44 | 8.04 | 6.80 | 6.65 | 7.48 | 6.49 | 6.72 |
| | 4 | 6.48 | 6.90 | 6.44 | 6.44 | 7.66 | 8.31 | 6.09 | 7.23 | 7.64 | 5.03 | 6.91 |

Part I of the Table 3. In the upper row the average coefficient of variation is presented for each item and for each quarter separately. In the lower row the coefficients of variation of all the items are shown as percentages of the errors in the first row. In this particular case these percentages make it possible to assess the errors of other items on the basis of the errors in the first row.

TABLE 3

**Average ceefficients of variation**

| *Item* | *Part I* | | | | *Part II* |
|---|---|---|---|---|---|
| | *Quarter* | | | | |
| | *I* | *II* | *III* | *IV* | |
| Total | 5.5<br>(100) | 4.6<br>(100) | 4.8<br>(100) | 5.5<br>(100) | 5.1<br>(100) |
| Less than 2 months | 8.2<br>(148) | 6.6<br>(144) | 7.7<br>(160) | 9.0<br>(164) | 7.9<br>(155) |
| 2-6 months | 6.7<br>(122) | 5.9<br>(128) | 6.5<br>(137) | 6.7<br>(123) | 6.5<br>(127) |
| 12 months | 6.0<br>(109) | 5.5<br>(121) | 5.0<br>(105) | 7.2<br>(132) | 5.9<br>(116) |
| 12 months and over | 7.3<br>(131) | 7.1<br>(153) | 7.4<br>(156) | 7.2<br>(132) | 7.3<br>(143) |
| Sows | 7.1<br>(128) | 6.6<br>(143) | 6.9<br>(144) | 6.8<br>(125) | 6.9<br>(135) |

One can easily go a step further in the summarization. If the variations of sampling errors for different quarters are not considered important for the purposes of the usual assessment of precision the average quarterly coefficients can be worked out for each item so that one single figure in each row represents all the errors presented in Table 2. This averaging was done in Part II of Table 3. The results obtained show that one single figure can be used to express the precision of the estimated aggregates for an item in the long range of 44 surveys taken successively over the period of eleven years.

With a bit less success one can go still further. If the variations between the average coefficients of variation in Part II are not

considered excessive for the purposes of the assessment of precision one single figure could be obtained to stand for sampling errors of all the items in all these surveys. If one does not wish to go that far the alternative would be to group the characteristics involved according to the magnitude of their respective coefficients of variation. For example, one might put together "total pigs", "2-6 months", and "6-12 months". The other group would cover the rest. In such a case only two figures are sufficient to provide an information about sampling errors of the whole group of surveys.

A practical conclusion obviously follows. Under the conditions of stability of variation of the type presented in Table 2 there is no need to compute errors in the repetitive surveys. Once the variation pattern is established in the beginning the related sampling errors can be utilized afterwards. In other words, if the aggregates as collected in the field are communicated by telephone on the first day of each quarter the next day the results of the survey could be released together with the associated sampling errrors.

The question now arises of the risk involved in doing so. In answering this question Table 4 might be useful. This table exhibits the degree of deviations of individual coefficients of variation for all the items in Table 2 from the average coefficient of variation for each quarter. In the stub of this table is the interval of variation in percentages from the average coefficient of variation of each quarter separately. Under each quarter the number of errors is shown first that fall in a particular interval of deviations and the cumulative percentages afterwards. Thus, the first row shows that 27 individual errors of the first quarter fall within the range of 95-105 per cent of the respective average coefficient of variation for that quarter. This amounts to 44.3 per cent of all the individual coefficients. Similarly, 19 individual coefficients fall in the interval of 90-110 per cent. This amounts to 75.4 per cent of the total number of individual coefficients for that quarter, etc.

This shows that the stability of variation in Table 2 is satisfactory and no practical risk is likely to arise in the assessment of precision on the basis of the past material. Needless to say, this conclusion is based here on the known average coefficient of variation for a long series of surveys. This condition will not be fulfilled in practice. Therefore, this degree of risk increases in practice. However, this risk can be taken care of by the repetition of calculations of errors from time to time and the above mentioned process of averaging the results obtained.

TABLE 4

**Deviations of individaul coefficients of variation from the average coefficeint of variation of all the items in Table 2**

| *Interval* | *Quarter 1* | | *Quarter 2* | | *Quarter 3* | | *Quarter 4* | |
|---|---|---|---|---|---|---|---|---|
| | *Number of errors* | *Cummulative percentage* | *Number of errors* | *Cummulative percentage* | *Number of errors* | *Cummulative percentage* | *Number of errors* | *Cummulative percentage* |
| 95—105 | 27 | 44.3 | 22 | 36.7 | 15 | 22.7 | 22 | 33.3 |
| 90—110 | 19 | 75.4 | 14 | 60.0 | 24 | 59.1 | 28 | 75.8 |
| 85—115 | 12 | 95.1 | 15 | 85.0 | 9 | 72.7 | 8 | 87.9 |
| 80—120 | 2 | 98.4 | 3 | 90.0 | 11 | 89.4 | 4 | 94.0 |
| 75—125 | — | — | 3 | 95.0 | 2 | 92.4 | 2 | 97.0 |
| 70—130 | — | — | 3 | 100.0 | 3 | 97.0 | 2 | 100.0 |
| 65—135 | 1 | 100.0 | — | — | 1 | 98.5 | — | — |
| 60—140 | — | — | — | — | 1 | 100.0 | — | — |

## IV

As a result of recent tendencies in all the countries towards decentralization, the increasing importance of regional social and economic planning, and the related decision taking at the level of smaller areas, modern surveys have to provide data by a larger number of subdivisions in addition to the country as a whole. In this connection the question arises of how the stability of variation patterns, as presented above at the level of Yugoslavia as a whole, looks like in subdivisions, *viz.* republics and autonomous provinces.

The answer to this question is provided in Table 5 for the republic of Bosnia and Herzegovina. This table exhibits the same information that was shown in Table 2 for the country as a whole. The estimated aggregates for subdivisions are omitted in order to reduce the space.

The estimation of aggregates was not among the objectives of these surveys. Neither the size of the sample nor its design are adequate for this purpose. In view of the small size of the sample of statistical districts the coefficients of variation for subdivisions are large. However, they clearly show the stability of variation patterns. In other words, the same conclusion is equally valid regarding the assessment of sampling errors of future surveys on the basis of past data.

Data similar to those in Table 5 are available for other republics and autonomous provinces as well. They are not included here for reasons of space. However, they lead to the same conclusions as those presented above in connection with Table 5.

## V

The stability of variation patterns as presented in Tables 2 and 5 makes it possible to provide a summarized picture of sampling errors for all the characteristics included in this survey and for all the subdivisions as well. For this purpose the average coefficient of variation is calculated for each characteristic and each subdivision for the whole period of 11 years (as it was done in Part II of Table 3 for the country as a whole). The results obtained are presented in Table 6.

Within the limits of the validity of the assumption made regarding the stability of variation patterns, Table 6 is a summarized picture of sampling errors in all these surveys. It could be used as a basis for an approximate assessment of sampling errors in subsequent surveys of the same type.

TABLE 5

**Cofficients of variation of the estimated aggregates of the number of pigs in Bosnia and Herzegovina by years, quarters, age, and sex classes**

| *Item* | *Quarter* | *1964* | *1965* | *1966* | *1967* | *1968* | *1969* | *1970* | *1971* | *1972* | *1973* | *1974* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total | 1 | 11.89 | 14.05 | 11.73 | 11.36 | 11.81 | 13.45 | 15.24 | 14.15 | 15.19 | 16.77 | 15.89 |
| | 2 | 9.63 | 11.45 | 10.00 | 9.93 | 9.52 | — | 10.05 | 11.80 | 12.47 | 13.12 | 13.85 |
| | 3 | 10.69 | 10.61 | 9.74 | 9.38 | 9.99 | 10.88 | 11.80 | 11.60 | 12.71 | 13.82 | 13.94 |
| | 4 | 12.86 | 11.61 | 11.67 | 13.28 | 13.88 | 13.54 | 14.85 | 14.87 | 15.65 | 16.46 | 16.34 |
| Less than 2 months | 1 | 18.03 | 23.30 | 23.05 | 19.11 | 19.49 | 22.92 | 26.27 | 22.81 | 26.47 | 27.61 | 27.52 |
| | 2 | 11.46 | 11.72 | 17.06 | 13.61 | 14.78 | — | 11.99 | 15.68 | 17.50 | 18.34 | 18.96 |
| | 3 | 17.88 | 21.62 | 16.39 | 16.45 | 20.81 | 23.45 | 21.71 | 21.35 | 23.40 | 25.70 | 22.39 |
| | 4 | 21.98 | 21.81 | 20.48 | 25.94 | 24.97 | 20.45 | 22.56 | 28.52 | 26.99 | 20.12 | 21.21 |
| 2-6 months | 1 | 11.32 | 12.13 | 13.02 | 11.27 | 14.08 | 13.41 | 12.89 | 13.66 | 13.89 | 14.37 | 14.65 |
| | 2 | 13.37 | 14.98 | 11.92 | 12.05 | 10.90 | — | 13.03 | 16.66 | 18.08 | 17.92 | 21.44 |
| | 3 | 11.72 | 9.62 | 11.25 | 10.43 | 14.58 | 10.50 | 10.31 | 11.15 | 15.76 | 18.81 | 19.12 |
| | 4 | 10.13 | 9.66 | 10.44 | 12.62 | 12.24 | 12.29 | 13.54 | 12.75 | 18.37 | 18.44 | 16.44 |
| 6-12 months | 1 | 11.00 | 9.71 | 12.01 | 11.74 | 11.16 | 10.24 | 11.90 | 12.13 | 11.86 | 13.54 | 13.19 |
| | 2 | 8.71 | 7.31 | 8.61 | 9.23 | 8.98 | — | 11.07 | 9.14 | 9.69 | 10.97 | 11.37 |
| | 3 | 10.14 | 10 08 | 10.44 | 9.96 | 9.12 | 9.56 | 9.56 | 9.58 | 9.50 | 9.30 | 10.54 |
| | 4 | 18.39 | 16.95 | 18.08 | 15.01 | 17.83 | 16.10 | 17.18 | 20.50 | 17.48 | 20.26 | 19.80 |
| 12 months and over | 1 | 16.27 | 20.12 | 21.36 | 17.69 | 17.71 | 19.99 | 21.97 | 20.58 | 22.41 | 22.73 | 24.58 |
| | 2 | 14.55 | 18.64 | 19.19 | 16.31 | 15.93 | — | 18.32 | 17.84 | 21.22 | 22.25 | 21.16 |
| | 3 | 11.58 | 13.30 | 16.59 | 14.39 | 15.42 | 16.25 | 18.54 | 16.34 | 20.63 | 21.81 | 21.41 |
| | 4 | 21.24 | 20.59 | 17.89 | 18.38 | 23.00 | 21.56 | 22.06 | 22.94 | 25.42 | 23.65 | 22.01 |
| Sows | 1 | 18.19 | 19.43 | 20.85 | 18.00 | 17.24 | 20.14 | 22.28 | 20.56 | 22.48 | 23.04 | 22.01 |
| | 2 | 16.60 | 14.55 | 18.17 | 15.41 | 16.12 | — | 18.06 | 18.11 | 20.54 | 20.34 | 20.27 |
| | 3 | 18.06 | 16.78 | 18.25 | 15.34 | 17.79 | 17.28 | 20.48 | 17.72 | 21.73 | 23.18 | 22.44 |
| | 4 | 21.10 | 20.38 | 16.45 | 18.09 | 20.28 | 21.26 | 21.34 | 22.61 | 25.19 | 23.06 | 21.86 |

Another summarization of the related sampling errors could be obtained by fitting to data in Table 6 a curve of the type $y=ax^c$, $x$ being the estimated aggregate and $y$ the corresponding coefficient of variation. In this case one single curve would provide the ground for an appronimate assessment of sampling errors in the country as a whole and in all the subdivisions as well.

## VI

The assumption of the stability of the variation patterns in pig surveys is also valid for the components of variation in the case of a two-stage design with statistical districts as psu and households as ssu. The relative variance of the estimated aggregate in the case of such a design is shown in the equation (6.3) on page 253 of *Sample Survey Methods and Theory* (Vol. I) by Hansen, Hurwitz and Madow. Data in Table 2 illustrate the stability of $B_x^2$, *viz.* the first term on the right hand side of that equation. The question now arises of the stability of the second term, *viz.* $W^2{}_x$.

In order to answer this question the variations in $B^2$ and $W^2$ over time were examined in data for the first quarter of 1965, 1969, 1971, and 1974 for all the characteristics on the programme of pig surveys. From these data estimates of $B^2$ and $W^2$, *i.e.* $b^2$ and $w^2$ were computed. The results obtained are presented in Table 7 for Croatia only.

It is seen from this table that there are some variations in $b^2$ and $w^2$ over time. However, for the purpose of the assessment of sampling errors these variations can be neglected. In other words, in the period from 1964 to 1974 the relative contribution of the second stage of sampling to the total error has remained constant.

The same type of results was obtained for other characteristics of pig surveys.

These results can be used to predict the magnitude of sampling errors of future surveys designed in a different way. In fact, the design of pig surveys was changed at the end of 1974 and, starting with the first quarter of 1975, a two-stage sampling scheme was used with different sampling fractions in each subdivision. The coefficients of variation obtained from the actual computations for "total number of pigs" are presented in col. 1 of Table 8. Parallel to this the estimates of $B^2$ and $W^2$ were computed from the results of past surveys for all the characteristics of the survey and all the subdivisions. These estimates were used to predict the coefficients of variation resulting from the redesigned survey. The predicted

TABLE 6

**Average coefficients of variation of estimated aggregates of all characteristics in all subdivisions**

| *Item* | *Yugoslavia* | *Bosnia and Herzegovina* | *Croatia* | *Macedonia* | *Slovenia* | *Restricted territory of Serbia* | *Voyvodina* |
|---|---|---|---|---|---|---|---|
| Total | 5,1 | 12,6 | 8,0 | 20,5 | 16,3 | 10,3 | 10,6 |
| Less than 2 months | 7,9 | 20,8 | 12,2 | 33,2 | 26,7 | 14,3 | 15,4 |
| 2—6 months | 6,5 | 13,6 | 10,7 | 20,0 | 15,0 | 12,1 | 14,2 |
| 6—12 months | 5,9 | 12,3 | 9,7 | 21,5 | 18,0 | 12,4 | 12,0 |
| 12 months and over | 7,3 | 19,4 | 10,6 | 35,6 | 21,2 | 12,1 | 12,6 |
| Sows | 6,9 | 19,6 | 11,2 | 36,5 | 24,0 | 12,1 | 12,4 |

TABLE 7

**Estimates of $B^2$ and $W^2$ by years and quarters for the characteristic "Total number of pigs" in Croatia**

| *Year* | *Quarters* | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | *I* | | *II* | | *III* | | *IV* | | *Average* | |
| | $b^2$ | $w^2$ | $b^2$ | $w^2$ | $b^2$ | $w^2$ | $b^2$ | $w^2$ | $b^2$ | $w^2$ |
| 1965 | 0,3926 | 1,2500 | 0,2882 | 1,0822 | 0,2799 | 1,0544 | 0,5459 | 1,6245 | 0,3767 | 1,2528 |
| 1969 | 0,4182 | 1,6356 | 0,3234 | 1,2905 | 0,3134 | 1,3284 | 0,6574 | 1,9586 | 0,4281 | 1,5533 |
| 1971 | 0,5271 | 1,5266 | 0,4262 | 1,2223 | 0,3483 | 1,2363 | 0,5730 | 2,3314 | 0,4687 | 1,5792 |
| 1974 | 0,3832 | 1,5893 | 0,4517 | 1,0643 | 0,3261 | 1,1550 | 0,4860 | 1,8140 | 0,4118 | 1,4057 |
| Averages | 0,4303 | 1,5004 | 0,3724 | 1,1648 | 0,3169 | 1,1935 | 0,5656 | 1,9321 | 0,4213 | 1,4477 |

coefficients for "total number of pigs" are presented in the second column of Table 8. It will be seen that they are close to the actually computed values.

TABLE 8

**Actually computed and predicated values of coefficients of variation of the estimated aggregates of "total number of pigs" by subdivisions in the first quarter of 1975**

| *Subdivision* | *Coefficients of variation* | |
|---|---|---|
| | *Computed* | *Predicted* |
| Bosnia and Herzegovina | 4.2 | 3.8 |
| Croatia | 3.4 | 3.1 |
| Macedonia | 9.2 | 7.8 |
| Slovenia | 15.2 | 13.2 |
| Serbia (restricted territory) | 5.7 | 6.1 |
| Voyvodina | 8.3 | 7.1 |

These results obviously point out a possibility of the estimation of the components of variation from a past survey and the utilization of the estimates obtained for the prediction of sampling errors of future surveys that might be differently designed. Needless to say, this possibility is to be used *cum grano salis*.

## VII

In this section an illustration of the stability of variation patterns will be presented from annual livestock surveys. In addition to the quarterly pig surveys a general livestock survey is taken in January of each year. The survey has a large variety of characteristics on the programme. In each of the eight republics and autonomous provinces of Yugoslavia a different design is used. Data reported here refer to livestock surveys in the republic of Serbia that consists of three subdivisions, *viz.* the restricted territory of Serbia, Kosovo and Voyvodina. The years covered are 1973, 1974, 1975 and 1976.

The design used in the republic of Serbia consists of a sample of statistical districts as psu's selected with probabilities proportional to the number of households and a subsample of households as ssu's, the assupmtion being that there is a correlation between the number of different types of livestock and the number of households.

In each of the three subdivisions the size of the sample of both the first stage units and the second stage units is different.

In Tables 9 through 11 the coefficients of variation of the estimated aggregates for a selected number of characteristics are exhibited as obtained in the actual calculations. Each of these tables refers to a different subdivision.

It will be seen that a considerable stability of variation patterns was found for almost all the characteristics and all the four years. Only some characteristics deviate from the general trend. These are the characteristics that refer to rare types of stock. Their sampling errors are relatively high. In the situations of this kind it is only normal to expect a lesser amount of stability.

The material presented in this section shows that whatever was said before about the possibilities resulting from the assumption of the stability of variations in survey work is supported here by data on livestock.

## VIII

Another large group of sample surveys is found in population statistics. It is, therefore, useful to examine the validity of the assumption of the stability of variation patterns for the various population characteristics.

The following is the first illustration along this line.

In population surveys the settlements are frequently used as psu. The total number of settlements in the country is 27.568 with an average of 219 households and 797 persons. Out of that number 144 settlements have more than 10,000 inhabitants each and they are separately listed and frequently all included in the sample. The rest of the settlements is classified by size into a number of strata. For the purpose of this study the existing stratifications of settlements were disregarded and a new groupment was carried out with size classes as defined in the stub of Tables 12 and 13. For each settlement data were available on the number of inhabitants and the number of households as obtained in four consecutive cesuses of population, *viz.* 1948, 1953, 1961, and 1971. That information was on magnetic tapes for all the four censuses and the coefficients of variation of aggregates for settlements were computed for these two characteristics for all the strata, all the four censuses, and all the subdivisions. The results obtained are presented in Tables 12 and 13. Table 12 refers to the aggregates of persons and Table 13 to the aggregates of households.

TABLE 9

**Coefficients of variation of the estimated aggregates for the selected characteristics from livestock surveys in the restricted territory of Serbia**

| *Characteristic* | *Years* | | | |
|---|---|---|---|---|
| | *1973* | *1974* | *1975* | *1976* |
| Calves under six months | 1.54 | 1.67 | 1.51 | 1.62 |
| Young stock: 6 months of age and under 1 year | 2.12 | 2.09 | 2.11 | 3.48 |
| Young stock: one year of age and under two years | 2.36 | 2.26 | 2.21 | 3.08 |
| Young stock: 2 years and over | 4.15 | 4.39 | 4.38 | 4.09 |
| Heifers | 2.90 | 2.76 | 2.65 | 2.98 |
| Cows | 0.75 | 0.73 | 0.73 | 1.15 |
| Bulls for service | 8.71 | 7.94 | 8.07 | 9.38 |
| Oxen | 3.60 | 3.66 | 3.75 | 5.63 |
| Total cattle | 0.88 | 0.88 | 0.88 | 1.76 |
| Cattle for fattening | 5.43 | 4.87 | 5.40 | 5.57 |
| Cows kept for draft | 1.45 | 1.50 | 1.54 | 1.74 |
| Pigs: Under two months | 3.68 | 3.49 | 3.52 | 3.95 |
| Pigs: 2 months of age and under 6 months | 1.88 | 1.86 | 1.90 | 2.05 |
| Pigs: 6 months of age and over | 1.88 | 1.90 | 1.97 | 1.89 |
| Gilts | 2.79 | 2.67 | 3.04 | 3.01 |
| Sowa | 1.72 | 1.65 | 1.67 | 1.69 |
| Male pigs for service | 4.54 | 4.46 | 4.15 | 4.42 |
| Pigs for fattening | 8.60 | 8.38 | 7.73 | 7.78 |
| Total pigs | 1.52 | 1.48 | 1.50 | 1.51 |
| Lambs under one year of age | 2.65 | 2.70 | 2.67 | 2.91 |
| Males for service | 2.35 | 2.44 | 2.52 | 2.66 |
| Males and sterile females | 3.07 | 2.99 | 3.74 | 3.12 |
| Total sheep | 2.27 | 2.35 | 2.39 | 2.53 |
| Young horses | 5.65 | 6.00 | 6.10 | 6.70 |
| Horses: Females | 3.37 | 3.63 | 3.53 | 3.67 |
| Horses: Males | 3.12 | 3.25 | 3.15 | 3.21 |
| Total horses | 2.54 | 2.58 | 2.57 | 2.62 |
| Poultry | 1.02 | 1.02 | 1.05 | 0.93 |
| Beehives | 3.97 | 3.77 | 3.65 | 3.67 |
| Buffaloes | 3.84 | 4.37 | 3.84 | 3.23 |
| Number of milking cows | 1.03 | 0.86 | 0.89 | 0.82 |
| Production of milk | 1.63 | 1.35 | 1.42 | 1.27 |
| Number of milking sheep | 3.01 | 3.34 | 3.62 | 3.85 |
| Milk production (liter) | 3.63 | 3.90 | 4.23 | 4.00 |
| Number of sheep clipped | 2.35 | 2.38 | 2.45 | 2.58 |
| Quantity of wool produced (kg) | 2.83 | 2.47 | 2.62 | 3.30 |
| Number of laying hens | 1.05 | 0.91 | 0.99 | 0.91 |
| Egg production | 1.19 | 1.29 | 1.41 | 1.31 |
| Arable land of the household | 0.98 | 0.84 | 0.84 | 0.88 |
| Crop land | 1.62 | 0.97 | 0.98 | 1.06 |
| Fertilizers used (total) | 1.85 | 1.51 | 1.48 | 1.62 |
| Fertilizers on stock | 4.12 | 3.20 | 3.71 | 4.71 |

TABLE 10

**Coefficients of variation of the estimated aggregates for the selected characteristics from livestock surveys in Kosovo**

| *Characteristic* | *Years* | | | |
|---|---|---|---|---|
| | *1973* | *1974* | *1975* | *1976* |
| Calves under six months | 3.30 | 3.64 | 3.26 | 3.34 |
| Young stock — 6 months of age and under 1 year | 3.76 | 3.21 | 3.35 | 3.49 |
| Young stock — 1 year of age and under 2 years | 4.56 | 4.09 | 4.30 | 4.23 |
| Young stock — 2 years and over | 6.42 | 6.03 | 6.05 | 5.90 |
| Heifers | 6.19 | 5.50 | 5.51 | 5.18 |
| Cows | 1.87 | 1.78 | 1.84 | 1.83 |
| Bulls for service | 16.03 | 12.50 | 11.87 | 12.59 |
| Oxen | 4.21 | 4.17 | 4.39 | 4.43 |
| Total cattle | 2.09 | 1.99 | 2.05 | 2.10 |
| Cattle for fattening | 18.71 | 28.22 | 23.85 | 31.72 |
| Cows kept for draft | 5.97 | 5.83 | 6.01 | 6.56 |
| Pigs — Under 2 months | 17.39 | 17.50 | 17.81 | 19.86 |
| Pigs — 2 months of age and under 6 months | 8.21 | 8.64 | 7.89 | 7.96 |
| Pigs — 6 months of age and over | 9.80 | 10.13 | 10.17 | 9.70 |
| Cilts | 15.50 | 15.53 | 15.13 | 13.71 |
| Sows | 15.09 | 13.22 | 13.04 | 14.71 |
| Male pigs for service | 28.05 | 29.17 | 24.47 | 22.57 |
| Pigs for fattening | 27.20 | 23.14 | 29.34 | 33.49 |
| Total pigs | 7.00 | 7.35 | 7.02 | 6.93 |
| Lambs under one year of age | 6.68 | 6.71 | 7.18 | 6.32 |
| Males for service | 4.94 | 5.02 | 5.06 | 5.31 |
| Males and sterile females | 8.22 | 8.22 | 7.47 | 5.20 |
| Total sheep | 5.00 | 5.00 | 5.25 | 8.08 |
| Young horses | 12.85 | 13.18 | 13.73 | 13.84 |
| Horses — Females | 6.66 | 7.80 | | 8.34 |
| Horses — Males | 3.65 | 3.51 | 8.29 | 3.71 |
| Total horses | 3.14 | 3.18 | 3.29 | 3.29 |
| Poultry | 2.01 | 1.87 | 2.21 | 2.00 |
| Beehives | 8.47 | 7.91 | 8.23 | 7.99 |
| Buffaloes | 6.96 | 7.14 | 6.85 | 6.80 |
| Number of milking cows | 1.99 | 1.85 | 1.83 | 1.88 |
| Production of milk | 2.84 | 2.71 | 3.23 | 2.99 |
| Number of milking sheep | 4.73 | 4.85 | 3.20 | 5.53 |
| Milk production (litre) | 5.38 | 6.02 | 5.86 | 6.56 |
| Number of sheep clipped | 4.91 | 4.89 | 5.19 | 5.52 |
| Quantity of wool produced (kg) | 6.01 | 3.23 | 5.36 | 5.77 |
| Number of laying hens | 2.28 | 2.17 | 2.20 | 2.26 |
| Egg production | 3.45 | 3.22 | 3.16 | 3.16 |
| Arable land of the household | 1.93 | 1.84 | 2.10 | 2.10 |
| Crop land | 2.08 | 1.99 | 2.28 | 2.29 |
| Fertilizers used (total) | 3.67 | 3.85 | 3.40 | 3.61 |
| Fertilizers on stock | 9.99 | 8.92 | 9.02 | 9.84 |

TABLE 11

**Coefficients of variation of the estimated aggregates for the selected characteristics from livestock surveys in Voyvodina**

| *Characteristic* | *Years* | | | |
|---|---|---|---|---|
| | *1973* | *1974* | *1975* | *1976* |
| Calves under 6 months | 4.31 | 4·71 | 3.95 | 4.31 |
| Young stock: 6 months of age and under 1 year | 4.57 | 5.01 | 4.55 | 4.43 |
| Young stock: 1 year of age and under 2 years | 5.96 | 6.48 | 6.63 | 6.07 |
| Young stock: 2 years and over | 15.06 | 14.12 | 15.23 | 15.18 |
| Heifers | 6.97 | 6.28 | 6.31 | 6.94 |
| Cows | 2.68 | 2.67 | 2.68 | 2.75 |
| Bulls for service | 24.81 | 27.89 | 33.98 | 41.77 |
| Oxen | 25.65 | 32.63 | 30.00 | 40.22 |
| Total cattle | 2.70 | 2.86 | 2.75 | 2.79 |
| Cattle for fattening | 4.81 | 5.55 | 4.81 | 5.46 |
| Cows kept for draft | 60.00 | 50.34 | 37.83 | 37.19 |
| Pigs: Under 2 months | 3.82 | 3.44 | 4.96 | 5.69 |
| Pigs: 2 months of age and under 6 months | 3.97 | 3.38 | 4.34 | 5.22 |
| Pigs: 6 months of age and over | 6.61 | 6.62 | 5.50 | 6.65 |
| Gilts | 7.66 | 6.83 | 8.41 | 7.32 |
| Sows | 2.61 | 2.40 | 2.61 | 2.96 |
| Male pigs for service | 26.27 | 12.58 | 17.60 | 25.20 |
| Pigs for fattening | 5.10 | 5.07 | 4.90 | 5.14 |
| Total pigs | 2.52 | 2.35 | 2.45 | 2.84 |
| Lambs under one year of age | 10.71 | 10.89 | 14.65 | 14.58 |
| Males for service | 9.20 | 9.80 | 10.42 | 10.94 |
| Males and sterile females | 12.71 | 14.37 | 13.27 | 15.74 |
| Total sheep | 8.93 | 9.75 | 11.18 | 10.79 |
| Young horses | 5.07 | 5.24 | 7.86 | 4.56 |
| Horses: Females | 3.05 | 3.13 | 3.14 | 4·65 |
| Horses: Males | 3.21 | 3.31 | 4.20 | 4.72 |
| Total horses | 2.39 | 2.42 | 3.04 | 2.99 |
| Poultry | 2.12 | 2.85 | 2.54 | 1.83 |
| Beehives | 16.03 | 13.30 | 13.02 | 14.16 |
| Buffaloes | — | — | — | — |
| Number of milking cows | 4.18 | 2.66 | 6.08 | 5.28 |
| Production of milk | 2.95 | 2.85 | 5.07 | 3.06 |
| Number of milking sheep | 10.62 | 11.16 | 8.00 | 11.79 |
| Milk production (liter) | 8.80 | 11.79 | 12.40 | 11.26 |
| Number of sheep clipped | 8.95 | 9.08 | 13.42 | 14.12 |
| Quantity of wool produced (kg) | 10.86 | 9.48 | 10.43 | 10.97 |
| Number of laying hens | 1.86 | 1.78 | 3.40 | 1.80 |
| Egg production | 2.25 | 2.01 | 2.35 | 2.02 |
| Arable land of the household | 1.80 | 1.77 | 1.96 | 2.09 |
| Crop land | 1.82 | 1.78 | 2.11 | 2.19 |
| Fertilizers used (total) | 2.42 | 2.58 | 2.62 | 2.36 |
| Fertilizers on stock | 9.81 | 6.95 | 6.68 | 7.88 |

TABLE 12

**Coefficients of variation of aggregates of persons in four consecutive censuses of population by sub-divisions and size of settlements (Percentages)**

| *Size class (persons)* | *Year* | *Yugoslavia* | *Bosnia and Herzegovina* | *Montenegro* | *Croatia* | *Macedonia* | *Slovenia* | *Serbia restricted territory* | *Voyvodina* | *Kosove* |
|---|---|---|---|---|---|---|---|---|---|---|
| Total | 1948 | 4,67 | 3,24 | 1,81 | 7,36 | 4,23 | 4,78 | 2,49 | 1,60 | 2,18 |
| | 1953 | 4,97 | 3,36 | 2,11 | 7,90 | 4,94 | 5,15 | 2,78 | 1,66 | 2,30 |
| | 1961 | 5,75 | 3,79 | 3,13 | 9,26 | 6,38 | 5,68 | 3,34 | 1,86 | 2,70 |
| | 1971 | 6,98 | 4,47 | 4,53 | 11,52 | 8,47 | 6,33 | 4,02 | 2,24 | 3,39 |
| 0—49 | 1948 | 0,43 | 0,37 | 0,34 | 0,54 | 0,71 | 0,39 | 0,21 | 0,45 | 0,31 |
| | 1953 | 0,38 | 0,34 | 0,26 | 0,40 | 0,40 | 0,38 | 0,56 | — | 0,28 |
| | 1961 | 0,40 | 0,35 | 0,25 | 0,42 | 0,54 | 0,40 | 0,28 | — | 0,30 |
| | 1971 | 0,48 | 0,43 | 0,37 | 0,51 | 0,92 | 0,44 | 0,39 | — | 0,54 |
| 50—99 | 1948 | 0,19 | 0,19 | 0,18 | 0,19 | 0,17 | 0,20 | 0,17 | 0,18 | 0,17 |
| | 1953 | 0,19 | 0,19 | 0,19 | 0,19 | 0,18 | 0,20 | 0,14 | 0,10 | 0,19 |
| | 1961 | 0,19 | 0,18 | 0,17 | 0,19 | 0,20 | 0,20 | 0,17 | 6,00 | 0,16 |
| | 1971 | 0,20 | 0,19 | 0,19 | 0,19 | 0,19 | 0,20 | 0,16 | 0,03 | 0,16 |
| 100—199 | 1948 | 0,19 | 0,19 | 0,19 | 0,19 | 0,19 | 0,20 | 0,18 | 0,23 | 0,19 |
| | 1953 | 0,19 | 0,19 | 0,20 | 0,19 | 0,19 | 0,20 | 0,17 | 0,17 | 0,18 |
| | 1961 | 0,20 | 0,20 | 0,19 | 0,19 | 0,19 | 0,20 | 0,18 | 0,22 | 0,18 |
| | 1971 | 0,19 | 0,19 | 0,19 | 0,19 | 0,19 | 0,20 | 0,17 | 0,19 | 0,19 |
| 200—499 | 1948 | 0,26 | 0,27 | 0,26 | 0,26 | 0,26 | 0,26 | 0,24 | 0,25 | 0,26 |
| | 1953 | 0,26 | 0,26 | 1,27 | 0,26 | 6,25 | 0,26 | 0,24 | 0,27 | 0,26 |
| | 1961 | 0,26 | 0,26 | 0,27 | 0,26 | 0,25 | 0,26 | 0,24 | 0,24 | 0,26 |
| | 1971 | 0,26 | 0,26 | 0,28 | 0,26 | 0,25 | 0,26 | 0,24 | 0,25 | 0,25 |
| 500—999 | 1948 | 0,20 | 0,20 | 0,19 | 0,20 | 0,20 | 0,21 | 0,20 | 0,20 | 0,20 |
| | 1953 | 0,20 | 0,20 | 0,20 | 0,20 | 0,20 | 0,20 | 0,19 | 0,17 | 0,20 |
| | 1961 | 0,20 | 0,20 | 0,20 | 0,20 | 0,20 | 0,20 | 0,19 | 0,18 | 0,19 |
| | 1971 | 0,20 | 0,20 | 0,20 | 0,20 | 0,19 | 0,20 | 0,20 | 0,19 | 0,20 |
| 1000—4999 | 1948 | 0,47 | 0,47 | 0,50 | 0,45 | 0,47 | 0,53 | 0,42 | 0,44 | 0,29 |
| | 1951 | 0,47 | 0,44 | 0,56 | 0,44 | 0,40 | 0,52 | 0,42 | 0,45 | 0,32 |
| | 1961 | 0,47 | 0,43 | 0,50 | 0,45 | 0,41 | 0,49 | 0,44 | 0,44 | 0,40 |
| | 1971 | 0,47 | 0,44 | 0,47 | 0,47 | 0,44 | 0,51 | 0,43 | 0,43 | 0,42 |
| 5000 and over | 1948 | 1,61 | 1,17 | 0,26 | 2,14 | 1,18 | 0,85 | 0,96 | 0,99 | 0,45 |
| | 1953 | 1,67 | 1,19 | 0,33 | 2,28 | 1,44 | 0,98 | 1,06 | 1,02 | 0,46 |
| | 1961 | 1,77 | 1,32 | 0,68 | 2,42 | 1,55 | 1,06 | 1,12 | 1,16 | 0,51 |
| | 1971 | 1,89 | 1,33 | 0,95 | 2,59 | 1,84 | 1,01 | 1,20 | 1,34 | 0,71 |

TABLE 13

**Coefficients of variation of aggregates of households in four consecutive censuses of population by subdivision and size of settlements (Percentages)**

| *Size class (persons)* | *Year* | *Yugoslavia* | *Bosnia and Herzegovina* | *Montenegro* | *Croatia* | *Macedonia* | *Slovenia* | *Serbia restricted territory* | *Voyvodina* | *Kosovo* |
|---|---|---|---|---|---|---|---|---|---|---|
| Total | 1948 | 4,96 | 5,06 | 2,41 | 9,42 | 5,80 | 6,75 | 4,14 | 1,99 | 3,10 |
| | 1953 | 7,21 | 4,92 | 2,72 | 10,73 | 6,39 | 6,71 | 4,27 | 1,97 | 3,17 |
| | 1961 | 7,88 | 5,27 | 3,90 | 11,87 | 7,74 | 6,80 | 4,66 | 2,15 | 3,69 |
| | 1971 | 8,83 | 5,83 | 5,28 | 13,99 | 9,87 | 7,54 | 4,99 | 2,48 | 4,46 |
| 0—49 | 1948 | 0,51 | 0,47 | 0,39 | 0,59 | 0,72 | 0,45 | 0,33 | 0,50 | 0,43 |
| | 1953 | 0,44 | 0,39 | 0,38 | 0,48 | 0,50 | 0,43 | 0,43 | — | 0,49 |
| | 1961 | 0,47 | 0,45 | 0,40 | 0,45 | 0,89 | 0,44 | 0,38 | — | 0,32 |
| | 1971 | 0,53 | 0,51 | 0,44 | 0,55 | 0,96 | 0,48 | 0,58 | — | 0,59 |
| 50—99 | 1848 | 0,30 | 0,28 | 0,29 | 0,28 | 0,28 | 0,28 | 0,33 | 0,17 | 0,29 |
| | 1953 | 0,31 | 0,35 | 0,27 | 0,27 | 0,39 | 0,29 | 0,37 | 0,06 | 0,27 |
| | 1961 | 0,30 | 0,30 | 0,30 | 0,27 | 0,36 | 0,27 | 0,46 | 0,00 | 0,27 |
| | 1971 | 0,30 | 0,31 | 0,30 | 0,27 | 0,32 | 0,26 | 0,32 | 0,00 | 0,29 |
| 100—199 | 1948 | 0,33 | 0,29 | 3,27 | 0,35 | 0,28 | 0,28 | 0,27 | 0,24 | 0,31 |
| | 1853 | 0,30 | 0,27 | 0,27 | 0,27 | 0,27 | 0,27 | 0,27 | 0,20 | 0,26 |
| | 1961 | 0,30 | 0,27 | 0,30 | 0,26 | 0,37 | 0,26 | 0,28 | 0,29 | 0,27 |
| | 1971 | 0,29 | 0,29 | 0,26 | 0,24 | 0,29 | 0,25 | 0,29 | 0,25 | 0,29 |
| 200—499 | 1948 | 0,35 | 0,32 | 0,31 | 0,32 | 0,34 | 0,32 | 0,31 | 0,25 | 0,30 |
| | 1953 | 0,35 | 0,33 | 0,36 | 0,32 | 0,29 | 0,32 | 0,31 | 0,26 | 0,32 |
| | 1961 | 0,36 | 0,35 | 0,33 | 0,32 | 0,30 | 0,32 | 0,32 | 0,22 | 0,32 |
| | 1971 | 0,35 | 0,34 | 0,31 | 0,30 | 0,31 | 0,30 | 0,30 | 0,24 | 0,35 |
| 500—999 | 1948 | 0,32 | 0,27 | 0,34 | 0,28 | 0,24 | 0,28 | 0,28 | 0,24 | 0,27 |
| | 1953 | 0,32 | 0,30 | 0,31 | 0,29 | 0,25 | 0,26 | 0,28 | 0,22 | 0,26 |
| | 1961 | 0,33 | 0,32 | 0,31 | 0,29 | 0,28 | 0,27 | 0,28 | 0,21 | 0,28 |
| | 1971 | 0,32 | 0,28 | 0,31 | 0,28 | 0,28 | 0,25 | 0,26 | 0,20 | 0,29 |
| 1000—4999 | 1948 | 0,64 | 0,57 | 0,60 | 0,59 | 0,70 | 0,66 | 0,56 | 0,47 | 0,51 |
| | 1953 | 0,64 | 0,64 | 0,61 | 0,57 | 0,55 | 0,61 | 0,55 | 0,47 | 0,51 |
| | 1961 | 0,62 | 0,55 | 0,68 | 0,56 | 0,59 | 0,56 | 0,55 | 0,47 | 0,58 |
| | 1971 | 0,62 | 0,55 | 0,59 | 0,57 | 0,55 | 0,57 | 0,51 | 0,45 | 0,55 |
| 5000 and over | 1948 | 1,19 | 1,35 | 0,30 | 2,04 | 1,21 | 0,96 | 1,12 | 1,20 | 0,49 |
| | 1953 | 1,88 | 1,31 | 0,33 | 2,42 | 1,45 | 1,02 | 1,19 | 1,18 | 0,51 |
| | 1961 | 1,96 | 1,41 | 0,74 | 2,57 | 1,54 | 1,06 | 1,24 | 1,32 | 0,57 |
| | 1971 | 2,06 | 1,41 | 0,97 | 2,77 | 1,88 | 1,03 | 1,30 | 1,46 | 0,78 |

The coefficients presented vary from stratum to stratum. However, the stability of variation patterns is quite high in spite of data for 1971. Some changes in the definition of settlements have taken place prior to that census and this is reflected in the magnitude of the coefficients of variation.

The reader will also notice that some coefficients of variation in the same strata of different subdivisions have almost the same magnitude. This will obviously greatly facilitate the presentation of sampling errors for subdivisions.

## IX

The last illustration refers to the variations of the characteristics that are usually encountered in censuses of population or in demographic surveys.

For this illustration data are taken from the Yugoslav censuses of population in 1961 and 1971. A limited number of characteristics is selected that were common to both censuses. As the aggregates for settlements of persons having a given attribute were available on tapes the coefficients of variation of these aggregates were calculated as before for all the selected characteristics and in five republics or autonomous provinces (subdivisions).

The results obtained are presented in Table 14. In the stub of that table the characteristics are shown that were selected for this study. The columns contain the names of subdivisions. In the body of the table the respective values of coefficients of variation are given in two lines related to 1961 and 1971.

From data in this table the same conclusion follows as before regarding the stability of variation patterns. In two censuses that are ten years apart from each other the values of coefficients stay at the same level for a large number of census characteristics. In other words, data from an old census can be utilized many years after the census for a satisfactory assessment of sampling errors of future surveys and for other related studies, such as the presentation of sampling errors.

## X

The material presented makes possible the following conclusions :

(*i*) If the survey is taken for the first time and no data are available from the past that could be utilized for the purpose of an

TABLE 14

**Coefficients of variation for the selected characteristics in censuses of population in 1961 and 1971 (by subdivisions)**

| *Characteristics* | *Year* | *Monten-egro* | *Slovenia* | *Restricted territory of Serbia* | *Kosovo* | *Voyvo-dina* |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1. Total population | 1961 | 3,1 | 5,7 | 3,3 | 2,7 | 1,9 |
| | 1971 | 4,5 | 6,3 | 4,0 | 3,4 | 2,2 |
| 2. Total males | 1961 | 3,2 | 4,4 | 3,3 | 2,9 | 1,8 |
| | 1971 | 4,0 | 5,2 | 4,0 | 3,2 | 2,2 |
| 3. Total females | 1961 | 3,0 | 4,7 | 3,4 | 2,7 | 1,9 |
| | 1971 | 3,5 | 5,4 | 4,1 | 3,4 | 2,3 |
| 4. School attainment : | | | | | | |
| Without formal education | 1961 | 1,8 | 2,7 | 1,4 | 2,0 | 1,3 |
| | 1971 | 2,5 | 3,7 | 1,6 | 2,6 | 1,4 |
| Four years | 1961 | 2,7 | 3,5 | 2,8 | 2,8 | 1,6 |
| | 1971 | 3,5 | 4,2 | 2,8 | 2,9 | 1,7 |
| Eight years | 1961 | 5,8 | 5,0 | 6,3 | 5,6 | 3,3 |
| | 1971 | 6,2 | 5,3 | 5,9 | 4,7 | 2,8 |
| Schools for qualified workers | 1961 | 8,2 | 8,7 | 9,2 | 9,3 | 3,7 |
| | 1971 | 8,2 | 9,7 | 8,3 | 8,7 | 3,6 |
| High school | 1961 | 7,3 | 17,0 | 15,1 | 11,1 | 5,2 |
| | 1971 | 8,7 | 16,2 | 13,0 | 10,1 | 5,2 |
| Vocational schools | 1961 | 8,5 | 11,0 | 10,3 | 9,1 | 4,7 |
| | 1971 | 10,4 | 12,2 | 9,4 | 8,3 | 4,5 |
| Higher schools | 1961 | 10,5 | 13,1 | 12,7 | 14,2 | 5,4 |
| | 1971 | 9,9 | 14,5 | 10,8 | 11,5 | 5,0 |
| University | 1961 | 12,3 | 21,2 | 20,0 | 15,4 | 6,5 |
| | 1971 | 14,4 | 19,3 | 18,8 | 16,0 | 7,3 |
| Unknown | 1961 | 9,5 | 9,9 | 6,6 | 7,0 | 8,5 |
| | 1971 | 8,7 | 10,2 | 9,1 | 6,3 | 3,7 |
| 5. Number of illiterates | 1961 | 1,6 | 2,7 | 1,2 | 1,9 | 1,3 |
| | 1971 | 2,3 | 3,8 | 1,5 | 2,5 | 1,3 |
| 6. Branches of industry : | | | | | | |
| Manufacturing and mining | 1961 | 8,0 | 6,6 | 7,3 | 6,5 | 4,2 |
| | 1971 | 8,4 | 7,8 | 7,0 | 7,5 | 4,0 |
| Agriculture and fishing | 1961 | 0,9 | 1,2 | 0,9 | 0,9 | 0,8 |
| | 1971 | 1,0 | 1,4 | 0,9 | 0,9 | 0,8 |
| Forestry | 1961 | 3,3 | 3,4 | 3,8 | 4,5 | 3,2 |
| | 1971 | 4,3 | 3,9 | 3,7 | 4,6 | 3,0 |
| Construction work | 1961 | 5,2 | 8,2 | 7,7 | 5,4 | 3,1 |
| | 1971 | 6,3 | 10,5 | 6,9 | 4,6 | 3,2 |
| Transportation | 1961 | 7,1 | 6,9 | 9,0 | 7,4 | 4,8 |
| | 1971 | 7,1 | 8,3 | 7,8 | 7,3 | 4,1 |
| Commerce and services | 1961 | 8,6 | 10,3 | 10,0 | 10,7 | 4,8 |
| | 1971 | 8,0 | 11,0 | 9,4 | 9,7 | 4,7 |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| 7. Nationality : | | | | | | |
| Montenegrians | 1961 | 3,2 | 13,1 | 13,2 | 7,9 | 5,8 |
| | 1971 | 5,2 | 14,2 | 10,6 | 10,6 | 5,7 |
| Croats | 1961 | 9,8 | 9,3 | 18,9 | 17,2 | 4,5 |
| | 1971 | 10,4 | 12,2 | 16,7 | 18,5 | 4,9 |
| Macedonians | 1961 | 12,8 | 11,6 | 13,9 | 13,6 | 7,0 |
| | 1971 | 11,7 | 14,5 | 12,1 | 14,9 | 6,6 |
| Moslems (in sense of nationality) | 1961 | 5,3 | 17,6 | 10,9 | 6,5 | 5,5 |
| | 1971 | 5,0 | 16,1 | 13,1 | 7,6 | 4,9 |
| Slovenians | 1961 | 9,0 | 4,4 | 16,4 | 12,8 | 4,5 |
| | 1971 | 10,8 | 6,1 | 15,0 | 12,6 | 4,7 |
| Serbs | 1961 | 7,5 | 11,0 | 3,1 | 3,2 | 1,9 |
| | 1971 | 5,3 | 13,4 | 3,8 | 4,1 | 2,4 |
| Albanians | 1961 | 5,6 | 13,2 | 10,2 | 2,4 | 4,6 |
| | 1971 | 5,7 | 12,3 | 10,5 | 3,0 | 4,8 |
| Hungarians | 1961 | 9,1 | 16,4 | 14,4 | 10,9 | 3,0 |
| | 1971 | 10,9 | 16,2 | 12,7 | 12,7 | 3,3 |
| 8. Households by number of members : | | | | | | |
| 1 | 1961 | 5,8 | 9,0 | 9,4 | 7,3 | 3,3 |
| | 1971 | 6,1 | 10,5 | 8,0 | 7,4 | 3,3 |
| 2 | 1961 | 7,9 | 6,6 | 6,6 | 5,9 | 2,4 |
| | 1971 | 5,8 | 8,9 | 6,0 | 6,6 | 2,6 |
| 3 | 1961 | 4,6 | 5,9 | 5,9 | 5,5 | 2,3 |
| | 1971 | 6,5 | 8,9 | 6,3 | 6,8 | 2,9 |
| 4 | 1961 | 4,7 | 5,2 | 4,8 | 4,9 | 2,0 |
| | 1971 | 7,1 | 7,1 | 5,4 | 7,0 | 2,3 |
| 5 | 1961 | 4,0 | 3,8 | 2,8 | 4,1 | 1,5 |
| | 1971 | 5,9 | 4,6 | 2,9 | 5,3 | 1,7 |
| 6 | 1961 | 2,9 | 2,8 | 1,6 | 3,4 | 1,2 |
| | 1971 | 4,1 | 3,1 | 1,7 | 4,3 | 1,3 |
| 7 | 1961 | 2,2 | 2,1 | 1,2 | 3,0 | 1,1 |
| | 1971 | 2,8 | 2,4 | 1,5 | 3,7 | 1,3 |
| 8 and over | 1961 | 1,6 | 2,1 | 1,1 | 1,7 | 1,2 |
| | 1971 | 2,1 | 2,6 | 1,7 | 2,3 | 1,4 |
| 9. Sources of income : | | | | | | |
| Agriculture | 1961 | 0,9 | 1,2 | 1,0 | 1,0 | 0,9 |
| | 1971 | 1,0 | 1,5 | 1,0 | 1,0 | 0,9 |
| Mixed | 1961 | 1,3 | 1,4 | 1,5 | 1,9 | 1,5 |
| | 1971 | 1,3 | 1,2 | 1,2 | 1,4 | 1,2 |
| Non-agricultural | 1961 | 9,0 | 8,9 | 10,6 | 10,0 | 4,4 |
| | 1971 | 8,0 | 9,7 | 8,8 | 8,4 | 3,9 |

advanced assessment of sampling errors the data collected in the survey itself have to be used for the computation of errors. In that case the use of the stability of variation patterns does not arise. The variation patterns are not known.

(*ii*) In repetitive surveys the variation patterns are known. This fact makes it possible to abolish the computation of errors in subsequent surveys and use instead the estimates of precision based on the information available from the first survey. It also makes possible to proceed at ease with a study of the presentation of errors in subsequent surveys. More time available for such studies will open up better chances of success without any danger of delaying the release of data from new surveys.

(*iii*) The same use of the stability of variation patterns can be made in the cases when surveys are designed on the basis of past censuses. In this case census data are used to assess sampling errors that will follow from the design adopted for the subsequent surveys.

(*iv*) While preparing for a survey to be repeated latter on it is a matter of good policy to plan a broader programme of data processing in the initial survey so that estimates of the components of variation are secured. Data thus obtained will facilitate the efficiency studies of the first design and reduce the burdon of sampling errors in the subsequent surveys as long as their design is based on the known components of variation.

(*v*) Some risk arises in the use of past information for purposes presented here. This is particularly true in cases when the first survey is based on a small sample or the characteristics that appear on the programme of the first survey are likely to vary considerably over time, such as food consumption, expenditure, income of agricultural population, sales of seasonal goods, unemployment, etc. In this type of situations various precautionary measures are needed, such as the fresh calculation of errors from time to time, etc.

(*vi*) The use of the above possibilities for the reduction of problems associated with sampling errors is particularly important if the survey organizations are facing difficulties in data processing because of the lack of computer capacity, the skills on the part of staff, or both.

(*vii*) In case of considerable experience in the utilization of computers in survey work, the related ability of survey organization to arrange for quick data processing, and an easy access to computers

the computation of sampling errors is just an additional piece of work for the computer and the staff. In this case the problem of sampling errors has a different notice. It is proposed to deal with this issue separately.

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