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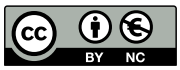

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DECISION MAKING PROCESSE UNDER UNCERTAINTY: AN ECONOMETRIC ANALYSIS

FABIO ZAGONARI

No 175

DECISION MAKING PROCESSES UNDER UNCERTAINTY: AN ECONOMETRIC ANALYSIS

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Abstract

This paper utilizes panel data from rural India on a daily rated labour market to examine how workers deal with the uncertainty which arises from the existence of involuntary unemployment. In particular, it measures the relative explanatory power of the three models which the literature suggests should better fit the conditions prevailing in this market: the Expected Utility Model (EUM) with linear objective probabilities, the EUM with linear subjective probabilities and the EUM with non-linear subjective probabilities. The econometric analysis indicates that the EUM with linear has to be preferred to that with non-linear probabilities. Moreover, it supports the hypothesis that the decision making model is under uncertainty and that people work out their subjective probabilities through their past experiences. Finally, agents in the sample turn out to be risk-averse and not to have a positive reservation wage.

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The standard von Neuman-Morgenstern theory of choice under uncertainty has been challenged on several grounds from both inside and outside economics. Experimental economics, in particular, has highlighted many phenomena which that theory is not in a position to explain (Machina 1989, Camerer 1989). Common consequence effect, common ratio effect and utility evaluation effect can not be caught by an expected utility model (EUM) with linear probabilities; when individuals are asked to formulate probabilities, they do not seem to do it correctly; response mode effect, stocastic dominance violation and reference point effect are inconsistent with an EUM.

In this paper I utilize panel data from rural India on a daily rated labour market (DRLM) to examine how workers deal with the uncertainty which arises from the existence of involuntary unemployment. In particular, I measure the relative explanatory power of the three models which the literature suggests should better fit the conditions prevailing in this market: the EUM with linear objective probabilities, the EUM with linear subjective probabilities and the EUM with non-linear subjective probabilities.

I focus on the DRLM for two reasons. First, when one studies the decision making process of agents supplying labour in several different markets, one should have data for the received wages and the frequencies of unsuccess to enter each market in each single period for each single agent. Women in the sample, however, can not participate in other labour markets but the DRLM: data for this market, therefore, make me in a position to obtain a measure of the expected wages. Second, the characteristics of this market reduces the set of decision making models which may be worthy testing; comparing couple of estimates made on their basis allows me to assess three of the more controversial dilemmas of the standard theory of choice under uncertainty: whether the EUM is suitable or not; whether the EUM, if accepted, is linear or not in probabilities; whether agents utilize objective or subjective probabilities in taking their decisions.

The empirical results indicate that the EUM with linear has to be preferred to that with non-linear probabilities. They support the hypothesis that the decision making model is under uncertainty and

that people work out their subjective probabilities through their past experiences. Moreover, agents in the sample turn out to be risk-averse and not to have a positive reservation wage.

The structure of the paper is as follows.

In section 1, a framework for exploring the decision of supplying labour under uncertainty is obtained from the compound analysis of the characteristics of the DRLM and the relevant theoretical literature. A one-to-one relationship between the parameters of the decision making models and those of the labour supply function is provided.

Section 2 contains a description of the data and a discussion of measurement issues.

Section 3 provides the procedure that leads to the decision making model estimates and the analysis of the results.

The conclusion appears in section 4.

1.THE THEORETICAL FRAMEWORK

I consider an adult worker without land or, at most, with an insufficient amount of land to live on, who supplies labour in different labour markets having taken the decision to enter one or more of them: since there is involuntary unemployment, he chooses the number of days of work (L_i) for each market according to the expected wage ($w_i\pi_i$) in that market assessed by using the probability to get the job (π_i). Because segmentation forces female workers in the sample to supply labour in the DRLM only (see Table 1 and 2), I am allowed to focus my attention simply on it [1].

Table 1
Non-farm Employment Days

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
	.00	113	98.3	98.3	98.3
	6.00	1	.9	.9	99.1
	8.00	1	.9	.9	100.0
	TOTAL	115	100.0	100.0	
Valid Cases 115	Missing Cases	0			

Table 2
Government Employment Days

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
	.00	115	100.0	100.0	100.0
	TOTAL	115	100.0	100.0	
Valid Cases 115	Missing Cases	0			

1 I will take into account of the two positive entries in the non-farm employment days (NGEMPDAY) when I work out the probability to enter the DRLM.

In the market for daily rated labour, contracts are negotiated for short periods, usually a single day or at most a week; payments (sometimes in cash, sometimes in kind) are made every day for a fixed number of hours: workers engaged in harvesting and post-harvesting operations are mostly remunerated on a piece-rate basis, those carrying out pre-harvesting operations are paid daily wages. The (interrelated) characteristics which most distinguish this market are twofold: its impersonal nature and its dissociation from market for land and credit. Usually in the evenings farmers and their regular farm servants or wives of their regular farm servants go to the workers' houses and invite them to work for the following day [2]: if a preferred worker is not available, employers are willing to hire any employee, regardless of his caste or other socio-economic status; employees, in turn, are willing to work for almost all the employers and usually they do for a large number of them in the course of the year: it is not irregular for the same labourer to be engaged by more than 20 employers annually. If this practice makes this market to give everyone the same chance of participation, its impersonal nature, however, prevents daily rated workers from getting a loan or an advance from an employer even on the basis of a promise that he will work for him in a peak season whenever needed. Apart from harvesting and threshing, in the daily rated market tasks are sex specific: even if there are some regional variations in the sexual division of labour, males usually do plowing, females transplanting and weeding. Ideological support for this segmentation is strong. A taboo prevents women from touching the plow and males who do domestic chores or other female-specific tasks are ridiculed; moreover the lack of physical strength and stamina of women is generally considered a good reason for women wages to be lower. Apart from sex differences, however, daily income from daily rated jobs is lower than that from contract jobs.

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2 When, on the contrary, workers are forced to ask for a job, they put themselves in a poor bargaining position and have to accept discounted wages.

The characteristics of the DRLM depicted above lead me to identify a subset from the wide variety of functional forms that a decision making process can take.

The absence of alternative labour markets resolves the portfolio effect; the daily experience of agents entering the DRLM suggests that the temporal resolution of uncertainty issue does not matter. I will leave out other decision problems in the model.

Internal consistency and reasoned pursuit of objectives are the two main elements which define the strongest concept of rationality under certainty. The critiques which Simon made to this framework are twofold. First he (1957) (1979) introduced the concept of "satisficing behaviour". The gap between satisficing and maximizing, however, may be reduced if one thinks of the former as the latter according to an effectively incomplete information (Debreu 1959). Second, he (1983) suggested the concept of "bounded rationality". Simon (1958) himself, however, distinguished between programmed and non-programmed decision making, where "whether a particular situation will bring forth programmed or non-programmed choice behaviour depends on the previous history of the person confronted with the choice". The daily experience of agents entering the daily rated labour market drives one to assume that the gap is relatively small and that the decision making is programmed. I will assume a maximizing behaviour.

The same elements introduced to define the concept of rationality under certainty can be applied under uncertainty, except that one has to introduce the use of the probability calculus.

One can assume that the decision making is under risk and that agents apply the expected utility method with the probabilities known in advance (von Neumann and Morgenstern 1947). I will depict this case by using a single average probability to enter the daily rated labour market for all agents.

One can assume, conversely, that the decision making is under uncertainty and that by applying the expected utility criterion each agent tries to assess his own probabilities (Savage 1954). The daily experience of agents entering the daily rated labour market suggests to work out those probabilities in the spirit of the formula of

induction to the next case. I will depict this case by using a different probability to enter the daily rated labour market for each agent.

Karni, Schmeidler and Vind (1983) developed an expected utility representation of state dependent preferences. The uniqueness of the decision and the relatively short period of time under considerations drives one to expect that differences in states are not significant. Moreover, the reversal preference phenomenon does not matter because agents face a gamble with two outcomes only (getting and not getting a job). I will assume the expected utility model.

Experimental observations have pointed out several violations of linearity in probabilities (Machina 1982). I will depict that by using a non-linear functional form for the expected utility model.

Since workers take a decision about two entities (wages and days of work) which are perfectly comformable and monodimensional in their characteristics, the assumption of a separable form for the utility function is made.

Therefore, three models seem to survive the above process of successive deletion.

Taken the decision to enter the market, the worker chooses the number of days of work (L) in order to maximise:

$$U(wL)\pi_o - V(L) \tag{1}$$

in the EUM with linear objective probabilities;

$$U(wL)\pi_s - V(L) \tag{2}$$

in the EUM with linear subjective probabilities;

$$U(w\pi_s L) - V(L) \tag{3}$$

in the EUM with non-linear subjective probabilities.

In these expressions, $U(.)$ depicts the utility obtained from wages and $V(.)$ the disutility linked to labour efforts: I assume $U' > 0 \quad U'' < 0 \quad V' > 0 \quad V'' > 0$

Moreover, L are the number of days of work offered in the period under consideration; w the total wages received, in cash or in kind; π_o the objective and π_s the assessed subjective probabilities to get a job.

The solution to the previous maximization problems identifies the conditions under which the labour supply function is increasing and concave. Since a labour market characterized by unemployment and underemployment allows to assume internal solution, those conditions are given by:

$$\frac{1}{wL} > -\frac{U''}{U'} \tag{4}$$

$$\frac{2}{wL} > -\frac{U'''}{U''} \tag{5}$$

in the models with linear probabilities;

$$\frac{1}{w\pi L} > -\frac{U''}{U'} \tag{4'}$$

$$\frac{2}{w\pi L} > -\frac{U'''}{U''} \tag{5'}$$

in the model with non-linear probabilities.

In particular, the labour supply function is increasing ((4) and (4')) if either the coefficient of absolute risk aversion or if wages are small. Moreover (4) $\Rightarrow$ (4').

The labour supply function is always concave ((5) and (5′)) when $U''' < 0$; when $U''' > 0$, if wages are small. Moreover (5) $\Rightarrow$(5′).

Additionally, (4) $\Rightarrow$ (5) if:

$$U''' < \frac{2(U'')^2}{U'} \qquad (6)$$

The degree of concavity is greater in absolute value in the model with non linear probability ((5) and (5′)) if conditions (5) and (5′) are met.

2.THE DATA

The preceding framework indicates that to test for the relative explanation power of alternative decision making models through the analysis of the behaviour of workers entering the DRLM requires panel data on employment, wages and unemployment, voluntary and involuntary.

The ICRISAT Indian village surveys have regularly offered detailed panel data information on, among others, labour, draft animal and major machinery utilisation from the crop year 1975-76. Indeed, ICRISAT has collected data approximately every three weeks on all transactions for 40 households in each of the six villages selected to represent broad agroclimatic sub-regions in the semi-tropical India.

This work uses a data set on the village of Aurepalle (Mahbubnagar District, Andhra Pradesh State) for the crop year 1979-80 which provides the number of days of voluntary and involuntary unemployment for each round and so allows to construct a measure of the probability of supplying labour in the DRLM.

3.ESTIMATES OF THE LABOUR SUPPLY FUNCTIONS

The control variable I am interested in is the number of days a worker supplied in the period under consideration provided he decided to enter the market. In order to avoid the sample bias, one has to make sure that workers who decided to enter the market but did not manage to supply labour are also considered in the sample. The ICRISAT manual of instruction reads: "A person that does not participate in the DRLM is one who receives zero entries (always or in some rounds) in both the involuntary unemployment and the employment columns". I will select, therefore, all records with a positive value for at least one of these variables.

Only do 4 out of 119 cases, however, show a zero entry in the employment and positive entry in the involuntary unimployment column. I will leave out those 4 cases.

The probability to enter the labour market does not have to depend on the wage. This condition is met because I use a measures of probability based on answers to the following question: "On how many days since the last visit (interview) did you try to find a job but fail to find one at the usual wage rates during this season?" (ICRISAT manual of instruction). I will assume that agents consider the probability not to enter the labour market in the future as the frequency of unsuccess (INUNEMP) over the total frequency faced in the near past. In order to assess the total frequency, however, one has to make sure that workers did really try to enter the labour market in the whole period under consideration. This may not be the case for several reasons: because the worker is sick, out of station, on holiday, temporally migrated or he has left permanently; moreover, because he decides for voluntary unemployment or he has idle bullocks. ICRISAT data provides a variable (REASNWOR) which specifies all the previous reasons for not participating in the DRLM in each round. I will drop all the records where agents do not try to enter it at all for one of those reasons. ICRISAT manual of instruction reads again: "[The days of involuntary unemployment and wage employment] do not usually add up to the number of days between the rounds, since some days may be [...] working on own farm, market days, etc. I will not

do anything for the market days: since one can assume that they are on average the same for each worker, I should multiply each probability by a constant. I will subtract, however, the number of days worked on land of property (OWNFWD) and in off-farm non-government activities (NGEMPDAY) from the period under consideration where agents accidentally refrain from entering the DRLM.

Consequentially, the subjective probability to enter the labour market is assessed with:

$$SUBJPROB = 1 - \frac{INUNEMP}{DAY_t - DAY_{t-1} - OWNFWD - NGEMPDAY} \qquad (7)$$

Since observations are gathered on average every four weeks, this measure accounts for stagionality as well.

Wage rates do not have to depend on individual characteristics. The between estimation of the following equation may show whether this is the case:

$$UNWGTOT = \beta_0 + \beta_1 AGE + \beta_2 AGES + \beta_3 CASTE07 + \beta_4 CASTE11 + \alpha_i + \lambda_t + \epsilon \qquad (8)$$

where I created two dummy variables (CASTE07 and CASTE11) for two of the three CASTCODE values which occur in the sample and I introduced the time effect to catch the stagionality component [3].

In accordance with previous results in the literature (Rosenzweig 1984), the estimates of coefficients support the independence of wages from individual characteristics (see table 3).

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3 In equation (8) a variable (DISABIL) which specifies the capacity to do any farm or domestic work was dismissed as irrelevant since it had the same value for all records.

Table 3
Estimates of The Independence of Wages from Individual Characteristics

BETWEEN ESTIMATOR (TIME EFFECTS)

Valid cases:	13	Dependent variable:	UNWGTOT
Total SS:	2.575	Degrees of freedom:	8
R-squared:	0.139	Rbar-squared:	-0.291
Residual SS:	2.216	Std error of est:	0.526

Variable	Estimate	Standard Error	t-value	Prob >|t|
CONST	5.134997	38.057824	0.134926	0.896
AGE	-0.117673	2.052033	-0.057345	0.956
AGES	0.000001	0.026249	0.000051	1.000
CASTE07	0.587924	7.579288	0.077570	0.940
CASTE11	-1.876577	15.987546	-0.117377	0.909

One can use the actual days (FEMPDAY) as the dependent variable only in the event, which Ham (1982) defines as "unlikely", where the difference between the desired days of work and the actual days supplied is independent of the vector of the regressors (AGE, AGES, WGTOT and WGTOTS). As shown above the rate of unemployment faced by each individual does not depend on the wage and the wage, in turn, does not depend on the individual characteristics. I will use that dependent variable.

Thus, the number of days of work supplied by each worker are given by:

$$FEMPDAY = \beta_0 + \beta_1 WGTOT + \beta_2 WGTOTS + \beta_3 AGEWG + \beta_4 AGE + \beta_5 AGES + \alpha_i + \epsilon \qquad (9)$$

where WGTOT and WGTOTS will be substituted by EWGTOT and EWGTOTS, LNEWGTOT and LNEWGTOTS, LNEWGTOT and NEWGTOTS according to the decision making model under consideration (See APPENDIX for the

definition of these variables) [4].

Two observations are worthy here. First, I introduced the square of wages (WGTOTS) in order to catch a non-linear labour supply function through a Taylor expansion. Second, I used the square of age (AGES) in order to get the life cycle effect (Aoschenfelter and Hackman 1974)

Since individuals are observed in different days, estimates (see Table 4-6) are obtained with the Hausman-Taylor estimator.

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4 In equation (9) I was forced to dismiss as irrelevant two variables (EDUCAT and EDUCTERM) which could have taken as a proxy of the work experience because all individuals in the sample were illiterate.

Table 4
OBJECTIVE PROBABILITY EUM

ESTIMATED FIXED INDIVIDUAL EFFECTS

1.0000000	-1.4872845
2.0000000	-0.40098781
3.0000000	-0.070313416
4.0000000	-0.65760249
5.0000000	-0.50221067
6.0000000	0.61211977
7.0000000	-0.13822108
8.0000000	-1.7024850
9.0000000	-0.32456715
10.000000	-1.0781922
11.000000	-0.31121442

VARIANCE COMPONENTS ESTIMATION

Theta = -0.49063278

EXOGENEITY TESTS

Breusch-Pagan LM(1) test = 1.36280 (p= 0.243052)
Approx. Hausman = 9.29190 3.00000 D.F. (p= 0.0256514)
Hausman test = 22.1918 3.00000 D.F. (p= 5.95045E-05)

HAUSMAN-TAYLOR ESTIMATOR

Valid cases:	104	Dependent variable:	FEMPDAY
Total SS:	2879.952	Degrees of freedom:	98
R-squared:	0.894	Rbar-squared:	0.889
Residual SS:	304.883	Std error of est:	1.764

Variable	Estimate	Standard Error	t-value	Prob >|t|
CONST	2.042818	6.026375	0.338980	0.735
EWGTOT	0.652451	0.076834	8.491709	0.000
EWGTOTS	-0.005041	0.000909	-5.543657	0.000
AGEEWG	0.000804	0.001786	0.450405	0.653
AGE	-0.079887	0.364935	-0.218908	0.827
AGES	0.000088	0.004925	0.017905	0.986

Table 5
LINEAR SUBJECTIVE PROBABILITY EUM

ESTIMATED FIXED INDIVIDUAL EFFECTS

1.0000000	-0.61742731
2.0000000	0.91742782
3.0000000	0.95880933
4.0000000	0.52323671
5.0000000	0.91765338
6.0000000	1.6381425
7.0000000	1.1766916
8.0000000	0.16067341
9.0000000	2.5541699
10.000000	-0.70384707
11.000000	0.39110904

VARIANCE COMPONENTS ESTIMATION

Theta = 0.37980501

EXOGENEITY TESTS

Breusch-Pagan LM(1) test = 1.33710 (p= 0.247546)
Approx. Hausman = 1.98031 3.00000 D.F. (p= 0.576503)
Hausman test = 1.11637 3.00000 D.F. (p= 0.773124)

HAUSMAN-TAYLOR ESTIMATOR

Valid cases:	104	Dependent variable:	FEMPDAY
Total SS:	2826.139	Degrees of freedom:	98
R-squared:	0.865	Rbar-squared:	0.858
Residual SS:	381.102	Std error of est:	1.972

Variable	Estimate	Standard Error	t-value	Prob >|t|
CONST	2.428343	7.549921	0.321638	0.748
LNEWGTOT	0.619862	0.084978	7.294383	0.000
LEWGTOTS	-0.003068	0.000827	-3.710998	0.000
AGELNEWG	-0.001088	0.001974	-0.551096	0.583
AGE	-0.042448	0.450378	-0.094250	0.925
AGES	-0.000218	0.006004	-0.036336	0.971

Table 6
NON-LINEAR SUBJECTIVE PROBABILITY EUM

ESTIMATED FIXED INDIVIDUAL EFFECTS

1.0000000	-0.93885106
2.0000000	0.60548236
3.0000000	0.70300076
4.0000000	0.20937409
5.0000000	0.59526867
6.0000000	1.4126833
7.0000000	1.1131046
8.0000000	-0.28992761
9.0000000	1.9703218
10.000000	-0.90275577
11.000000	0.16687463

VARIANCE COMPONENTS ESTIMATION

Theta = 0.41258748

EXOGENEITY TESTS

Breusch-Pagan LM(1) test = 1.14551 (p= 0.284491)
Approx. Hausman = 0.196945 3.00000 D.F. (p= 0.978081)
Hausman test = 0.0853200 3.00000 D.F. (p= 0.993539)

HAUSMAN-TAYLOR ESTIMATOR

Valid cases:	104	Dependent variable:	FEMPDAY
Total SS:	2827.219	Degrees of freedom:	98
R-squared:	0.797	Rbar-squared:	0.787
Residual SS:	573.233	Std error of est:	2.419

Variable	Estimate	Standard Error	t-value	Prob >|t|
CONST	8.953441	17.990281	0.497682	0.620
LNEWGTOT	0.632822	0.101737	6.220174	0.000
NEWGTOTS	-0.004099	0.001204	-3.404158	0.001
AGELNEWG	-0.000651	0.002393	-0.272042	0.786
AGE	-0.411201	1.028322	-0.399875	0.690
AGES	0.004206	0.013055	0.322201	0.748

The negative value of Theta one gets from the objective probability model supports the hypothesis that the decision making process is under uncertainty and that people work out their subjective probabilities through their past experiences. The smaller value of Theta which one finds in the linear than that in the non-linear probability model makes one to prefer the first one; considered together with the daily experience of agents entering the daily rated labour market, this confirms the intuition by Hammond (1986) who claims that "consequential reasoning taking into account all the relevant considerations will push us in the direction of the expected utility maximisation". The value of β_0 is consistent with the hypothesis that females do not have a positive reservation wage. The positive values of β_1 in both models support conditions (4) and (4'). The greater value of β_1 in the non-linear than in the linear probability model is consistent with the relationship between conditions (4) and (4'): (4) $\Rightarrow$ (4'). The negative values of β_2 in both models support conditions (5) and (5') and the expected risk aversion of agents; their magnitude depicts their low incomes. The greater absolute value of β_2 in the non linear model proves the robustness of the previous result, since it is consistent with condition (4), where (4) $\Rightarrow$ (4'). The small magnitude of β_2 in both models implies that condition (4) is just met and so $U''' < 0$; moreover, since ωL is presumably small and, therefore, the absolute value of U''' is small with respect to U'' which, in turn, is small itself, a value of U''' close to 0 seems to be suggested. The non significance of β_3 in both models supports the expected ortogonality between ages and wages. The values of β_4 and β_5 are consistent with the absence of a life cycle effect justified by the omogeneity of the sample with respect to ages.

4.CONCLUSION

Uncertainty is a prominent feature of the experience of workers who enter the DRLM. In this paper I have obtained evidence that the EUM with linear subjective probabilities catches their decision making

process. The results suggest, in particular, that agents are risk-averse, have no a positive reservation wage and work out their subjective probabilities through their past experiences.

The evidence is against the common supposition that agents take their decisions under uncertainty on the base of objective probabilities and, all the more reason, it questions the validity of the representative agent models.

The analysis has taken as given the functional form of the decision making process: a linear or non-linear probabilities EUM with a separable utility function. Although these assumptions have been justified on theoretical grounds, it is clear that a joint hypothesis has been tested.

Creating the conditions for testing such a complicated set of hypothesis cost quite a lot in terms of sample size. Unlike the result of experimental economics, however, it can not be charged of being artificial: choices are made in an economically important context where agents have appropriate incentives to take the decision seriously.

APPENDIX

VARIABLE DEFINITIONS

FEMPDAY	'Farm Employment days'
NGEMPDAY	'Non-farm Employment days'
GEMPDAY	'Govt. Employment days'
INUNEMP	'Involuntary unemployment (days)'
AGE	'Age of individuals (year)'
AGES	'Square of AGE'
SUBJPROB	'Subjective probability as defined by equation (7)'
OBJPROB	'Mean of subjective probabilities over all records'
WGTOT	'Sum of wages received in kind and in cash'
WGTOTS	'Square of WGTOT'
UNWGTOT	'WGTOT over $DAY_t - DAY_{t-1} - OWNFWD - NGEMPDAY - INUNEMP$'
EWGTOT	'Product of WGTOT and OBJPROB'
EWGTOTS	'Square of EWGTOT'
LNEGWTOT	'Product of WGTOT and SUBJPROB'
LEWGTOTS	'Product of WGTOTS and SUBJPROB'
NEWGTOTS	'Square of LNEWGTOT'
AGEWG	'Product of AGE and WGTOT'
AGEEWG	'Product of AGE and EWGTOT'
AGELNEWG	'Product of AGE and LNEWGTOT'
CASTE07	'Dummy' 1 for CASTCODE 7
CAST11	'Dummy' 1 for CASTCODE 11
EDUCAT	'Education code 1 for ILLITERATE
DISABIL	'Degree of disability'1 for ABSENCE OF ANY DISABILITY
OWNFWD	'Work days on own farm'
EDUCTERM	'Education termination year'

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