Annex 1: Analysis of National Sample Survey Data

A1.1 The sample for the 50th round of the National Sample Survey consisted of 115,394 households in 11,601 first sampling units (FSUs). The total number of households represented by the survey was 177.9 million. The rural sample consisted of 69,225 households, representing a total of 132.2 million households. The corresponding figures for the urban sample were 46,169 and 45.7 million, respectively.

A1.2 The 55th round sampled 120,309 households in 10,104 FSUs, representing a total of 188.7 million households. The rural sample consisted of 71,385 households, representing 137.4 million households. The corresponding figures for the urban sample were 48,924 and 51.4 million, respectively.

A1.3 The design of the NSS changed in 1999–2000 in ways that make it difficult to compare its results with those from the previous years. Historically, the NSS used 30-day recall for all consumption items. This changed with the survey in 1994–95 and the subsequent surveys carried out until 1998. For these surveys, the NSS administered two different consumption schedules to two independent subsamples of households. One used the traditional 30-day recall, and the other used multiple recall periods, depending on the consumption item: 7 days for food; 30 days for high-frequency nonfood, including fuels; and 365 days for low-frequency nonfood, such as durables, clothing, footwear, and educational and institutional medical expenditures. The 1999–2000 NSS included additional changes. In this round, food consumption was obtained by both 7-day and 30-day recall for the same set of households. The numbers for the mean of food consumption from the 1999–2000 NSS round were far more similar than those in the four previous experimental rounds in which different households were given different recall schedules. Spending on low-frequency nonfood consumption items was obtained using only a 365-day recall period. The only item for which there was continuity was high-frequency nonfood, for which 30-day recall was used.

A1.4 The above changes in the 55th round led to the conflicting findings that the poverty rate decreased by about 10 percentage points between 1993–94 and 1999–2000 if food expenditures were based on 30-day recall, but increased between 1994–95 and 1999–2000 if they were based on 7-day recall (Datt and Ravallion 2002). Deaton (2003) attempted to adjust the 55th round poverty estimates to make them comparable with earlier official estimates. Correcting for this lack of comparability involved making two key assumptions: (a) that the 1999–2000 results for the common 30-day recall period were unaffected by the change in survey design; and (b) that there was no change in the distribution of total consumption, conditional on consumption of the common-recall goods, so that the distribution could be inferred from the 1993–94 round. These adjustments led to the revised finding that the poverty rate fell by 8 percent, rather than 10 percent, between 1993–94 and 1999–2000.

A1.5 The incomparability of the data sets is a serious concern for assessing poverty trends over time. For the purpose of this work, however, it affects only the descriptive statistics comparing the trend between 1993–94 and 1999–2000, and largely the distribution of households among the 10 expenditure deciles. Given the large measurement uncertainties associated with expenditures on fuels, as described below, adjusting total expenditures would be expected to have essentially no impact on the conclusions drawn. Therefore, no adjustments were made to the data in this study.

Information Collected

A1.6 In the absence of reliable information on household income, total expenditures were taken as a proxy for income. Total expenditures consisted of consumption items, durable goods purchased in the past 365 days and converted to monthly equivalent expenditures by multiplying by 30/365, and housing or land rentals. While an imputed value for nonrented housing in urban areas was estimated, this was not used in calculating the total monthly household expenditure. Housing that was not rented carried no value, which could seriously underestimate the expenses in rural areas, making rural households appear poorer compared to their urban counterparts. This needs to be borne in mind when interpreting results aggregated nationally. Total expenditures were adjusted for interstate price differences.

A1.7 Households were divided into 10 groups, each containing the same number of households unless indicated otherwise, ranked in order of increasing per capita expenditure (total household expenditures adjusted by the cost-of-living index and divided by the household size). Decile 1 corresponds to the bottom 10 percent, decile 10 to the top 10 percent. Because poor households are larger in size, the lower deciles have more people than upper deciles. In one case, the population was divided into 10 groups, each containing the same number of individuals rather than households. This was to help assess the number of people who live in houses using different fuel types. Households were typically divided into urban and rural areas before analysis. In these cases, the per capita expenditure in each per decile is higher in urban areas than in rural areas. When households are analyzed across the country, the top decile is dominated by urban households and the bottom decile by rural households. Population and expenditure statistics for deciles in which each decile group contains the same number of households (as opposed to individuals) are shown in Table A1.1. The lower expenditures in any given decile in rural areas compared to urban areas, and the population of lower deciles by rural households and of higher deciles by urban households, when deciles are taken nationally, emerge clearly in the table.

Table A1.1 Population and Expenditure Statistics, 1999–2000

Per capita expenditure decile	*Range (Rs per capita)*	*Median (Rs per capita)*	*Mean (Rs per capita)*	*Household size*	*Number of people in rural*	*Number of people in urban*
Rural 1	0-277	234	224	6.0	81,379,553	N.A.
2	278–332	293	292	5.8	78,859,202	N.A.
3	333–380	339	339	5.5	74,933,194	N.A.
4	381–429	382	382	5.5	74,735,782	N.A.
5	430–482	426	426	5.2	70,490,802	N.A.
6	483–543	477	477	5.1	68,446,685	N.A.
7	544–624	535	536	4.8	65,111,421	N.A.
8	625–737	617	618	4.5	61,833,333	N.A.
9	738–949	745	752	4.4	59,040,219	N.A.
10	more than 949	1,069	1,252	3.7	50,330,351	N.A.
Urban 1	0–345	285	274	6.1	N.A.	31,337,821
2	346–431	380	379	5.5	N.A.	28,041,782
3	432–515	459	459	5.3	N.A.	26,686,662
4	516–607	542	542	5.0	N.A.	25,230,062
5	608–710	635	637	4.8	N.A.	24,258,426
6	711–837	748	749	4.4	N.A.	22,561,648
7	838–1,003	888	889	4.1	N.A.	20,872,650
8	1,004–1,238	1,075	1,078	3.7	N.A.	18,996,742
9	1,239–1,653	1,367	1,380	3.4	N.A.	17,340,678
10	more than 1,653	2,115	2,594	3.0	N.A.	15,489,932
National 1	0–310	246	236	6.0	108,000,000	3,682,252
2	311–382	316	315	5.7	98,916,620	7,485,666
3	383–449	372	372	5.6	94,109,185	9,887,355
4	450–521	425	426	5.3	85,163,537	13,411,174
5	522–607	485	486	5.1	78,603,170	16,206,361
6	608–715	555	557	4.9	69,845,223	21,527,664
7	716–868	651	653	4.7	59,705,859	27,324,158
8	869–1,107	794	798	4.5	48,379,132	35,001,557
9	1,108–1,579	1,052	1,065	4.1	30,371,880	45,573,948
10	more than 1,579	1,757	2,161	3.4	12,031,104	50,716,268

N.A. = not applicable

A1.8 The survey asked for the "primary" sources of energy for cooking and lighting. It collected information on the consumption of coke, firewood and chips, electricity, dung, kerosene sold through the PDS, kerosene from sources other than PDS, matches, coal, LPG, charcoal, candles, gobar gas, and other fuels. The quantities were not recorded for dung, gobar gas, and other fuels. The values in rupees were recorded for all of the above items. Sources were categorized according to (1) only purchase, (2) only home-grown stock, (3) both purchase and home-grown stock, (4) only free collection, and (5) others.

A1.9 Where items were not paid for in cash, imputed values were assigned. In the case of fuels, two main categories that required the assigning of imputed values were dung and firewood. The values were solicited from respondents by enumerators, so that there is a large element of subjective judgment. Where there is a well-established market for firewood, as would be the case in many peri-urban and urban areas, the imputed values are more likely to reflect the market value of firewood in the community. For biomass-rich areas without commercial wood markets nearby, imputed values should ideally reflect the value of time involved in biomass collection. It is not clear, and in fact unlikely, that the respondents tried to estimate the cash equivalent value of the time spent on fuel collection.

A1.10 Table A1.2 lists the percentage of households in each per capita expenditure decile that resided in FSUs in which no household reported (1) or (3) as described in paragraph A1.8 as the source of firewood—that is, where nobody reported purchasing firewood. Also shown in the table are the imputed values reported by these households as well as those households that relied only on cash-free firewood but lived in FSUs in which at least one household reported purchasing firewood. About one-quarter of rural households lived in villages (FSUs) where nobody reported purchasing firewood, whereas in rural areas only a very small percentage of households lived in FSUs where nobody purchased wood.

A1.11 In principle, a household will buy wood on the market if the cost of collection exceeds the sum of the market price and the cost of transporting the wood from the market to the house. To the extent that the cost of transporting wood (or any other fuel, for that matter) from the market to the house is not included, the market price underestimates the actual cost to the household of using a specific fuel. If the sum of the cost of collection and the cost of transporting wood to the market is lower than the market price, then the household may collect wood for sale. For wood-selling households, the market price of wood reflects the value of wood. Even if a household resides next to an abundant source of firewood that can be gathered at little cost, and the market price of wood is relatively high, if it is costly to transport wood to the market (on account of distance or bad road conditions), the household will not collect wood for sale. For those households that are neither selling nor buying firewood, the market price may overestimate the cost and value of firewood, in some cases by a large margin.

Table A1.2 Households Living in FSUs where Nobody Reported Firewood Purchase, 1999–2000

Per capita expenditure decile	*RURAL*			*URBAN*		
	% of households	*Rs / mo*[1]	*Rs / mo*[2]	*% of households*	*Rs / mo*[1]	*Rs / mo*[2]
1	28%	74	75	4%	60	84
2	25%	82	81	4%	65	92
3	24%	86	84	4%	75	85
4	23%	92	91	4%	59	91
5	21%	92	96	3%	70	104
6	21%	92	99	4%	66	96
7	22%	98	99	3%	61	91
8	22%	99	103	3%	90	89
9	22%	99	105	2%	67	96
10	20%	108	103	2%	71	83
Average	23%	91	93	4%	66	90

[1] Imputed value of cash-free firewood in rupees per month per household, averaged across those who lived in FSUs where no household reported purchasing firewood. [2] Imputed value of cash-free firewood in rupees per month per household, averaged across all households that reported using only home-grown or freely collected firewood and that lived in FSUs where at least one household reported purchasing firewood.

A1.12 Similarly, the actual cost to a household of using kerosene and LPG includes additional expenses incurred in bringing the fuel to the house. Home delivery of LPG refill cylinders, required in principle for those that live within a certain distance of the dealership, was unreliable and often did not happen, especially in peri-urban and rural areas, so that consumers would have had to make their own arrangements for cylinder collection, such as paying a third party to do the work. It is not clear to what extent the full cost of kerosene and LPG use was captured in the survey. To the extent that respondents were not asked to estimate the value of the time spent on the purchase of commercial fuels, the expenditures reported underestimate the actual cost.

A1.13 Expenditures on kerosene, LPG, and electricity as a percentage share of the total household expenditure are shown in Table A1.3 and Table A1.4 for rural and urban households, respectively. Among users, LPG accounts for the largest share of household expenditures, except in the top 30 percent of urban households where electricity expenditures exceed those for LPG. Averaged across all households, electricity had the largest share in urban areas irrespective of expenditure decile. Kerosene dominated for the bottom half in rural areas, consistent with the reliance of lower-income rural households on kerosene as the primary energy source for lighting.

Table A1.3 Expenditure on Energy by Rural Households, 1999–2000 (percentage of total household expenditure)

	Users only			*All households*		
p.c. decile	*Kerosene*	*LPG*	*Electricity*	*Kerosene*	*LPG*	*Electricity*
1	1.3	6.8	2.6	1.3	0.0	0.5
2	1.2	4.3	2.4	1.2	0.0	0.7
3	1.2	5.6	2.3	1.1	0.0	0.8
4	1.2	6.3	2.4	1.1	0.1	0.9
5	1.2	5.4	2.5	1.1	0.1	1.0
6	1.1	4.6	2.5	1.1	0.1	1.2
7	1.1	4.5	2.6	1.1	0.2	1.3
8	1.1	4.2	2.5	1.1	0.3	1.5
9	1.1	3.8	2.5	1.0	0.5	1.6
10	1.0	3.0	2.4	0.9	0.8	1.8
Average	1.1	3.6	2.5	1.1	0.2	1.1

Table A1.4 Expenditure on Energy by Urban Households, 1999–2000 (percentage of total household expenditure)

	Users only			*All households*		
p.c. decile	*Kerosene*	*LPG*	*Electricity*	*Kerosene*	*LPG*	*Electricity*
1	2.2	7.2	4.1	2.0	0.5	2.2
2	2.5	7.3	3.9	2.3	1.1	2.7
3	2.3	6.1	4.0	2.1	1.5	3.1
4	2.6	5.5	4.0	2.2	1.8	3.3
5	2.5	5.1	3.9	2.0	2.2	3.4
6	2.5	4.5	4.0	1.8	2.4	3.5
7	2.3	4.1	3.9	1.5	2.5	3.5
8	2.4	3.7	3.9	1.4	2.3	3.4
9	2.0	3.2	3.9	0.9	2.2	3.5
10	1.4	2.2	3.9	0.4	1.7	3.5
Average	2.3	4.1	3.9	1.7	1.8	3.2

A1.14 One interesting question is how much households that use purchased wood as their primary cooking fuel spend compared to those that use LPG as their primary cooking fuel. Table A1.5 and Table A1.6 take only those households that reported using cash wood as the primary cooking fuel (those that recorded (1), cash wood only, as their source of wood, and

excluding those that reported both purchased and home-grown wood) and those that reported LPG for rural and urban areas, respectively. Figure A1.1 shows the distribution of these households across the expenditure deciles. It is clear that in terms of percentages, those households that used purchased wood typically paid more for kerosene, LPG, and wood than did those that used LPG, in both rural and urban areas.

Table A1.5 Expenditure on Cash Wood or LPG as Primary Cooking Fuel in Rural India, 1999–2000 (percentage of total household expenditure)

P.c.	*Cash wood as primary fuel*					*LPG as primary fuel*				
Decile	*Kerosene*	*LPG*	*Wood*	*Total*[1]	*Electricity*	*Kerosene*	*LPG*	*Wood*	*Total*[1]	*Electricity*
1	1.4	0.0	6.1	7.5	0.8	0.8	4.8	1.8	7.4	2.0
2	1.2	0.0	5.7	7.0	1.0	0.8	3.9	0.0	4.7	2.3
3	1.2	0.0	5.6	6.8	1.0	0.8	3.9	0.7	5.3	2.6
4	1.1	0.0	5.3	6.4	1.1	0.7	4.9	0.4	5.9	2.7
5	1.2	0.0	5.1	6.2	1.3	0.7	5.5	0.4	6.6	2.7
6	1.2	0.0	4.9	6.1	1.5	0.6	4.8	0.2	5.6	3.2
7	1.1	0.0	4.9	6.0	1.5	0.7	4.8	0.2	5.7	3.1
8	1.1	0.0	4.9	6.0	1.5	0.5	4.4	0.3	5.2	2.6
9	1.1	0.1	4.4	5.5	1.7	0.6	4.1	0.2	4.9	2.7
10	0.9	0.1	3.8	4.8	1.7	0.3	3.3	0.1	3.7	2.5
Total	1.2	0.0	5.1	6.2	1.3	0.5	3.9	0.2	4.5	2.6

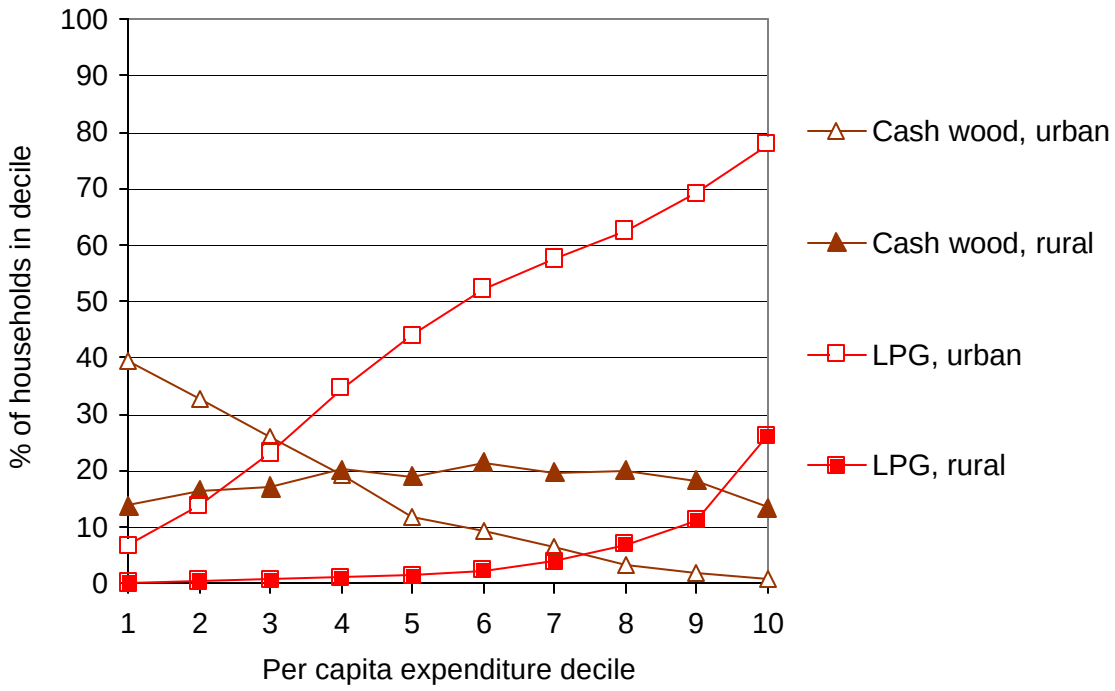
[1] Sum of kerosene, LPG, and wood.

Table A1.6 Expenditure on Cash Wood or LPG as Primary Cooking Fuel in Urban India, 1999–2000 (percentage of total household expenditure)

P.c.	*Cash wood as primary fuel*					*LPG as primary fuel*				
Decile	*Kerosene*	*LPG*	*Wood*	*Total*[1]	*Electricity*	*Kerosene*	*LPG*	*Wood*	*Total*[1]	*Electricity*
1	1.4	0.0	5.8	7.2	1.8	0.8	5.9	0.4	7.1	3.9
2	1.2	0.0	5.4	6.6	2.1	0.7	5.5	0.3	6.5	3.5
3	1.3	0.0	4.9	6.2	2.3	0.6	5.6	0.2	6.3	3.5
4	1.2	0.0	4.7	5.9	2.3	0.5	4.9	0.1	5.6	3.7
5	1.1	0.0	4.8	5.9	2.3	0.4	4.4	0.1	5.0	3.7
6	1.2	0.1	4.3	5.6	2.3	0.4	4.1	0.1	4.5	3.6
7	1.4	0.0	4.3	5.7	2.1	0.3	3.8	0.1	4.1	3.7
8	1.0	0.1	3.8	4.8	2.0	0.3	3.3	0.0	3.6	3.7
9	0.9	0.1	3.7	4.7	1.8	0.2	3.0	0.0	3.2	3.7
10	1.4	0.1	2.8	4.2	0.9	0.1	2.1	0.0	2.2	3.8
Total	1.3	0.0	5.1	6.4	2.1	0.3	3.7	0.1	4.1	3.7

[1] Sum of kerosene, LPG, and wood.

Figure A1.1 Percentage of Households Using Cash Wood or LPG as Primary Cooking Fuel, 1999–2000



A1.15 To answer if this is because wood is expensive in some parts of India, including rural areas, Table A1.7 and Table A1.8 show how much these households paid in nominal terms on average in each expenditure decile. It becomes immediately clear that those households that used LPG as the primary cooking fuel paid more in cash, and that the reverse trend observed with the percentage share is on account of wood-users being poorer in each decile group. That is to say, those who purchase wood do so because using wood is cheaper given their specific total household budget. The per capita expenditure ranking hides the fact that the total household expenditure is a function of the household size in any decile group, and because of economies of scale in a number of household economic activities such as housing, cooking, and lighting, both per capita and household expenditures should be standardized for proper comparison. In each per capita expenditure decile, those who used purchased wood as the primary cooking fuel had a smaller household size. When households are compared at the same per capita and household expenditures, those who cooked with purchased wood were found to be paying less, both as a percentage share of the total household budget and in rupees, than those who cooked with LPG. What is more difficult to explain is the fact that this trend is observed in each expenditure decile. One important point to bear in mind is that more than 13 million households were on the waiting list for LPG at the time of the survey. In addition to personal preferences and fuel availability, possible explanations include the weak correlation between cash income on one hand and expenditures, including imputed values and excluding many durable goods and real estate, recording and recall errors during the survey, and unrecorded transaction costs of different fuel use, on the other.

Table A1.7 Nominal Monthly Expenditure on Cash Wood or LPG as Primary Cooking Fuel in Rural India, 1999–2000 (rupees)

P.c.	*Cash wood as primary fuel*					*LPG as primary fuel*				
Decile	*Kerosene*	*LPG*	*Wood*	*Tota1*[1]	*Electricity*	*Kerosene*	*LPG*	*Wood*	*Total*[1]	*Electricity*
1	18	0	79	97	11	8	53	22	84	21
2	19	0	91	110	16	17	91	0	107	51
3	20	0	96	116	18	15	84	9	108	50
4	21	0	105	127	22	14	102	6	123	54
5	22	0	102	124	28	18	138	13	168	69
6	25	0	104	130	34	19	141	5	165	91
7	25	1	111	136	35	18	137	7	162	92
8	26	1	115	143	39	19	152	9	180	91
9	27	3	117	147	48	20	148	10	178	103
10	27	6	132	165	59	16	153	7	176	123
Total	23	1	105	130	31	17	147	8	173	107

[1] Sum of kerosene, LPG, and wood. The expenditures are not adjusted for cost-of-living differences.

Table A1.8 Nominal Monthly Expenditure on Cash Wood or LPG as Primary Cooking Fuel in Urban India, 1999–2000 (rupees)

P.c.	*Cash wood as primary fuel*					*LPG as primary fuel*				
Decile	*Kerosene*	*LPG*	*Wood*	*Total*[1]	*Electricity*	*Kerosene*	*LPG*	*Wood*	*Total*[1]	*Electricity*
1	24	1	107	132	37	20	137	10	167	93
2	27	0	119	147	49	20	147	9	175	96
3	30	1	120	151	61	18	156	6	180	112
4	29	1	120	150	65	18	162	5	185	129
5	31	0	133	164	69	16	163	5	183	142
6	32	2	120	153	71	14	163	4	181	153
7	31	2	106	139	58	13	165	3	181	169
8	34	4	122	160	60	12	160	2	173	189
9	30	5	129	164	69	8	163	2	173	219
10	60	11	141	212	43	6	162	2	170	345
Total	28	1	117	146	54	28	1	117	146	54

[1] Sum of kerosene, LPG, and wood. The expenditures are not adjusted for cost-of-living differences.

A1.16 It is difficult to obtain accurate data on the consumption of fuels using a household survey unless the questionnaire is carefully designed for this purpose. One source of error, aside from recall errors, is the tendency of households to report their last purchase rather than how much they consume in a month. One way of reducing this error is to ask two or more sets of questions that can be used to check the internal consistency of the answers provided. For example, one question can ask about the quantity consumed in the last 30 days, and another can ask how much was purchased the time before last and how long the purchased fuel lasted. This was unfortunately not done in the NSS, which is not a household energy survey. Table A1.9 shows the distribution of answers given for LPG. That there is "bunching" around 1 cylinder may indicate that there is an upward bias. This interpretation is further supported by the average quantity of LPG consumed by rural households, and especially the rural poor. Among rural LPG users, even the bottom two deciles reported consuming close to 9 kg a month, which is much higher than average rural household consumption figures reported by the LPG marketing departments of the state oil companies. It appears therefore that LPG consumption figures carry an upward bias.

Table A1.9 Reported Monthly Household Consumption of LPG, 1999–2000 (percentage of LPG-consuming households)

Quantity in kg/month	*Rural*	*Urban*	*National*
up to 2	4%	3%	4%
2–4	5%	1%	2%
4–6	7%	3%	4%
6–7	6%	3%	4%
7–8	14%	8%	10%
8–9	1%	1%	1%
9–10	8%	9%	9%
10–11	3%	3%	3%
11–12	2%	3%	2%
12–13	1%	1%	1%
13–14.2	6%	6%	6%
14.2	31%	42%	39%
14.2–15	6%	6%	6%
15–16	2%	2%	2%
16–18	1%	2%	2%
18–20	1%	1%	1%
20–25	1%	3%	2%
25–30	1%	2%	2%
30 or more	0%	1%	1%

A1.17 In the case of wood, the quantities reported consumed are probably more accurate for those who purchase wood regularly. For those that use freely collected or home-grown wood, it is not clear how accurate are their estimates of wood consumed.

A1.18 For dung, questions were not asked about quantities consumed, presumably because of the difficulties involved in estimating them. The respondents were asked about the value of the dung consumed, but in the absence of a market for dung, it is not clear how these imputed values were estimated. The percentage of those who purchased dung was small in rural areas (16 percent), but in urban areas 54 percent reported paying for dung.

Annex 2: Modeling

A2.1 For modeling household energy consumption in this study, a discrete choice analysis and a continuous choice model conditional on the discrete choices were used. Urban and rural households were modeled separately. A household's decision-making consists of choosing energy sources and how much of each to consume. For energy choice, households are divided into different energy mix groups using multinomial logit. The multinomial logit model is for data in which the response is a set of choices and is measured on a nominal scale. A set of coefficients ßik are estimated corresponding to each outcome category,

$$\text{Pro}_{i,n} = \exp \sum_{k} b\text{ik} \cdot \text{Xikn} \,/ \sum_{j} \exp(\sum_{k} b\text{jk} \cdot \text{Xjkn})$$

where $\text{Pro}_{i,n}$ is the probability of household n choosing energy mix i, and X_{ikn} represents the value of the characteristic k for household n and the energy mix option i.

A2.2 After allocating each household to a specific energy mix group, the quantity of each fuel consumed is modeled using conditional demand equations, where the effect of an independent variable is conditional on the household choosing among different energy mix alternatives. Estimation of the conditional demand by ordinary least squares gives inconsistent coefficient estimates because the choice of energy mix and its use are endogenous. Consistent estimates can be obtained by means of instrumental variables or by correcting for the self-selection bias. In this study, the latter approach was used. The aggregate demand for each fuel is obtained as a weighted average of the choice probabilities and conditional demands.

A2.3 For defining energy mix categories, households were not categorized according to their primary cooking and lighting energy sources. This is because different combinations of energy sources were used by households with the same primary energy sources for cooking and lighting. Instead, energy mixes were defined as follows for two separate models, hereafter called model 1 and model 2.

A2.4 Only firewood, PDS kerosene, market kerosene, LPG, and electricity are explicitly considered in modeling because these are the most commonly used energy sources. Dung use, although common in rural areas, is not modeled because there is no information on the quantity consumed. Model 1 specifies the choice set based on the combination of these five energy sources. Model 2 does not distinguish between PDS and market kerosene but distinguishes energy sources on the basis of their use in cooking and lighting. For cooking, the fuels considered are firewood, kerosene, and LPG. For lighting, kerosene and electricity are considered.

A2.5 Model 2 splits household kerosene consumption into its use in cooking and lighting. Because the survey questionnaire does not provide information on how kerosene was

used by each household, assumptions have to be made so that kerosene can be assigned to cooking or lighting. In principle, the two models can be integrated so that kerosene can be traced to both its source (PDS or market) and its use (cooking or lighting). In practice, this would lead to many cases and increase the number of parameters to be estimated in the multinomial logit. Although the sample size of the NSS is large, the computational burden increases with the number of alternatives and often the maximum likelihood algorithms fail to converge. No model encompassing all the possible combinations was set up.

Assigning Kerosene to Lighting and Cooking

A2.6 For the purpose of assigning kerosene to lighting and cooking in model 2, those households that reported positive consumption of kerosene were classified into five groups:

- households whose primary lighting code was kerosene and primary cooking code was *not* kerosene
- households whose primary lighting code was kerosene and primary cooking code was *also* kerosene
- households whose primary lighting code was electricity and primary cooking code was *not* kerosene
- households whose primary lighting code was electricity and primary cooking code was *also* kerosene
- households that did not fall into any of the above categories

A2.7 Table A2.1 shows the distribution of households among the five categories and the monthly consumption of kerosene per household, averaged in each category. The following assumptions were made in allocating kerosene to lighting and cooking. In the first category, the average monthly household consumption of kerosene was nearly 4 liters in rural areas and 5 liters in urban areas. As kerosene was the primary lighting fuel but not the primary cooking fuel, it is reasonable to assign the entire kerosene consumption to lighting. In the second category, kerosene was used for both lighting and cooking. The differences in consumption between the first and second categories of 6 liters in rural areas and 10 in urban were assigned to cooking. In the third and fourth categories, electricity was the primary lighting source. In the third category, kerosene was not the primary fuel for lighting or cooking, and so could be regarded as a supplementary fuel. Because rural households tend to use kerosene mostly for lighting and urban households use kerosene more for cooking, kerosene consumption in rural areas was assigned entirely to lighting and in urban areas to cooking. Comparison of the third and fourth categories gives an increase in monthly kerosene consumption of nearly 10 liters in rural areas and close to 13 liters in urban areas. For rural households in category 4, this additional demand for kerosene was assigned to cooking. That is to say, even when electricity was the primary lighting and kerosene the cooking code, not all the kerosene was assigned to cooking. In contrast, all kerosene consumption among category 4 urban households was assigned to cooking. For the

last category, which includes only a few households, kerosene was considered a supplementary fuel and was assigned in rural areas to lighting and in urban areas to cooking.

Table A2.1 Monthly Kerosene Consumption per Household, 1999–2000

			RURAL		*URBAN*	
Category	*Primary cooking fuel*	*Primary lighting source*	*Liters per month*	*% Households*	*Liters per month*	*% Households*
1	Not kerosene	Kerosene	3.9	50	5.0	8.7
2	Kerosene	Kerosene	10.0	0.3	15.2	1.5
3	Not kerosene	Electricity	3.9	46	3.1	69
4	Kerosene	Electricity	13.5	2.4	15.9	20
5	Other combinations		3.7	1.2	4.9	0.9

Energy Choice Categories

A2.8 Model 1 looks only at the choice of energy sources and not at their intended purposes. The following top six combinations, accounting for 80 percent of all rural households, were examined. Households that also used dung were included in each category: for example, a household using PDS kerosene, firewood, and dung was included in the first category listed below, of households that used PDS kerosene and firewood.

- PDS kerosene and firewood (26 percent of rural households)
- PDS kerosene, firewood, and electricity (25 percent)
- PDS kerosene, market kerosene, and firewood (12 percent)
- market kerosene and firewood (10 percent)
- market kerosene, firewood, and electricity (5.3 percent)
- LPG and electricity (1.5 percent)

The eight leading combinations, accounting for 70 percent of urban households examined in model 1, were:

- LPG and electricity (21 percent of urban households)
- PDS kerosene, LPG, and electricity (12 percent)
- PDS kerosene, firewood, and electricity (10 percent)
- PDS kerosene, market kerosene, and electricity (7.7 percent)
- market kerosene and electricity (6.7 percent)
- market kerosene, LPG, and electricity, (4.9 percent)
- PDS kerosene and firewood, (4.4 percent)
- market kerosene and firewood (3.3 percent)

A2.9 Model 2, in contrast, divided households on the basis of the energy sources used for cooking and lighting. The four leading combinations, accounting for 87 percent of all rural households examined in model 2, were:

- firewood for cooking; kerosene for lighting (47 percent of rural households)
- firewood for cooking; electricity and kerosene for lighting (34 percent)
- LPG, kerosene, or both for cooking; electricity and kerosene for lighting (6.2 percent)
- LPG, kerosene, or both for cooking; kerosene for lighting (1 percent)

The seven leading combinations, accounting for 84 percent of all urban households examined in model 2, were:

- LPG for cooking; electricity for lighting, (22 percent of urban households)
- kerosene for cooking; electricity for lighting (18 percent)
- LPG and kerosene for cooking; electricity for lighting (18 percent)
- kerosene and firewood for cooking; electricity for lighting (17 percent)
- firewood for cooking; kerosene for lighting (7.2 percent)
- LPG, kerosene, or both for cooking; kerosene for lighting (1.6 percent)
- firewood for cooking; electricity for lighting (1 percent)

Explanatory Variables

A2.10 For both models, the explanatory variables given in Table A2.2 were used. In the discrete choice model in the first stage of modeling, all the variables were included. For conditional demand equations in the second stage, two criteria were used for retaining variables. A variable was retained if the variable was of policy significance or needed on theoretical grounds, or if retaining the variable increased the adjusted R-squared (that is, the absolute value of the t-statistic associated with the coefficient is greater than unity).

Table A2.2 Independent Variables Used in Regression Analysis

Variable	*Description*
Total expenditure	Total monthly household expenditure, adjusted for interstate price differences
Firewood price	Household-specific expenditure (cash or imputed, in rupees) on firewood, divided by kilograms consumed, adjusted for interstate price differences; or if the household does not consume firewood, the mean price paid in the FSU, district, or region (whichever is the smallest unit for which data exist)
PDS kerosene price	Household-specific expenditure on PDS kerosene, divided by liters purchased, adjusted for inter-state price differences; or if the household does not consume firewood, the mean price paid in the FSU, district, or region (whichever is the smallest unit for which data exist)

Variable	*Description*
Market kerosene price	Household-specific expenditure on market kerosene, divided by liters purchased, adjusted for interstate price differences; or if the household does not consume firewood, the mean price paid in the FSU, district, or region (whichever is the smallest unit for which data exist)
LPG price	Household-specific expenditure on LPG, divided by kilograms purchased, adjusted for interstate price differences; or if the household does not consume firewood, the mean price paid in the FSU, district, or region (whichever is the smallest unit for which data exist)
Electricity access and price	Multiple of a dummy variable taking on 1 if at least one household in the FSU reports using electricity, 0 otherwise, and the price of electricity obtained by dividing household-specific expenditure on electricity by quantity consumed for each household, adjusted for interstate price differences; or if the household does not consume firewood, the mean price paid in the FSU, district, or region (whichever is the smallest unit for which data exist)
Household size	Number of people in the household
Social group	1/0 dummy for four categories: scheduled tribe, scheduled caste, other backward classes, and others
Occupation	1/0 dummy for the activity from which the household derives more than 50 percent of its income. The five categories in rural areas are self-employment in nonagriculture, agricultural labor, other labor, self-employment in agriculture, and others. The four categories in urban areas are self-employment, regular wage/salary, casual labor, and others
Kerosene quota	The amount of kerosene in liters per month to which a household with no LPG connection is entitled
Kerosene allocation	Amount of PDS kerosene allocated to each state, divided by the number of PDS-consuming households in the state
Median cluster expenditure	Median monthly household expenditure in the FSU
Access to kerosene quota	80th percentile of PDS kerosene in liters purchased by households in the FSU
Kerosene dealers per area	Number of PDS kerosene dealers in the state, divided by the surface area of the state in square kilometers (km^2)
Kerosene dealers per household	Number of PDS kerosene dealers in the state, divided by the number of households in the state
LPG dealers per area	Number of LPG dealers for state oil companies in the state, divided by the surface area of the state in square kilometers (km^2)
LPG dealers per household	Number of LPG dealers for state oil companies in the state, divided by the number of households in the state
Per capita electricity consumption	Per capita consumption of electricity for noncommercial use in the state

A2.11 In addition, the impact of education on fuel use was examined briefly. Information was collected in the survey on the education of the head of the household and the spouse. However, due to missing entries about 12,000 observations each in rural and urban areas were lost, accounting for about 20 percent and 27 percent, respectively, of the total sample. As an alternative approach, education variables were defined as dummies for the maximum level of any member in the household. Three dummies were used for a maximal education level of primary, secondary, and post-secondary. The omitted category was below-primary. Defining the education variables in this way avoided losing any observations.

A2.12 Model 1 was run with the above education dummies in addition to the explanatory variables shown in Table A2.2. For urban households there were essentially no differences in the results, except in the case where total household expenditures were increased by 10 percent. In that scenario, including education dummies increased overall LPG consumption and decreased firewood consumption markedly. In rural areas, there were more cases with marked differences, all of which related to consumption of LPG, which increased except for the scenario in which the price of LPG was increased by 10 percent. Among the scenarios that were retained according to the criteria defined in paragraph 4.2 of Chapter 4, including the education dummies increased overall LPG consumption markedly when the total household expenditures were increased by 10 percent, and decreased LPG consumption when the price of LPG was increased by 10 percent.