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OCCUPATIONAL CODING

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Social scientists study occupational mobility to determine among other things how flexible a society and an economic system are and/or to measure the importance of particular types of job experience on earnings.[1] Because of data limitations, studies of occupational mobility are generally based on the respondent's report of current job and recalled information on his (or father's) occupation in an earlier period. Two messy problems that arise with such studies are the assignment of occupation from the job descriptions and the accuracy of recalled information. About the only information available on these topics is contained in Census studies [2, 3, 4] based on renumeration surveys, matched records from several different surveys or reanalysis of say the 1950 occupation responses on the basis of 1960 classification rules. However, the analysis in the later instance was restricted to those categories in which changes were known to have been made.

Using the NBER-TH sample, this note attempts to shed some light on the coding error arising from the use of one rather than another coding or assignment system, the usefulness of recalled occupational histories and the advantages of asking for and coding job descriptions rather than asking respondents to check the box that best describes their occupation. These results will be of interest to people who use the occupational information in the NBER-TH and even in other samples. In addition the results have some relevance to the design and processing of future samples.

CONCLUSIONS

Before getting the reader bogged down in detailed comparisons, I will state my conclusions and what I think are the implications for the design and processing of future samples. First, if broad occupational groupings are all the investigator requires, reasonably accurate data can be obtained by having respondents check the appropriate item from a list. Incidentally, these responses do not indicate that individuals inflate their status position. Since such a list can be precoded, this procedure saves time and money. The list, however, might have to be broadened somewhat from the one used in this study to allow for more professional subcategories. Also, separate questions on being self employed and number of people supervised could be added.

Second, the information on recalled estimates when combined with the mobility tables suggests that differences in coding rules and in coders can lead to relatively large differences in the distribution of the processed outcomes; but memory recall on job histories is not a serious problem. This observation raises the question, which we cannot answer, of whether it would be possible to use a precoded occupation list for different dates when obtaining an occupation history.

[1] See Blau and Duncan [1], Sewell, Haller, and Portes [5], Wolfle and Smith [8] on the first use and Taubman and Wales [6] on the second.

This also suggests that to help achieve comparability between different samples, time periods and studies, it would be useful for various data collectors to use the same detailed coding system.

Finally, it is important to note that the people in this sample are all at least high school graduates and have at least an average IQ. The memory recall and accuracy of check off systems might vary by education and IQ. Also, because of their IQ and education, people in this sample are not distributed over occupations the same as the population as a whole.

NBER-TH Sample

The NBER-TH sample is a rich and rather unusual body of data. For a complete description of the sample see Taubman–Wales [6] but for our purposes the crucial elements are the following. In 1955 Thorndike and Hagen [7] undertook a study of the usefulness of some seventeen tests that measure various types of skills in predicting the post World War II vocational success of air force veterans. A crucial ingredient of their study was the assignment of the respondent to one of 125 occupations on the basis of detailed job descriptions he supplied. As is evident from reading their book, a great deal of expertise and attention to detail went into the assignment process. The results of these codings will be referred to as TH.

In 1969 the NBER conducted another survey of these men, collecting among other things a job history, from which the NBER has also carefully and meticulously assigned 9 major and 102 minor occupational codes. In the history nearly everyone reported a current occupation, which will be denoted NBER69.[2] But since details were sparse for earlier years an occupation code was assigned only for a period in which a job (not necessarily an occupation) change occurred or in which the reported interval on a particular job covered the period.[3] One such span of years was 1953–57 for which responses are available for some 1,800 people. We will denote this coding as NBER37. In addition, in 1969 the respondents were asked to check off one of 13 broad categories that best described their current job (as well as separate columns for their father and father-in-law).[4] The information contained in the 13 broad categories will be denoted as OWN.

The Coding Process

A coding process is the implementation of a set of rules to transform or classify responses to questions into one of several mutually exclusive categories.

Ideally, we would like to be able to answer the following questions. First, would the coding rules, R, be the same for two or more researchers? That is, would R^1 equal $R^2 \ldots R^N$ where the superscripts are individual researchers? Second, when individuals are asked to recall information, do they recall correctly and do they report it in the same way so that a given R would transform it to the same

[2] Most questionnaires were answered in 1969, but about 15 percent were answered in 1970.

[3] If the period is 1953–57, and the person was on one job from 1950–56 and changed jobs in 1957, the 1957 job was included.

[4] The actual questions are given in the appendix.

category? Third, given the rules and responses would different coding clerks end up with the same categories, Y_j? In the comparisons of NBER37 and TH, it is not possible to evaluate each of these questions separately though we can compare the overall correspondence of the two answers.

In the comparisons of NBER69 and OWN, there are fewer reasons for differences in the Y_j. That is, we can assume the respondents supplied the same general information to themselves or OWN and the NBER coders who calculated NBER69. The differences, thus, occur because the rules used by each individual and the NBER vary, because the detailed categories had to be aggregated to grosser levels, and because the particular description connote different things to the individual and the coder.

NBER69 AND OWN

Both because the responses are in general the same and because the results are better, let us consider first the OWN and NBER69 comparisons. In making these comparisons we will have to allow for the fact that some of the possible categories were not available in both OWN and NBER69. Generally this will not cause a problem since, for example, the self employed and salaried professional groups in OWN should be contained in the total professional group in NBER69.[5] Also the medical and law categories as well as the professional (other) in NBER69 should be contained in the two OWN professional categories. The detailed categories contained in the broad NBER groups, which were designed by the author, will be made available on request.

Consider the distribution of each of the responses over the NBER groups in Table 1. There is no "owner" group in the NBER code (except in the class of worker code), but such people would be expected to be found mostly in the manager category especially since self-employed professional is a possible response in OWN. 75 percent of the owners do appear in the NBER manager cell. The next largest concentration, $8\frac{1}{2}$ percent, is found in the low management sales category. In the NBER code this group would include some insurance brokers.[6] The same explanation may apply to garage owners and self employed accountants in the other professional and technical category though numbers involved here are small.

The OWN manager group also is heavily concentrated (75 percent) in the NBER high manager category with another 9 percent in the low level manager sales group. The only other large concentration is in the engineering group, but Mantell who studied the engineers intensively has personally informed me that by 1969 many engineers had supervisory responsibilities over the engineers and titles such as engineering manager. It seems likely that this is a coding difference arising from rule ambiguity and/or the exact informational content of respondents.

About 72 percent of the self-employed professionals are found in the medical, law, engineering, and other professional categories of the NBER. An additional 9 percent are in the NBER teacher group which would be a more likely response for the salaried professional. This large group may be either an error in which

[5] The additional class of worker code in the NBER which indicates self-employment was not used here.

[6] The NBER also has a class of worker code which would indicate self-employment but it was not used here.

TABLE 1

	NBER69 Occupations						
	Professional	Teacher	Medical	Engineering	Law	Technical	Managerial
Owner							
Percent	1.7	0.2		0.6	0.3	2.9	76.2
Number	16	2		6	3	27	719
Manager							
Percent	1.8	2.9	0.1	4.3	0.1	1.1	74.4
Number	27	44	2	64	2	17	1,113
Self-Employed Professional							
Percent	12.6	9.1	20.5	5.4	33.1	7.6	7.6
Number	40	29	65	17	105	24	24
Salaried Professional							
Percent	11.9	38.5	0.4	26.8	3.8	4.1	8.3
Number	87	282	3	196	28	30	61
Technical							
Percent	2.5	0.7		18.2		60.7	7.0
Number	7	2		52		173	20
Clerical							
Percent	2.6			2.6		14.1	9.0
Number	2			2		11	7
Sales							
Percent	0.6	0.3		5.3		0.6	14.9
Number							
Service							
Percent				2.1		1.4	7.1
Number				3		2	10
Other							
Percent	1.4	0.8		3.3		5.5	9.2
Number	7	4		16		27	45
Total							
Percent	3.9	7.6	1.5	7.8	2.9	6.5	42.6
Number	188	364	70	373	188	313	2,047

TABLE 1 (continued)

	NBER69 Occupations					Total	
	Clerical	Sales	Service	Farm	Skilled-Unskilled	Number	Percent
Owner							
Percent	0.4	8.5	0.3	7.1	1.7		19.6
Number	4	80	3	67	16	943	
Manager							
Percent	2.8	9.0	1.6	0.1	1.6		31.1
Number	42	135	24	1	24	1,495	
Self-Employed Professional							
Percent	0.3	3.2		0.3	0.3		6.6
Number	1	10		1	1	317	
Salaried Professional							
Percent	2.6	1.8	1.1		0.7		15.2
Number	19	13	8		5	732	
Technical							
Percent	2.5	0.7			7.7		5.9
Number	7	2			22	285	
Clerical							
Percent	50.0	5.1	11.5		5.1		1.6
Number	39	4	9		4	78	
Sales							
Percent	0.3	76.7	0.3		0.9		6.7
Number	1	247	1		3	322	
Service							
Percent	5.0	2.1	66.4		15.7		2.9
Number	7	3	93		22	140	
Other							
Percent	2.3	1.6	3.3	0.4	72.1		10.2
Number	11	8	16	2	352	488	
Total							
Percent	2.7	10.5	3.2	1.5	9.4		100.0
Number	131	502	154	71	449	4,800	

box the respondents checked or in punching. The other two large entries are in the managerial and technical groups. Both may be ambiguity errors over, for example, accountants and garage mechanics who own firms but did not so note in the histories used by the NBER.

About 85 percent of the salaried professionals fall into the NBER codes of other professionals, teachers, medical, law, and engineering. Once again and perhaps for the same reason there are relatively large numbers who appear in the technical and managerial groups.

Of those who considered themselves in the technical occupation, 61 percent are in the NBER technical groups. Another 18 percent were classified as engineers by the NBER--a surprising result since the latter's code rules automatically classified a high school graduate working as engineer as a skilled worker. The other concentrations in the NBER code are in the skilled-unskilled and the management groups. The NBER tends to place people with supervisory roles in management even if the person supervises several lathe workers.

Half of the office workers are found in the clerical group with 35 percent more in the technical, managerial and service groups. This 35 percent probably represents code rule differences since the NBER places most postal employees and many other government workers who are not top level bureaucrats or professionals in the service group. Also the NBER might treat the chief clerk as a manager and count certain office technicians as technical.

The sales group finds three-quarters of its members in the NBER low management-sales group and most of the rest in the managerial group. The latter would include salesmen who supervise other sellers. Nearly two-thirds of the OWN service workers are contained in the NBER service group with a large concentration in the skilled-unskilled category and smaller ones in the manager and clerical group. It is not clear what causes these differences other than the supervisory rule in the NBER codes, though it is surprising that the NBER tends to assign people to higher status positions than the OWN code.

The "other" group which includes foremen, skilled and unskilled blue collar workers and probably some farm workers has 72 percent of its members in the NBER skilled-unskilled group and $5\frac{1}{2}$ and 9 percent among technicians and managers. Once again the NBER seems to be assigning more status.

If we examine the whole table, nearly 70 percent of the people are in the "same" category under the two codings even if we make no allowance for the low management sales group including managers and for engineers including technicians, etc. Reasonable allowance for these and related categories would raise the correspondence rate to at least 80 percent. Much of the remaining difference would seem to arise from coding rule ambiguities or a difference of the relative importance assigned to supervisory tasks. Surprisingly, there is little evidence that people tended to inflate the status of their OWN evaluation. The remaining differences do not greatly change a person's occupational status. I would conclude from this discussion that for occupational mobility and other studies that can rely on broad occupational groupings, a question that asks a person to check his own occupation would work as well as coding up a detailed job information history, but would cost substantially less. Such a self coding question could be improved by allowing for more categories such as lawyer, engineer, and govern-

ment employee. A major qualification to this conclusion is that the NBER-TH sample is a highly educated and mentally very able group and the correspondence may decline for the population as a whole though the skilled-unskilled group which contains more of the less educated and able members of the sample also match well.

NBER AND TH

Next let us compare the NBER37 and TH codes. The two results can differ because the information, coding rules, and coders differ. The NBER37 series transforms job descriptions recalled for a period more than a decade ago by a classification scheme designed in the light of current technological requirements and attitudes. The coding process may also vary because different people set the rules. One such difference noted earlier arises for a person who supervises lathe operators. In the TH system, he would be considered a "lathe operator" with a worker code of "supervisor." The NBER code would consider him a "manager." Some of this difference could be narrowed by using the supplementary information in the job worker code in both systems, but this complicates matters and also hides some relevant rule differences.

The NBER37 series can also differ from the TH material because the respondents recall the 1953–57 period incorrectly, because different key words are used to describe the same job, because people changed occupations in 1956 or 1957, and because coding rules contain some ambiguity and the coders are different. Thus a comparison of NBER37 with TH combines various sources of misclassification. But some separation of causes can be made on the basis of other results, as described below.

In principle it would be possible to compare the NBER37 and TH on the most disaggregated basis such as welder, but in my work and in occupational mobility analysis only relatively broad categories are used. Since for these purposes intracategory misclassifications involve no loss in information, I will use the fairly broad categories given below. However there is available upon request a list of the number of people for whom both codes are available, in each occupation in the code list.

COMPARISONS OF NBER37 WITH TH

A detailed examination of the subcategories in the twelve major occupation groups for both codes reveals general conformity but a few major discordancies. For example the NBER considers a person a "professional engineer" only if he has a college degree while TH does not make this distinction. The NBER classifies government workers who are not executives or professionals as "service" workers while TH includes postal workers in the "clerical" category. The NBER also distinguishes between lower level and other managers while the same breakdown is not available in TH. Moreover the NBER would tend to count as management, clerks and others who have supervisory responsibilities. On the other hand, TH has a "contractor" category which is not available in the NBER code.

Several other comments about these divisions are appropriate. First the components of the aggregated categories were selected by the author (after the NBER coding was completed). Second in many instances in which there are obvious misclassifications, it is not possible to disaggregate further the codes, though we have some idea of the numbers involved because of comments on detail made by Thorndike and Hagen in their separate chapters.[7] In an important sense, these are errors arising from the independent construction of the coding rules.

Despite the similarity of names in the rest of aggregate categories we might still find nonconformity of occupations because of all the reasons discussed earlier. Let us, therefore, turn to Table 2 which contains a cross classification of the number of people who fall into occupation *j* on the TH system and occupation *k* in the NBER system and (2) the percentage distribution over the *k* classes within each of the *j* classes in the TH code.

Of course those people who are classified the same would appear in the row and column of the same name. For convenience, we will denote all such cells as the diagonal even though that the TH code has the extra category of contractor. The percentages (of the row sum) in these diagonal cells varies from 31 percent for both clerical and other professionals to 83 percent for teachers.[8] Combining the contractor category with management, we find that 60 percent of the people are classified the same.

It hardly seems necessary to test whether such concordance is significantly different from zero or a random assignment. However, this is a very weak and almost trivial conclusion. But I would also say that 60 percent is not a strong degree of concordance and less than that found in Table 1. Of course some of this poor performance occurs because of the known coding rule differences. For example as explained earlier postal employees are in the TH "clerk" category and NBER "service category." About 9 percent of the TH clerks are in the NBER service category. Not all of these people need be postal workers. If random miscoding from *i* to *j* is equally as likely from *j* to *i*, we could estimate that only two TH postal employees are in the service group. Several of the other known misclassifications are harder to analyze since there is one subgroup belonging in manager in TH and manager-sales in NBER with another subgroup misclassified oppositely. More light will be shed on this problem shortly but it suffices for the moment to note that after making generous allowance for such misclassifications, the concordance rate does not exceed 70 percent.[9] This is of course less than the 80 percent figure for OWN and NBER[69]. The increase from 60 to 70 percent is an indication of the error from coding rule ambiguity.

[7] For example on their p. 234 they state about clerks, "*Communication and Classification Record Work*. This group was composed in largest part of postal workers," and "the job that occurred most frequently in this category Clerical and Public Contact Work was Post Office clerk". Since these categories are in the NBER service area, we should expect a large off diagonal element though not a symmetrical relationship.

[8] The percentages are somewhat different if column sums are used. Then medical reaches 100 percent but clerical remains at 50 percent.

[9] Even if we aggregate to three broad categories of all professional, manager and sales, and other, the concordance rate is 74 percent. But this aggregation must overstate the degree of conformity.

We can use both the NBER37 and TH along with NBER69 responses to calculate occupational mobility from "1955" to 1969. The two occupational mobility matrices are given in Tables 3 and 4.

Since the purpose of this paper is to shed light on the classification problem and not discuss occupational mobility, only brief comments on mobility will be made. For this purpose we will concentrate on Table 3 which uses the two NBER codes and which indicates the percentage of people in various 1969 occupations for a given NBER37 occupation. The percentages in the diagonal cells, and the retention rate, range from 25 to 93 percent with an overall average of 56 percent. The distribution of the row and column sums indicates some large movement to management and movement out of engineering, sales, and the skilled-unskilled category. At least in terms of income, this is upward job mobility. The retention rate in the professional, technical, clerical, management-sales, farm, skilled-unskilled category is less than 50 percent. Other than manager, only the low management-sales and teaching groups registered gains and these were small.

Let us contrast these results with those in Table 4 based on the TH-NBER69 classifications. In this table the retention rates on the diagonal range from 14 to 83 percent with an average of 54 percent.[10] The four groups of teacher, law, medical, and manager have conformity rates over 50 percent and the rest are less than 50 percent though several are close. Overall there appears to be slightly higher retention rates when the common NBER codes are used. Assuming the recall aspect of the NBER37 code does not affect the mobility estimates, this slight improvement suggests that coding rules and coders have only limited effect on estimates of occupational mobility.

A more compact comparison of the two mobility matrixes is given in Table 5. The difference in retention rates by occupation ranges from +20 to −10 percentage points. These differences are not correlated with the conformity rate between NBER37 and TH—given in the last column.[11] But if the coding rules caused misclassifications and if occupation retention rates were higher than entry rates from other occupations, we would expect that fewer people would (appear to) remain in the TH occupations in 1969. This shift may not have happened because retention rates were not much greater than entry rates.

Next, consider the cases in which the discrepancies between column 1 and 2 in Table 5 are large. About half of the 20 percentage point retention rate difference in the professional group shows up in the 10 point difference (40 percent versus 30 percent) of the people who were managers in 1969. But in Table 2, the largest percentage of TH professionals classified differently in the NBER code were found in the manager category (17 percent). The next largest element in Table 2 is the clerical group (13 percent) which accounts for another 4 points of the difference in Table 5. For professionals it seems likely that much of the 20 point retention rate difference arises from the differences in coding rules and coders (informational differences would not lead to this pattern). The managerial retention rate difference of 10 points in Table 5 is offset by the 5 points in the manager-sales

[10] Once again contractor has been merged with manager.
[11] A regression of the difference on the conformity rate has an R^2 of 0.001.

TABLE 2

	NBER37 Occupations						
TH Codes	Professional	Teacher	Medical	Engineering	Law	Technical	Managerial
Professional							
Percent	40.2	5.3		2.3	0.8	5.3	17.4
Number	65	7		3	1	7	23
Teacher							
Percent	3.1	82.9		0.8			3.1
Number	4	107		1			4
Medical							
Percent	8.6	2.9	80.0				5.7
Number	3	1	28				2
Engineering							
Percent	2.4	1.6		63.9	0.4	5.5	14.9
Number	6	4		163	1	14	38
Law							
Percent	6.7				77.8		6.7
Number	3				35		3
Technical							
Percent	1.7	4.3		10.4		54.8	9.6
Number	2	5		12		63	11
Managerial							
Percent	3.2	2.2		6.4		2.6	54.8
Number	16	11		32		13	273
Contractor							
Percent				7.1			71.4
Number				1			10
Clerk							
Percent	4.0	1.0		5.0		12.0	21.0
Number	4	1		5		12	21
Sales							
Percent	1.9	1.0		2.4		3.8	21.2
Number	4	2		5		8	44
Service							
Percent	2.4			2.4	4.9	12.2	19.5
Number	1			1	2	5	8
Farm							
Percent	3.4	6.9		3.4		6.9	10.3
Number	1	2		1		2	3
Skilled-Unskilled							
Percent	0.4	0.4		6.7		10.3	11.7
Number	1	1		15		23	26
Total							
Percent	6.0	7.7	1.5	13.1	2.1	8.1	25.5
Number	110	141	28	239	39	147	466

TABLE 2 (continued)

TH Codes	NBER37 Occupation					Total	
	Clerical	Sales	Service	Farm	Skilled-Unskilled	Number	Percent
Professional							
Percent	12.9	6.1	0.8				7.2
Number	17	8	1			132	
Teacher							
Percent	1.6	3.1	3.1		2.3		7.1
Number	2	4	4		3	129	
Medical							
Percent		2.9					1.9
Number		1				35	
Engineering							
Percent	2.4	5.5			3.5		14.0
Number	6	14			9	255	
Law							
Percent	4.4	4.4					2.5
Number	2	2				45	
Technical							
Percent	2.6	7.8		0.9	7.8		6.3
Number	3	9		1	9	115	
Managerial							
Percent	5.2	16.5	2.0	0.4	6.6		27.3
Number	26	82	10	12	33	498	
Contractor							
Percent		7.1			14.3		0.8
Number		1			2	14	
Clerical							
Percent	31.0	7.0	9.0		10.0		5.5
Number	31	7	9		10	100	
Sales							
Percent	1.4	63.9	1.4	0.5	2.4		11.4
Number	3	133	3	1	5	208	
Service							
Percent	7.3	4.9	39.0		7.3		2.2
Number	3	2	16		3	41	
Farm							
Percent	6.9	6.9	10.3	31.0	13.8		1.6
Number	2	2	3	9	4	29	
Skilled-Unskilled							
Percent	2.7	4.0	2.2		61.4		12.2
Number	6	9	5		137	223	
Total							
Percent	5.5	15.0	2.8	0.7			100.0
Number	101	274	51	13		1,824	

TABLE 3

NBER37	NBER69 Occupations						
	Professional	Teacher	Medical	Engineering	Law	Technical	Managerial
Professional							
Percent	52.3	5.5		1.8		1.8	30.3
Number	57	6		2		2	33
Teacher							
Percent	3.5	78.7	0.7	0.7		1.4	11.3
Number	5	111	1	1		2	16
Medical							
Percent			93.1	3.4			
Number			27	1			
Engineering							
Percent	2.5	2.5	0.4	45.8	0.4	3.8	38.1
Number	6	6	1	108	1	9	90
Law							
Percent				5.3	94.7		
Number				2	36		
Technical							
Percent	5.0	2.2		14.4		36.7	26.6
Number	7	3		20		51	37
Managerial							
Percent	1.3	1.8		2.8	0.2	1.5	81.6
Number	6	8		13	1	7	373
Clerical							
Percent	2.0	2.0	1.0			6.1	43.9
Number	2	2	1			6	43
Sales							
Percent	2.3	4.5		1.1	1.5	3.4	46.2
Number	6	12		3	4	9	123
Service							
Percent	2.0	2.0			2.0	2.0	22.4
Number	1	1			1	1	11
Farm							
Percent						8.3	33.3
Number						1	4
Skilled-Unskilled							
Percent	0.5	3.4		8.7	0.5	5.3	30.0
Number	1	7		18	1	11	62
Total							
Percent	5.1	8.8	1.7	9.4	2.5	5.6	44.5
Number	91	156	30	168	44	99	792

TABLE 3 (continued)

	NBER Occupations					Total	
NBER37	Clerical	Sales	Service	Farm	Skilled-Unskilled	Number	Percent
Professional							
Percent	0.9	6.4	0.9				6.1
Number	1	7	1			109	
Teacher							
Percent	0.7	2.1	0.7				7.9
Number	1	3	1			141	
Medical							
Percent		3.4					1.6
Number		1				29	
Engineering							
Percent	0.4	4.2			1.7		13.3
Number	1	10			4	236	
Law							
Percent							2.1
Number						38	
Technical							
Percent	3.6	5.8	0.7		5.0		7.8
Number	5	8	1		7	139	
Managerial							
Percent	0.9	7.7	1.1	0.2	0.9		25.7
Number	4	35	5	1	4	457	
Clerical							
Percent	25.5	9.2	1.0	1.0	8.2		5.5
Number	25	9	1	1	8	98	
Sales							
Percent	1.9	36.5	0.4	0.4	1.9		14.9
Number	5	97	1	1	5	266	
Service							
Percent	2.0	4.1	55.1		8.2		2.8
Number	1	2	27		4	49	
Farm							
Percent	8.3	8.3	8.3	25.0	8.3		0.7
Number	1	1	1	3	1	12	
Skilled-Unskilled							
Percent	0.5	2.9	2.9	1.0	44.4		11.6
Number	1	6	6	2	92	207	
Total							
Percent	2.5	10.1	2.5	0.4			100.0
Number	45	179	44	8		1,781	

TABLE 4

TH Codes	NBER69 Occupations						
	Professional	Teacher	Medical	Engineering	Law	Technical	Managerial
Professional							
Percent	31.5	7.9	0.7	2.9	0.7	3.6	39.8
Number	88	22	2	8	2	10	111
Teacher							
Percent	2.9	81.8			1.0		8.4
Number	9	252			3		26
Medical							
Percent	9.1		83.1			1.3	3.9
Number	7		64			1	3
Engineering							
Percent	2.7	1.2		45.6	0.4	2.9	39.0
Number	13	6		222	2	14	190
Law							
Percent	2.2			0.7	83.2		13.1
Number	3			1	114		18
Technical							
Percent	2.8	2.2		9.8		47.1	30.2
Number	9	7		32		153	98
Managerial							
Percent	2.8	2.1	0.2	3.1	0.5	1.8	70.5
Number	37	28	3	41	6	24	934
Contractor							
Percent		1.5				3.1	89.2
Number		1				2	58
Clerical							
Percent	1.8	1.8		1.8	0.4	5.4	39.8
Number	5	5		5	1	15	111
Sales							
Percent	0.9	2.8		1.7	0.7	1.9	48.9
Number	5	15		9	4	10	263
Service							
Percent				5.7	2.5	6.6	16.4
Number				7	3	8	20
Farm							
Percent		3.9		0.6		3.9	34.4
Number		6		1		6	53
Skilled-Unskilled							
Percent	0.5	2.1		6.4		10.7	22.3
Number	3	14		42		70	146
Total							
Percent	3.8	7.5	1.5	7.7	2.8	6.6	42.8
Number	179	356	69	368	135	313	2,031

TABLE 4 (continued)

	NBER Occupations					Total	
TH Codes	Clerical	Sales	Service	Farm	Skilled-Unskilled	Number	Percent
Professional							
Percent	4.3	7.2	0.7		0.7		5.9
Number	12	20	2		2	279	
Teacher							
Percent	1.9	2.3	1.3		0.3		6.5
Number	6	7	4		1	308	
Medical							
Percent		2.6					1.6
Number		2				77	
Engineering							
Percent	0.8	5.7	0.2		1.4		10.3
Number	4	28	1		7	487	
Law							
Percent		0.7					2.9
Number		1				137	
Technical							
Percent	1.2	2.8		0.3	3.7		6.8
Number	4	9		1	12	325	
Managerial							
Percent	2.0	12.5	1.1	0.8	2.6		27.9
Number	27	165	15	10	34	1,324	
Contractor							
Percent		3.1			3.1		1.4
Number		2			2	65	
Clerical							
Percent	13.6	7.2	17.2	0.4	10.8		5.9
Number	38	20	48	1	30	279	
Sales							
Percent	1.9	38.1	0.7	0.7	1.7		11.3
Number	10	205	4	4	9	538	
Service							
Percent	4.1	5.7	49.2		9.8		2.6
Number	5	7	60		12	122	
Farm							
Percent	2.6	5.2	5.8	33.1	10.4		3.2
Number	4	8	9	51	16	154	
Skilled-Unskilled							
Percent	2.6	3.7	2.1	0.6	48.9		13.8
Number	17	24	14	4	320	654	
Total							
Percent	2.7	10.5	3.3	1.5			100.0
Number	127	498	157	71		4,749	

TABLE 5
PERCENTAGES ON DIAGONAL OF CROSS CLASSIFICATIONS WITH NBER69 OCCUPATIONS

Occupation	Cross Classified with NBER37	Cross Classified with TH	Difference	Diagonal Elements of NBER37 and TH[c]
Professional	52	32	20	49
Teacher	79	82	−3	83
Medical	93	83	10	80
Engineering	46	46	0	64
Law	95	83	12	78
Technical	37	47	−10	55
Managerial[a]	82	72	10	55
Clerical	26	14	12	31
Sales[b]	37	38	−1	64
Service	55	49	6	39
Farm	25	33	−8	31
Skilled-Unskilled	44	49	−5	61
ALL	56	54	4	58

[a] Non-low management in 1969, contractors included in 1955.
[b] Includes low management in NBER codings.
[c] Percentage of row sums.

group which in Table 3 contains the major source of the NBER37, TH discrepancy. The clerical difference of 12 points is more than offset by the 16 percent extra movement to the service group in 1969 in Table 5 which uses the TH code.[12] Interestingly, while 21 percent of the TH clerks were in the NBER managerial group, more clerks are calculated to have moved into managerial jobs using NBER37 rather than TH.

The difference in the law and medical categories also conforms to the pattern that the groups in which large discrepancies are found in Table 2 are the ones which offset the retention rate differences in Table 5. There is a higher retention rate in the technical category when the 1955 occupations are assigned by the TH code despite the coding differences between NBER and TH. The usual pattern with Table 2 does not stand out as strongly here.

The mobility matrices of Tables 3 and 4 when combined with the classification matrix of Table 2 indicate that coding rule differences lead to relatively large differences in occupational mobility for about half our occupations. Except in the case of management, most of these differences involve occupations with fairly close average earnings or status.

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[12] This suggests that the postal worker problem is important, though in Table 2 only 9 per cent of the TH clerks were in the NBER service group. But only 3 percent of the people in the TH codes 320 and 330, the ones containing postal workers, are found in Table 3 and in the 10,000 people studied by Thorndike and Hagen. The difference in pattern does not reflect a nonrepresentative sample used in Table 2.

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PROGRAMMING SOFTWARE NOTES

A PROGRAM FOR THE ESTIMATION OF DYNAMIC ECONOMIC RELATIONS FROM A TIME SERIES OF CROSS SECTIONS*

BY ALAN FREIDEN

An IBM FORTRAN IV level G computer program has been developed by the author which can be used to estimate parameters of the simple variance component model suggested by Marc Nerlove (1). This model is designed to treat data available on a large number of individuals but on each individual for only a short period of time. Examples of areas in which the program may be useful are the analysis of successive decennial censuses, short period longitudinal studies, and behavioral relationships involving lags or other forms of autoregressive processes.

The model can be described as follows. Let,

$$(1) \qquad y_{it} = \alpha y_{it-1} + \beta x_{it} + u_{it}, \qquad i = 1, \ldots, N \qquad t = 1, \ldots, T$$

where

$$y = (y_{11}, \ldots, y_{1T}, \ldots, y_{N1}, \ldots, y_{NT})'$$

$$y_{-1} = (y_{10}, \ldots, y_{1T-1}, \ldots, y_{N0}, \ldots, y_{NT-1})'$$

$$x = (x_{11}, \ldots, x_{1T}, \ldots, x_{N1}, \ldots, x_{NT})'$$

$$u = (u_{11}, \ldots, u_{1T}, \ldots, u_{N}, \ldots, u_{NT})'.$$

The u_{it} are unobserved random variables such that $u_{it} = \mu_i + v_{it}$

$$E\mu_i = Ev_{it} = 0, \qquad \text{all } i \text{ and } t,$$

$$E\mu_i\mu_{i'} = \begin{cases} \sigma_\mu^2, & i = i' \\ 0, & i \neq i' \end{cases}$$

$$Ev_{it}v_{i't'} = \begin{cases} \sigma_v^2, & i = i', \quad t = t' \\ 0, & \text{otherwise.} \end{cases}$$

The error term can be interpreted as the sum of an individual effect and an effect assumed to vary over both individuals and time.[1] The variance-covariance matrix of the error terms is

$$Euu' = \sigma^2 \begin{bmatrix} A & 0 & \ldots & 0 \\ 0 & A & \ldots & 0 \\ \vdots & \vdots & & \vdots \\ 0 & 0 & \ldots & A \end{bmatrix}$$

* The author wishes to thank Marc Nerlove for his helpful comments on an earlier version of this communication and for his advice on developing the computational procedure.

[1] A third component representing period specific and individually invariant effects may be added so that $u_{it} = \mu_i + \lambda_t + v_{it}$. The question of the effect on parameter estimates when the period specific effect is erroneously assumed absent (as it is in this version of the model), still is being investigated. See (3) for a preliminary analysis.