Chapter VII
Analysis of design effects for surveys in developing countries

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Abstract

The present chapter presents design effects for 11 household surveys from 7 countries and, for 3 surveys that are rather similar in design, compares design effects and rates of homogeneity (*roh*) for estimates of household consumption and possession of durables. It concludes with a discussion of the portability of estimates of *roh* across surveys.

Key terms: design effects, efficiency, rates of homogeneity, survey design, sample design, clustering.

A. Introduction

1. It is not yet common practice to calculate design effects as standard output for household surveys in developing countries. An exception occurs with respect to some standardized surveys like the Living Standards Measurement Study (LSMS) surveys and the Demographic and Health Surveys (DHS). For those surveys, design effects have been calculated and compared across countries (see chaps. XXII and XXIII). An earlier extensive comparative analysis has been made on 35 surveys conducted under the World Fertility Survey (WFS) programme (Verma, Scott and O'Muircheartaigh, 1980).

2. The present chapter presents design effects for 11 surveys from 7 countries. The selection of surveys was subjective and was mainly based on easy availability. The surveys come from: Brazil (3), Cambodia (1), the Lao People's Democratic Republic (1), Lesotho (1), Namibia (2), South Africa (2) and Viet Nam (1). The surveys are of different character and cover different topics. Among the surveys are multipurpose surveys, labour force surveys, a living standards survey and a demographic survey. Design effects have been calculated for a number of characteristics, mostly for survey planning purposes. The main purpose of this chapter is to give the reader a general idea of the levels of design effects experienced in various surveys.

3. For three surveys that are rather similar in design, a deeper analysis is made comparing design effects and rates of homogeneity for a few variables concerning household consumption and access to durables. The purpose is to examine the behaviour of (roughly) the same variable in different populations and to explore similarities and possible patterns in the findings.

B. The surveys

4. The surveys for which design effects are reported in this chapter are:

- The Lao Expenditure and Consumption Survey 1997/98 (LECS)
- The Cambodia Socio-Economic Survey 1999 (CSES)
- The Namibia Household Income and Expenditure Survey 1993/94 (NHIES)
- The Namibia Intercensal Demographic Survey 1995/96 (NIDS)
- The Viet Nam Multipurpose Household Survey 1999 (VMPHS)
- The Lesotho Labour Force Survey 1997 (LFS)
- The October Household Survey 1999 of the Republic of South Africa (OHS)
- The Labour Force Survey February 2000 of the Republic of South Africa
- PNAD (*Pesquisa Nacional por Amostra de Domicílios*) 1999, Brazil
- PME (*Pesquisa Mensal de Emprego*) for September 1999, Brazil
- PPV (*Pesquisa de Padrões de Vida*) 1996/97, Brazil

5. Table VII.1 summarizes the main design features of the 11 surveys. Standard two-stage probability proportional to size (PPS) designs were used in all the surveys except the Viet Nam survey where three stages are used. PNAD also employed three-stage sampling for small non-metropolitan municipalities, but these contained only about one third of the population covered by the survey. Most of the surveys used census enumeration areas as PSUs (with some modification of small EAs in some cases). Average PSU sizes of 90-150 households were common in these cases. Three surveys deviated from this pattern. The two surveys in Lesotho had much larger PSUs: the PSUs were groups of EAs with an average size of 340-370 households. At the other end, the rural PSUs in the Lao survey had on average only 50 households.

6. The sample sizes within PSUs (cluster sizes) were about 20 households for several of the surveys. The Namibia Intercensal Demographic Survey stands out with a large sample take of 50 households from each PSU. At the lower end were the Brazilian PPV survey where 8 households were selected per urban PSU, and the two South African surveys and the Cambodian survey with 10 households selected from each PSU. Most of the surveys had the same cluster sizes in urban and rural areas.

7. Most surveys were stratified explicitly on urban/rural areas within administrative divisions (provinces, regions). The Lesotho LFS had a further stratification in agroecological zones and the Lao LECS a further stratification on whether the village had road access or not. The Brazilian PNAD and PME surveys were stratified only implicitly into urban and rural, with systematic PPS selection of PSUs having taken place after sorting by location.

8. Systematic selection was used for selection of households within ultimate area units in all the surveys, except the PPV survey, where households were selected by simple random sampling.

9. An important feature of many of the sample designs is that they employed disproportionate sample allocations across provinces in order to produce provincial estimates of adequate precision. The weights needed in the analysis to compensate for the disproportionate allocations were very variable in some cases. For example, the ratio of largest to smallest sampling weight in the Brazilian PPV was about 40. Further details on the sample designs for the surveys are presented in the annex.

Table VII.1. Characteristics of the 11 household surveys included in the study

Survey	Number of area stages	First-stage sample: number of PSUs selected to the sample	PSU size: average number of households per PSU	Cluster size: number of households selected per PSU (or SSU, if two area stages)	Sample size: number of households in the survey	Sample allocation between strata
Lao Expenditure and Consumption Survey, 1997-1998	1	R: 348 U: 102	R: 51 U: 87	R: 20 U: 20	R: 6 960 U: 2 040	Disproportionate
Cambodia Socio-Economic Survey, 1999	1	R: 360 U: 240	R: 154 U: 243	R: 10 U: 10	R: 3 600 U: 2 400	Approximately proportionate
Namibia Household Income and Expenditure Survey, 1993-1994	1	R: 123 U: 96	R: 152 U: 148	R: 20 U: 20	R: 2 685 U: 1 712	Approximately proportionate
Namibia Intercensal Demographic Survey, 1995-1996	1	R: 120 U: 82	R: 152 U: 148	R: 50 U: 50	R: 5 600 U: 3 900	Approximately proportionate
Viet Nam Multipurpose Household Survey ,1999	2	839 PSUs, (2 SSUs selected in each PSU)	R: 1 417 U: 2 579 SSUs: R: 99 U: 105	R: 15 U: 15	25 170	Disproportionate
Lesotho Labour Force Survey, 1997	1	R: 80 U: 40	R: 370 U: 341	R: 33 (average) U: 25 (average)	R: 2 600 U: 1 000	Approximately proportionate
Labour Force Survey, 2000 of the Republic of South Africa	1	R: 426 U: 1 148	R: min 100 a/ U: min 100 a/	R: 10 U: 5	R: 4 059 U: 5 646	Disproportionate
October Household Survey, 1999 of the Republic of South Africa	1	R: 1 273 U: 1 711	R: 110-120 U: 80-100	R: 10 U: 10	R: 10 923 U: 15 211	Disproportionate
PNAD survey, 1999, Brazil	1 or 2	7 019	250	13	93 959	Disproportionate
PME survey for September 1999, Brazil	1	1 557	250	20	30 535	Disproportionate
PPV survey, 1996-1997, Brazil	1	554	250	R: 16 U: 8	4 944	Highly disproportionate

Note: R= rural, U=urban

a/ Minimum of 100.

C. Design effects

10. The design effects ($d^2(\bar{y})$) for a selection of estimates from each survey are shown in tables VII.2 through VII.6 (for a description on how the design effect is calculated, see chap. VI). The design effects have been calculated using Software for the Statistical Analysis of Correlated Data (SUDAAN) or StATA. In some cases, the design effects were provided by national statistical offices.[21]

11. The variation in design effects is substantial, as could be expected given the differences in sample design and variables among the surveys and the variation due to country-specific population conditions. Some effects are very high. Design effects in the range 6-10 for household variables are not unusual in the results displayed in tables VII.2-VII.6, and there are some effects in the range 10-15. Note that these design effects reflect the effects of the complex stratified clustered sample designs and the disproportionate allocations across provinces (where applicable). The tables of design effects presented in tables VII.2-V11.6 serve to illustrate the levels of design effects that have been experienced in some socio-economic and demographic household surveys in developing countries.

12. Table VII.2 presents estimates of design effects for seven surveys in Africa and South-East Asia for the national level and for urban and rural sub-domains. Most of the design effects concerned household socio-economic variables. Design effects from three of the surveys mainly concern labour-force variables on individual level. The overall average design effect on national level is 4.2. There is a rather wide variation in the effects, from 1.3 to 8.1, but most of the effects are in the range 2.0-6.0. The average design effects for the urban and rural sub-domains are 4.1 and 4.0, respectively. The differences in sample design and variables make it difficult to exploratorily search the results for any general differences between types of variables (for example, socio-economic/labour force) or domains (urban/rural) in the table. An attempt to compare some of the design effects is presented in table VII.7.

[21] Professor David Stoker of Statistics South Africa compiled the design effects for the Labour Force Survey and October Household Survey of the Republic of South Africa. The design effects for the Viet Nam Multipurpose Household Survey were provided by Mr. Nguyen Phong, Director of Social and Environmental Statistics Department, General Statistics Office of Viet Nam. The design effects for the Namibia Household Income and Expenditure Survey were calculated by Mr. Alwis Weerasinghe, National Central Statistics Office of Namibia. The design effects for the Brazilian surveys were calculated by Dr. Pedro Silva, IBGE. For the other surveys, the design effects were calculated by Dr. Hans Pettersson based on data provided by the national statistical institutes.

Table VII.2. Estimated design effects from seven surveys in Africa and South-East Asia

		Urban	Rural	National
Lao Expenditure and Consumption Survey, 1997-1998	Total monthly consumption per household	3.8	7.8	5.4
	Monthly food consumption per household	4.4	6.8	5.8
	Proportion of households with access to motor vehicle	1.3	3.3	2.1
	Proportion of households with access to TV	3.1	6.8	5.4
	Proportion of households with access to radio	2.7	4.8	4.5
	Proportion of households with access to video	3.9	6.1	5.5
Cambodia Socio-Economic Survey, 1999	Total monthly consumption per household	2.0	2.0	1.4
	Monthly food consumption per household	3.1	3.2	3.2
	Proportion of households with access to TV	2.4	2.2	2.6
Namibia Household Income and Expenditure Survey, 1993-1994	Total yearly household consumption	2.9	1.9	2.5
	Total yearly household income	2.9	2.8	2.8
	Proportion of households with access to TV	6.0	4.6	4.1
	Proportion of households with access to radio	2.7	2.1	2.4
	Proportion of households with access to telephone	6.2	4.6	4.5
Namibia Intercensal Demographic Survey	Proportion of households with access to TV	14.7	4.1	6.6
	Proportion of households using electricity for lighting	4.4	3.9	4.2
	Proportion of households experiencing a death of a household member during last 12 months	2.1	4.3	2.3
Viet Nam Multipurpose Household Survey, 1999	Poverty rate	..	..	7.1
Lesotho Labour Force Survey, 1997	Employment rate	5.6	3.1	6.6
	Proportion of population ages 10 years and over that have not attended school	4.6	5.9	5.5
	Proportion subsistence farmers	6.3	4.4	8.1
	Proportion own account workers	3.0	1.4	2.4
October Household Survey, 1999, Republic of South Africa	Employment rate	4.0	3.6	3.8
Labour Force Survey, 2000, Republic of South Africa	Employment rate	2.5	3.4	2.8

Note: Two dots (..) indicate data not available.

13. Table VII.3 presents estimates of design effects for a number of household-level estimates from the Brazilian PNAD.

Table VII. 3. Estimated design effects for country level and by type of area estimates for selected household estimates (PNAD 1999)

Variable	National	Metropolitan areas	Large municipalities	Other areas
Proportion with general net water supply	9.80	6.60	6.74	10.73
Proportion with water from source	9.24	4.04	4.19	9.43
Proportion with adequate sewerage	9.04	6.36	5.87	11.59
Proportion with general net piped water	8.48	5.16	4.79	9.40
Proportion with at least one bathroom	8.34	1.51	7.20	7.76
Proportion with owned land	8.10	11.53	4.49	7.09
Proportion with electricity	7.92	1.03	4.43	7.27
Proportion with adequate wall material	7.43	6.17	5.01	6.84
Proportion with piped water at least one room	7.09	4.74	5.45	7.04
Proportion with adequate roof material	5.68	2.91	2.41	5.65
Average number of rooms per household	5.32	6.26	4.50	5.09
Proportion with telephone	4.80	5.59	4.44	5.91
Proportion with fridge	4.59	1.53	2.77	5.02
Proportion with washing machine	4.34	3.98	3.49	6.25
Proportion with color TV	4.31	1.77	2.76	4.88
Proportion with freezer	3.83	3.55	2.68	4.67
Proportion with water filter	3.39	2.50	2.07	4.37
Proportion with radio	3.01	1.46	1.62	3.29
Proportion with black and white TV	2.79	1.50	1.30	2.93
Average rent	2.52	3.09	2.01	3.39
Proportion of owned households	2.46	3.18	1.74	2.30
Proportion of rented households	2.32	2.71	1.78	2.51
Average number of rooms used as dormitories	2.14	2.37	1.72	2.09

14. Design effects vary between 2 and 10 for estimates at the national level, with an average value of 5.5. Design effects are higher for variables such as proportion of households with general net water supply, proportion with water from source, and proportion with adequate sewerage. This is expected, given the very high degree of clustering that these variables tend to display. Design effects are lower for some of the "economic" variables, such as average rent, proportion of owned or rented households, and average number of rooms used as dormitories. Also as expected, design effects are generally lower for the metropolitan areas and larger municipalities where the design is two-stage cluster sampling, than for the other areas, where the design is more clustered (three-stage cluster sampling).

15. Design effects for a set of variables measured at the person level are presented in table VII.4.

Table VII.4. Estimated design effects for selected person-level characteristics at the national level and for various sub-domains (PNAD 1999)

Variable	National	Metropolitan areas	Large municipalities	Other areas
Proportion race=white	15.97	11.97	8.14	19.97
Proportion race=black or coloured	15.75	12.23	8.44	19.41
Proportion paid worker	8.44	4.45	5.81	7.49
Proportion self-employed	7.65	3.73	5.51	6.66
Proportion with social security	6.59	2.93	3.28	8.45
Proportion illiterate	6.33	3.67	4.37	7.10
Average income main occupation	5.54	7.16	4.45	6.38
Proportion housing benefit	5.23	3.80	3.00	5.54
Proportion transportation benefit	4.93	2.94	2.78	9.10
Proportion health benefit	4.90	3.76	2.29	8.79
Proportion working (10+ years)	4.79	1.97	1.67	7.08
Proportion food benefit	3.35	2.60	2.08	4.60
Proportion infants working (5-9 years)	3.27	1.25	2.04	3.00
Proportion employer	2.87	2.80	1.54	2.63
Proportion attending school	1.88	1.75	1.57	1.94
Proportion education benefit	1.87	1.85	1.74	2.22

16. Design effects for estimates at the national level vary from about 2 to 16, with an average of 6.2. Design effects are quite high for race variables, high for job- or income-related variables, and low for variables such as proportion attending school and proportion receiving education benefit. Again, design effects are higher for the other areas where the design is three-stage. Design effects for household variables are generally lower than those for person-level variables, which is expected because the number of persons is larger than the number of households surveyed per PSU. The substantial variations in design effects for different variables are expected because they display different degrees of clustering. These rather high design effects are also explained by the use of disproportionate sample allocation between strata, which leads to varying weights.

17. Design effects for the Brazilian PME are reported in table VII.5 for a selection of the estimates published every month. The values were obtained for September 1999, chosen because they have the same reference period as those for the PNAD 1999.

Table VII.5. Estimated design effects for selected estimates from PME for September 1999

Variable	Recife	Salvador	Belo Horizonte	Rio de Janeiro	São Paulo	Pôrto Alegre	All
Average income main occupation	3.43	4.47	2.49	4.44	4.89	4.79	6.23
Proportion employer	2.00	2.16	3.06	2.53	2.33	2.27	3.34
Proportion illiterate	4.23	4.43	1.86	2.69	2.11	2.13	3.24
Unemployment rate	1.64	2.62	1.98	2.06	1.65	1.67	2.43
Proportion with registered employment	1.61	1.87	1.66	1.50	1.40	1.75	2.02
Proportion economically active	1.59	1.99	1.78	1.61	1.31	1.40	1.96
Proportion paid worker	1.51	1.67	1.43	1.37	1.34	1.55	1.88
Proportion self-employed	1.53	2.26	1.60	1.47	1.19	1.14	1.78
Proportion attending school	1.41	1.57	1.64	1.24	1.26	1.49	1.72

18. Although not reported here, design effects for the same estimates were computed for other months in the series and found to vary little from month to month. The sample of enumeration areas is fixed throughout the decade and sample sizes also vary little in short periods of time. Design effects are larger for the average income in the main occupation and only moderate for the proportion illiterate and the proportion of employers. That these are in line with the values observed for similar estimates computed from PNAD for the metropolitan areas, is not surprising because essentially the same sample design was adopted for PME and PNAD, except for the larger sample take per PSU in PME. Design effects are below 2.5 for the other variables. That design effects for comparable variables estimated from PME are generally lower than those for PNAD, is due to the fact that the sample allocation is closer to proportional in PME than in PNAD.

19. Design effects for the Brazilian PPV are reported in table VII.6 for a small selection of the estimates obtained from that survey.

Table VII.6. Estimated design effects for selected estimates from PPV

Estimated population parameter	Deff estimate
Number of people older than 14 years of age who are illiterate	4.17
Proportion of people older than 14 years of age who are illiterate	3.86
Number of people who rated their health status as “bad”	3.37
Proportion of rented households	2.97
Average number of persons per household	2.64
Number of people between 7 and 14 years of age who are illiterate	2.64
Proportion of people between 7 and 14 years of age who are illiterate	2.46
Number of women aged 12-49 who had children born dead	2.03
Number of women aged 12-49 who had children	2.02
Number of women aged 12-49 who had children born alive	2.02
Dependence ratio (number aged 0-14 plus number aged 65 years or over, divided by number aged 15-64)	1.99
Average number of children born per woman aged 12-49	1.26

20. For the estimates considered here, design effects vary between 1.3 and 4.2. The relatively small values of these design effects reflect the lower degree of clustering in PPV, where only 8 households were selected per PSU. They also reflect the fact that mostly variables in the demographic and educational blocks of the questionnaire were considered, plus two variables at the household level.

21. We now select, from tables VII.2 through VII.6, a set of estimates that appear in more than one survey. The design effects are presented in table VIII.7. The design effects have been grouped in three categories: (a) household consumption and household income; (b) household durables; and (c) employment and occupation. Within each category, we have grouped the estimates that have roughly the same definitions.

Table VII.7. Comparisons of design effects across surveys

Topic/characteristic	Urban	Rural	National	Comments
Consumption, household income (household variables)				
- Total monthly consumption (Lao People's Democratic Republic: LECS)	3.8	7.7	5.4	
- Total monthly consumption (Cambodia: CSES)	2.0	2.0	1.4	
- Total domestic household consumption (Namibia: NHIES)	2.9	1.9	2.5	The cluster size in CSES is half the cluster sizes in LECS and NHIES
- Monthly food consumption (Lao People's Democratic Republic: LECS)	4.4	6.8	5.8	
- Monthly food consumption (Cambodia: CSES)	2.5	3.3	3.3	
Household durables (household variables)				
- Proportion of households with access to TV (Lao People's Democratic Republic: LECS)	3.1	6.8	5.4	
- Proportion of households with access to TV (Cambodia: CSES)	2.4	2.2	2.6	
- Proportion of households with access to TV (Namibia: NHIES)	6.0	4.6	4.1	
- Proportion of households with access to TV (Namibia: NIDS)	14.7	4.1	6.6	The fact that the cluster size in NIDS is more than double that in the other surveys explains the large design effect in the urban areas (but not the low design effect for the rural areas)

- Proportion of households with a color TV (Brazil: PNAD)	..	..	4.3	
- Proportion of households with access radio (Lao People's Democratic Republic: LECS)	2.7	4.8	4.5	
- Proportion of households with access to radio (Cambodia: CSES)	2.1	2.8	3.4	
- Proportion of households with access to radio (Namibia: NHIES)	2.7	2.1	2.4	
- Proportion of households with access to telephone (Namibia: NHIES)	6.2	4.6	4.5	
- Proportion of households with access to telephone (Brazil: PNAD)	-	-	4.8	
Employment, occupation (person variables)				
- Employment rate (South Africa: OHS)	4.0	3.6	3.8	The difference in design effects for the urban areas between the South African LFS and the South African OHS is an effect of the smaller cluster size in the urban domain in LFS (5 households as compared with 10 households in OHS)
- Employment rate (South Africa: LFS)	2.5	3.4	2.8	
- Employment rate (Lesotho: LFS)	5.6	3.1	6.6	
- Employment rate (Brazil: PNAD)	-	-	4.8	

Note: Two dots (..) indicate that data are not available.
A hyphen (-) indicates that the item is not applicable.

22. The design effects for national-level estimates vary between 1.4 and 6.6 with a median value of 4.3. Some of the design effects are very high. One that stands out is the design effect of 14.7 for the proportion of urban households with access to television in the Namibia NIDS. The large cluster take of 50 households contributes to this high value; if the cluster take had been 20 as in NHIES then the design effect would have been 6.7, in line with the NHIES design effect of 6.0. This is still a high design effect and there is no appreciable contribution from variable weights in this case. The design effects for most of the rural estimates in LECS are also high. In NHIES, some of the urban design effects for durables are high.

23. In all the surveys except the two South African surveys and the Cambodia survey there are clear urban/rural differentials. In the Lao and Brazilian surveys (see tables VII.2 through VII.6), the urban design effects are generally lower than the rural design effects. In the Namibia and Lesotho surveys the urban design effects are higher than the rural design effects. (Most of the surveys had the same cluster size in urban and rural areas so that the differentials are not the effect of different cluster sizes.)

24. The design effects include effects of stratification, unequal weighting, cluster size and the homogeneity of the clusters (see chap. VI for a detailed discussion of the effects). The surveys in table VII.7 may be broadly similar in their sample designs but there are distinct differences in stratification, cluster sizes, sample allocation, etc. This makes it difficult to compare the design effects across the surveys even for the same estimate. To achieve better comparability, it is desirable to remove the effects of cluster size and weighting from the design effects.

D. Calculation of rates of homogeneity

25. The analysis may be continued on a smaller set of surveys and variables, using a few estimates of household consumption and possession of durables from LECS, CSES and NHIES, three surveys that have similar sample designs. All surveys employed two-stage sample designs with EAs as primary sampling units. The PSUs were stratified in roughly the same way by provinces and urban/rural divisions within provinces. Households were selected by systematic sampling within EAs. Sample allocation over strata differed, however. The Lao survey had equal allocation over provinces, while the other two surveys had allocations close to proportional over provinces. The purpose of the analysis is to examine the effect of the complex sample designs on the precision of (roughly) the same estimate in different populations and to explore similarities and possible patterns in the rates of homogeneity.

26. A first step is to remove effects of unequal weights from the design effects. In table VII.8 the design effects have been separated into components due to weighting and clustering. These components are calculated using equations 23 and 20 in chapter VI. The equal sample sizes within provinces in LECS give a substantial variation in the sampling weights. Consequently, the design effects due to weighting are rather high for the LECS estimates. NHIES has some oversampling in less populous regions and in urban areas, resulting in design effects due to weighting above 1.0 but considerably lower than the effects for LECS. CSES also has oversampling in urban areas.

27. All three surveys used a design in which a constant number of households were selected from each PSU (using systematic sampling). These constant cluster sizes also contribute to the variation in the weights because imperfections in the measures of size of the PSUs will result in variation in the overall sampling weights.

Table VII.8. The overall design effects separated into effects from weighting ($d_w^2(\bar{y})$) and from clustering ($d_{cl}^2(\bar{y})$)

Topic/characteristic	Urban			Rural		
	Overall $d^2(\bar{y})$	Weighting $d_w^2(\bar{y})$	Clustering $d_{cl}^2(\bar{y})$	Overall $d^2(\bar{y})$	Weighting $d_w^2(\bar{y})$	Clustering $d_{cl}^2(\bar{y})$
Household consumption, income						
- Total monthly consumption (LECS)	3.8	1.60	**2.4**	7.7	1.55	**5.0**
- Total monthly consumption (CSES)	2.0	1.11	**1.8**	2.0	1.16	**1.7**
- Total domestic household consumption (NHIES)	2.9	1.20	**2.4**	1.9	1.23	**1.5**
- Monthly food consumption (LECS)	4.4	1.60	**2.8**	6.8	1.55	**4.4**
- Monthly food consumption (CSES)	2.5	1.11	**2.3**	3.3	1.16	**2.8**
- Total household income (NHIES)	2.9	1.20	**2.4**	2.8	1.23	**2.3**
Household durables						
- Proportion of households with access to TV (LECS)	3.1	1.60	**2.0**	6.8	1.55	**4.4**
- Proportion of households with access to TV (CSES)	1.9	1.11	**1.7**	1.8	1.16	**1.6**
- Proportion of households with access to TV (NHIES)	6.0	1.20	**5.0**	4.6	1.23	**3.7**
- Proportion of households with access to radio (LECS)	2.7	1.60	**1.7**	4.8	1.55	**3.1**
- Proportion of households with access to radio (CSES)	2.1	1.11	**1.9**	2.3	1.16	**2.0**
- Proportion of households with access to radio (NHIES)	2.7	1.20	**2.3**	2.1	1.23	**1.7**
- Proportion of households with access to video (LECS)	3.9	1.60	**2.4**	6.1	1.55	**3.9**
- Proportion of households with access to telephone (NHIES)	6.2	1.20	**5.2**	4.6	1.23	**3.7**

28. The design effects of clustering, $d_{cl}^2(\bar{y})$, depend on the cluster sample size. The Lao and Namibia surveys had cluster sample sizes of 20 households while the Cambodia survey had 10 sampled households per cluster. To remove the effects of different cluster takes in comparing results across surveys, we have calculated rates of homogeneity (*roh*) for the estimates in table VII.8 (see equation 30 in chap.VI). The results are presented in table VII.9. The *roh*'s measure the internal homogeneity of the PSUs (enumeration areas) for the survey variables. The issue to be examined is whether there are similarities in the levels and patterns of *roh*'s across countries.

Table VII.9. Rates of homogeneity for urban and rural domains

Topic/characteristic	Urban	Rural	Ratio urban/rural
Household consumption, income			
- Total monthly consumption (LECS)	0.072	0.209	0.3
- Total monthly consumption (CSES)	0.089	0.080	1.1
- Total domestic household consumption (NHIES)	0.071	0.025	2.9
- Monthly food consumption (LECS)	0.092	0.178	0.5
- Monthly food consumption (CSES)	0.139	0.204	0.7
- Total household income (NHIES)	0.071	0.058	1.2
Household durables			
- Access to TV (LECS)	0.049	0.178	0.3
- Access to TV (CSES)	0.079	0.061	1.3
- Access to TV (NHIES)	0.200	0.125	1.6
- Access to radio (LECS)	0.036	0.110	0.3
- Access to radio (CSES))	0.100	0.109	0.9
- Access to radio (NHIES)	0.063	0.032	1.9
- Proportion of households with access to video (LECS)	0.076	0.154	0.5
- Access to phone (NHIES)	0.208	0.125	1.7

29. Since the homogeneity of the clusters may differ between urban and rural clusters, the values of *roh* have been computed separately for these two parts of the population. The results are presented in table VII.9. There are some results that stand out in this table:

- The patterns of urban/rural differences in *roh* values are different in the three countries. The *roh´*s for the urban clusters in the Lao survey are consistently much lower than the *roh´*s for rural clusters. The average urban/rural ratio is 0.4. In the Namibian survey, the differences are in the opposite direction; the urban *roh*'s are on average larger than the rural *roh*'s by a factor of 1.9. In the Cambodian survey, there is no clear urban/rural pattern in the *roh*'s.

- The *roh*'s for rural clusters are high in the LECS (in the range of from 0.110 to 0.209, with a median value of 0.178). The *roh*'s for urban clusters are much lower (in the range 0.036 to 0.092, with a median value of 0.072).

- The *roh* for monthly food consumption is high in rural areas in Cambodia (0.204). This *roh* is considerably higher than the *roh* for total monthly consumption and also higher than the *roh*'s for the household durables estimates.

30. The large differences between urban and rural *roh´*s in the Lao People's Democratic Republic arise mainly because of the high *roh*'s for rural areas. These results are in line with results from a previous LECS survey in the country. High values of *roh* for the rural areas are not unreasonable considering the fact that the rural villages are small and rather homogeneous in socio-economic terms. Also, the urban areas have very little income-level segregation, making them rather mixed in socio-economic terms. The seasonality that is present for total monthly consumption and monthly food consumption may also be a contributing factor for these variables. Each PSU is visited for 1 month and the sample of PSUs is spread out over a 12-month period. Consequently, there is a "seasonal clustering" on top of the geographical clustering. There are reasons to believe that this seasonality is somewhat stronger in the rural areas.

31. In Namibia, many of the rural PSUs in the commercial farming areas are rather heterogeneous, containing mixtures of high-income farmer households and low-income farm labourer households. In the urban areas, on the other hand, there is a rather strong income-level segregation that has been taken care of only partly in the stratification. These circumstances may explain the larger *roh´*s for household consumption and household income in urban areas.

32. To the explanations above should be added two others. One is that the design effects (and consequently the *roh*'s) for the consumption variables are rather sensitive to values at the high end. Removal of a few of the highest values will, in some cases, change the design effect considerably. The other is that the *roh* values reflect more than simply measures of cluster homogeneity. They also capture interviewer variance effects, when different interviewers, or teams of interviewers, carry out the interviews in different PSUs.

E. Discussion

33. It is not possible to discern any similarities between countries in levels or patterns of *roh* in table VII.9. The results offer little consolation for a sampling statistician who wants to use *roh*'s from a similar survey in another country when designing the sample for a survey. It seems that country-specific population conditions may play a strong role in determining the degree of cluster homogeneity for the kinds of socio-economic variables studied here. The study is admittedly very limited; the only general conclusion that can be drawn is to urge caution when "importing" a *roh* from a survey in another country. The results also draw attention to the need to calculate and document design effects and *roh´*s from the current survey so that they can be used for the design of the next one.

34. The findings in the study, however uncertain, are contrary to the usual findings. Studies of the DHS surveys have found that estimates of *roh* for a given estimate are fairly portable across countries provided that the sample designs are comparable (see chap. XXII). Likewise, the study conducted on a number of WFS surveys also concluded that there were similarities in patterns in *roh* across countries. It may be that *roh*'s for demographic variables are more "well behaved" and more portable than *roh*'s for socio-economic variables.

Annex
Description of the sample designs for the 11 household surveys

The sample designs for the 11 surveys are described briefly below:

Lao Expenditure and Consumption Survey 1997/98 (LECS)

Census enumeration areas (EAs) served as PSUs. The PSUs were stratified by 18 provinces and urban/rural areas. The rural EAs were further stratified by "access to road" and "no access to road". Equal samples of 25 PSUs were selected with systematic PPS in each province (450 PSUs altogether) (Rosen, 1997). Twenty households were selected in each PSU, giving a sample of 9,000 households. The equal allocation of the sample over provinces resulted in a large variation in sampling weights on household level.

Cambodia Socio-Economic Survey 1999 (CSES)

Villages serve as PSUs. A few communes and villages were excluded because they could not be visited for security-related reasons; the excluded area amounted to 3.4 per cent of the total number of households in the country.

The villages were grouped into 5 strata based on ecological zones. Phnom Penh was treated as a separate stratum, and the rural and urban sectors were treated as separate strata. Thus, 10 strata were created from the 4 geographical zones (Phnom Penh, Plains, Tonle Sap, Coastal and Plateau/Mountain). From each stratum, four independent subsamples of villages were drawn. The sample was allocated approximately proportionally to strata.

Six hundred villages were selected with circular systematic PPS sampling. Ten households were selected within each village (National Institute of Statistics, Kingdom of Cambodia, 1999).

Namibia Household Income and Expenditure Survey 1993/94 (NHIES)

The PSUs were basically census enumeration areas. Some small EAs were combined with adjacent EAs before selection. The average PSU size was approximately 150 households. A primary stratification was carried out according to urban/rural divisions and 14 regions. A secondary stratification was effected in the urban domain where "urban" and "small urban" (semi-urban) strata were defined. The sample was allocated approximately proportionally to strata. However, a slight oversampling of urban areas was introduced. A sample of 96 urban and 123 rural PSUs was selected using a systematic PPS procedure (Pettersson, 1994).

Namibia Intercensal Demographic Survey 1995/96 (NIDS)

The design was the same as that for the NHIES. A sample of 82 urban and 120 rural PSUs was selected. For the NIDS, a rather large sample of 50 households was selected in each PSU, giving a total sample of 9,500 households (Pettersson, 1997).

Viet Nam Multipurpose Household Survey 1999 (VMPHS)

Communes were used as PSUs in rural areas. In urban areas, wards served as PSUs. Stratification was carried out on urban/rural and province (61 provinces). Eight hundred thirty-nine communes were selected with PPS. The sample was basically equal-sized for each province, but the large provinces were allocated somewhat larger samples. The secondary sampling units (SSUs) were villages within communes and blocks within wards. Two SSUs were selected within each selected commune. In each SSU, 15 households were selected. In all, approximately 25,000 households were selected (Phong, 2001).

Lesotho Labour Force Survey 1997

The sample was a two-stage sample. Primary sampling units were groups of enumeration areas. The average PSU size was 370 households. The PSUs were stratified by urban/rural divisions, regions (10) and agro-economic zones (4), to produce 33 strata altogether. The sample was allocated proportionally to strata, with two exceptions: two small strata were heavily oversampled. A systematic PPS procedure was used to select 120 PSUs. Within PSUs, 15-40 households were selected using systematic random sampling to generate a total sample size of 3,600 households. All eligible household members were included in the survey (Pettersson, 2001).

October Household Survey 1999 of the Republic of South Africa (OHS)

Census enumeration areas (EAs) served as PSUs. During the selection process, EAs having less than 80 households were combined with neighbouring EAs on the list using a method proposed by Kish (1965). The average size of PSUs was 80-100 households for urban PSUs and 110-120 households for rural PSUs. The PSUs were stratified by nine provinces. The sample was allocated over strata with a square-root allocation. Within each province, a further stratification by district councils (and metropolitan councils) was carried out. A sample of 2,984 PSUs was selected by systematic PPS sampling, 1,711 in urban areas and 1,273 in rural areas. In each PSU, a systematic sample of 10 "visiting points" (approximately the same as households) was drawn (Stoker, 2001).

Labour Force Survey February 2000 of the Republic of South Africa

The Labour Force Survey February 2000 was the first survey to use a new master sample that had been constructed at the end of 1999 based on the 1996 census database. The sample consisted of 2,000 PSUs. (Later in the year, the sample was expanded to 3,000 PSUs.) Census enumeration areas served as PSUs, with EAs having less than 100 households being linked with neighbouring EAs. The PSUs were stratified by nine provinces. The sample was allocated over strata with a square-root allocation. In each PSU, clusters of size 10 visiting points were formed, each cluster spread over the entire PSU. A set of clusters was selected to be used in the future Labour Force Survey.

As a result of budget problems it was decided to scale down the labour-force survey to 10,000 visiting points. This was effected as follows: from all the urban PSUs, only five visiting

points were selected from the identified cluster. For the rural sample, a PPS systematic subsample containing 50 per cent of the rural PSUs was drawn from the set of rural PSUs and in the drawn PSUs the entire identified cluster of 10 visiting points formed part of the sample (Stoker, 2001).

PNAD (*Pesquisa Nacional por Amostra de Domicílios*) 1999, Brazil

PNAD covers annually a sample of approximately 115,000 households, representing all of Brazil except the rural areas in the north (Amazon) region. Stratification was by geography into 36 explicit strata. The 36 strata comprised 18 of the States as one stratum each and the remaining 9 States as subdivided in two strata each. One stratum was then formed with PSUs located in the metropolitan area around the State capital, and one stratum was formed with the remaining PSUs in the State. In the strata formed by metropolitan areas, the design was a two-stage cluster sampling, where the PSUs were census enumeration areas, selected by systematic PPS sampling, with size measures equal to the number of private households as obtained in the latest population census. Prior to selection of PSUs, they were sorted by geography code, leading to an implicit stratification by municipality and by urban-rural status.

In the strata that were not metropolitan areas, the PSUs were municipalities. These were stratified by size and geography, forming strata of approximately equal population (using data from the latest available population census). Two municipalities (PSUs in these strata) were then selected in each stratum using systematic PPS sampling, with total population as the measure of size. Prior to systematic selection, some municipalities were declared to be "certainty" PSUs because of their large population, and were thus included in the sample of municipalities with certainty. Within each selected municipality, EAs were selected using systematic PPS sampling, with size measures equal to the number of private households as obtained in the latest population census. At the last stage of selection, households were selected within EAs by systematic sampling from lists updated yearly. Every member of selected households was included in the survey. A target sample of 13 households should have been selected from each EA. However, in order to reduce weight variation due to outdated measures of size, constant sampling fractions were used in each EA instead of constant sample *sizes,* yielding varying cluster takes.

The sample allocation was disproportional over the strata, and the ratio of largest to smallest weight was approximately equal to 8.

PME (*Pesquisa Mensal de Emprego*) for September 1999, Brazil

PME is a labour-force survey that covers a monthly sample of about 40,000 households in the six largest metropolitan areas in Brazil, from which the main current labour-force indicators are derived. The sample design is the same as for PNAD in the metropolitan area strata, except for the target cluster take, which is 20 for PME in contrast with 13 for PNAD.

PPV (*Pesquisa de Padrões de Vida*) 1996/97, Brazil

PPV targeted measurement of living standards, using the approach developed in the family of Living Standards Measurement Study (LSMS) surveys carried out in various countries

under sponsorship of the World Bank (Grosh and Muñoz, 1996). The Brazilian survey, carried out in 1996-1997, investigated a large number of demographic, social and economic characteristics using a sample of 4,944 households selected from 554 EAs in the north-east and south-east regions of Brazil. The sample design was a two-stage stratified cluster sample. Stratification comprised two steps. First, 10 geographical strata were formed to identify the 6 metropolitan areas of Fortaleza, Recife, Salvador, Belo Horizonte, Rio de Janeiro and São Paulo, plus 4 other strata that covered the remainder of the north-east and south-east regions, subdivided into urban and rural enumeration areas. Within each of these 10 geographical strata, EAs were further subdivided into 3 strata according to average head of household income as recorded in the 1991 population census. Hence, a total of 30 strata were formed.

The total sample size was fixed at 554 EAs, 278 for the north-east region and 276 for the south-east region. Allocation of the EAs within the strata was proportional to number of EAs in each stratum. Selection of EAs was carried out using a PPS with replacement procedure, with the number of private households per EA as the measure of size. In each selected urban EA, a fixed take of eight households was selected by simple random sampling without replacement. The survey take per rural EA was set at 16 households for cost-efficiency reasons.

Despite its small sample size when compared with PNAD and PME, the PPV survey provides useful information about design effects because it used direct income stratification of EAs, as well as smaller sample takes per EA than the other surveys. Another distinctive feature stems from the fact that estimation used only the standard inverse selection probability weights, and that no calibration to population projections was attempted. The variation of the sample weights for the PPV was substantial, with the largest weight over 40 times the smallest.

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