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This farm-level analysis seems to be a necessary step in an overall planning process.

A logical final step appears to be to make a selection at national and regional levels amongst the projects and their associated programme changes which were identified in this way.

Project identification thus forms the second stage in a three-stage planning sequence. This sequence appears to be suited to short- or medium-term planning of the allocation of government resources in a basically private sector part of the economy.

The role of national planning in this process is clear (*i.e.*, to identify national problems and to select regions of the country with comparative advantages in the production of various products). The role of regional planning is also clear (*i.e.*, the identification of regional problems and the identification of interactions of proposed projects). But the role of policies and strategies made at the sectoral level as a basis for project selection[3] is less obvious.

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BAYESIAN ANALYSIS OF CROP LOAN OVERDUES IN CO-OPERATIVE SOCIETIES IN THANJAVUR DISTRICT, TAMIL NADU: A NOTE

Crop loan overdues in the co-operative sector may arise due to (*a*) inability of the farmers (especially small farmers) to repay owing to either crop failures and/or use of borrowed funds for pressing consumption requirements instead of on production inputs and (*b*) refusal to pay even when the borrowers have the capacity to repay. The first category of defaults may be termed non-wilful, and the second wilful. The purpose of this short note is to (*a*) classify the defaulters into wilful and non-wilful defaulters and (*b*) analyse the socio-economic characteristics associated with wilful and non-wilful defaulters

DATA

The study is based on data bearing on the repayment of the crop loan (1981-82) of co-operatives in two selected blocks of Thanjavur district in Tamil Nadu. This district consists of two delta areas, *viz.*, New Delta and Old Delta. One block in each of the delta area was randomly selected (Kollidam block No. 1 in old delta and Madukkur block No. 2 in new delta). There were a total of 23 primary agricultural credit and service societies in these two blocks. Our sample comprised ten per cent of the defaulters in the 23 selected societies, the total numbering 170, belonging to the different holding size-groups (marginal, small, medium and large).[†] Cross-sectional data on various socio-economic characteristics of the sample defaulters were also collected for the year 1981-82.

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3. J. A. Mollett: Planning for Agricultural Development, Croom Helm Ltd., London, 1984.

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† Marginal farmers below 2.5 acres, small farmers 2.5 to 5 acres, medium farmers 5 to 7.5 acres and large farmers 7.5 acres and above.

METHODOLOGY

Bayes' Theorem is used here as an analytical model in its discrete form. The basic idea of the Bayesian argument is that given *a priori* distribution for the parameter, say 'P' which may be probability, we can calculate readily the posterior probabilities for given data.

It is required to find the posterior probabilities for wilful (W_1), and non-wilful (W_2) defaulters for given data when *a priori* probabilities $P(W_1)$ and $P(W_2)$ of W_2 are known. Let C_j $(j=1,2,...)$ represent the different socio-economic influencing characteristics. Suppose that C_j can occur together with one and only one of the mutually exclusive cases W_1 and W_2. In other words, we put

$$C_j = \sum_{i=1}^{2} C_j W_i$$

where $C_j W_1$ and $C_j W_2$ are mutually exclusive events.

From this we have

$$P(C_j) = \sum_{i=1}^{2} P(C_j W_i)$$

$$= \sum_{j=1}^{2} P(W_i) \, P(C_j/W_i) \qquad \ldots(1)$$

Equation (1) (total probability) plays a basic role in Bayesian rule.

In accordance with the multiplication theorem of probability, we have
$$P(W_i C_j) = P(W_i) \, P(C_j/W_i) = P(C_j) \, P(W_i/C_j)$$

Therefore, $P(W_i/C_j) = \dfrac{P(W_i) \quad P(C_j/W_i)}{P(C_j)} \qquad \ldots(2)$

Using (1) and (2)

$$P(W_i/C_j) = \dfrac{P(W_i) \quad P(C_j/W_i)}{\sum\limits_{i=1}^{2} P(W_1) \quad P(C_j/W_i)} \qquad \text{due to Bayes'}$$

where $P(W_i) = \dfrac{n_i}{n}$ and $P(C_j/W_i) = n_{ij}/n_i$

$n \quad = \sum\limits_{i=1}^{2} n_i = $ total number of defaulters,

$n_1 \quad = $ number of wilful defaulters,

$n_2 \quad = $ number of non-wilful defaulters,

$n_{ij} \quad = $ frequency of jth characteristics occurring in the group W_i.

To know the n_{ij}s possessed by the defaulter, we have divided all the characteristics into two or more categories. Details of these categories are given in Table I.

TABLE I. SOCIO-ECONOMIC CHARACTERISTICS WITH SUB-DIVISIONS AND CORRESPONDING CODES

Sr. No.	Socio-economic characteristics	Sub-division of socio-economic characteristics and their code numbers
1.	Operational size of holding in acres	1. Below 2.5 acres 2. 2.5 to 5 acres 3. 5 to 7.5 acres 4. 7.5 acres and above
2.	Annual gross income from agriculture	1. Below Rs. 6,000 2. Rs. 6,000 to 16,000 3. Rs. 16,000 to 26,000 4. Rs. 26,000 and above
3.	Income from other than agriculture	1. Below Rs. 2,000 2. Rs. 2,000 to 4,000 3. Rs. 4,000 to 6,000 4. Rs. 6,000 and above.
4.	Initial amount borrowed from co-operative societies	1. Below Rs. 1,000 2. Rs. 1,000 to 2,000 3. Rs. 2,000 to 3,000 4. Rs. 3,000 and above
5.	Amount borrowed from moneylenders	1. Below Rs. 600 2. Rs. 600 to 1,000 3. Rs. 1,000 and above
6.	Family consumption and other ceremonial expenditure	1. Below Rs. 4,000 2. Rs. 4,000 to 8,000 3. Rs. 8,000 to 12,000 4. Rs. 12,000 and above
7.	Percentage of dependent members	1. Below 25 per cent 2. 25 per cent to 50 per cent 3. 50 per cent and above
8.	Proportion of farm expenditure on seed, pesticide and fertilizers	1. Below 30 per cent 2. 30 per cent and above
9.	Proportion of farm expenditure on labour	1. Below 20 per cent 2. 20 per cent to 30 per cent 3. 30 per cent and above
10.	Proportion of cash crops in the total operated area	1. Below 40 percent 2. 40 per cent and above
11.	Level of education	1. Illiterate 2. Literate
12.	Caste	1. Low caste 2. Middle caste 3. High caste

Next, we present the general procedure for applying Bayes' formula to our study in different steps.

(1) $P(W_i)$ were worked out ($i = 1,2$)

(2) n_{ij} were calculated by sub-dividing all C_js into two or more categories (Code No.) and then $P(C_j/W_i)$ were worked out.

(3) $P(W_i) P(C_j/W_i)$ were known using steps 1 and 2.

(4) $\sum\limits_{i=1}^{2} P(W_i) P(C_j/W_i)$ were calculated using (3).

(5) The posterior or Bayesian probabilities were computed by dividing (3) by (4) as

$$P(W_i/C_j) \quad = \quad \frac{P(W_i) \ P(C_j/W_i)}{\sum\limits_{i=1}^{2} P(W_i) \ P(C_j/W_i)}$$

RESULTS AND DISCUSSION

We analyse the prior and posterior probabilities for wilful and non-wilful defaulters due to different socio-economic characteristics (see Table I) which are expected to influence crop loan overdues.

Kollidam Block

The results of the Kollidam block are presented in Table II. The posterior probability to become non-wilful defaulters with operated size of holdings below 2.5 acres was 0.9745, while it was only 0.0255 to become wilful defaulters. But the posterior probabilities to become wilful defaulters in all the remaining three cases were high with operated size of holdings 2.5 to 5, 5 to 7.5 and 7.5 acres and above respectively. Clearly, as farm size increases, the probability to become a wilful defaulter also goes up.

When we consider gross income from agriculture (which corrects for differences in productivity between small and large farms), again the probability to become a wilful defaulter approached unity with the rise in income from agriculture.

When the income from other than agriculture is considered, the chance of becoming a non-wilful defaulter is high at low levels of income, and that of a wilful defaulter at high levels of income.

As regards the role of the initial amount of loan, again the probability of becoming a non-wilful defaulter was high among borrowers with small size of loan, while that of a wilful defaulter was high among borrowers of large size of loan.

One of the factors which makes a defaulter a non-wilful defaulter is the loan borrowed from the moneylenders. Our results confirm this: the higher the loan borrowed from the moneylenders, the higher the chance of becoming a non-wilful defaulter.

TABLE II. KOLLIDAM BLOCK No. 1

Sr. No.	Characteristics	Code No.	$\sum_{i=1}^{2} P(W_i) \cdot P(C_j/W_i)$	Prior and conditional probabilities		Posterior probabilities	
				Wilful	Non-wilful	Wilful	Non-wilful
				$P(W_1),$ $P(C_j/W_1)$	$P(W_2).$ $P(C_j/W_2)$	$P(W_1/C_j)$	$P(W_2/C_j)$
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1.	Operational size of holdings in acres	1	0.4462	0.0114	0.4348	0.0255	0.9735
		2	0.3151	0.2499	0.0652	0.7931	0.2069
		3	0.0978	0.0978	0.0	1.00	0.0
		4	0.0978	0.0978	0.0	1.00	0.0
2.	Annual gross income from agriculture	1	0.0869	0.0	0.0869	0.0	1.00
		2	0.5217	0.0652	0.4565	0.125	0.8750
		3	0.0652	0.0652	0.0	1.00	0.0
		4	0.3152	0.3152	0.0	1.00	0.0
3.	Income from other than agriculture	1	0.6305	0.1087	0.5218	0.1724	0.8276
		2	0.1305	0.1196	0.0109	0.9165	0.0835
		3	0.0869	0.0869	0.0	1.00	0.0
		4	0.1522	0.1413	0.0109	0.9284	0.0716
4.	Initial amount borrowed from co-operative societies ...	1	0.3866	0.0170	0.3696	0.044	0.9560
		2	0.2532	0.0793	0.1739	0.3132	0.6868
		3	0.0737	0.0737	0.0	1.00	0.0
		4	0.0680	0.0680	0.0	1.00	0.0
5.	Amount borrowed from moneylenders	1	0.6086	0.3695	0.2391	0.6071	0.3929
		2	0.1848	0.0217	0.1631	0.1174	0.8826
		3	0.1847	0.0543	0.1304	0.294	0.7060
6.	Family consumption and other ceremonial expenditure ...	1	0.2391	0.0217	0.2174	0.0908	0.9092
		2	0.6087	0.2826	0.3261	0.4643	0.5357
		3	0.1087	0.1087	0.0	1.00	0.0
		4	0.0279	0.0170	0.0109	0.6093	0.3907
7.	Percentage of dependent members	1	0.0412	0.0412	0.0	1.0	0.0
		2	0.163	0.0978	0.0652	0.6	0.4
		3	0.4674	0.1848	0.2826	0.3954	0.6046
8.	Proportion of farm expenditure on seed, fertilizer and pesticides	1	0.3604	0.0778	0.2826	0.2159	0.7841
		2	0.595	0.3450	0.2500	0.5799	0.4201
9.	Proportion of farm expenditure on labour	1	0.0	0.0	0.0	0.0	0.0
		2	0.0218	0.0109	0.1019	0.5	0.5
		3	0.9782	0.4456	0.5326	0.455	0.5445
10.	Level of education	1	0.5556	0.2065	0.3491	0.3717	0.6283
		2	0.1848	0.1413	0.0435	0.7646	0.2354
11.	Caste	1	0.0978	0.0217	0.0761	0.2219	0.7781
		2	0.75	0.3478	0.4022	0.4637	0.5363
		3	0.3695	0.3043	0.0652	0.8235	0.1765

TABLE III. MADUKKUR BLOCK No. 2

Sr. No.	Characteristics	Code No.	$\sum\limits_{i=1}^{2}P(W_i).$ $P(C_j/W_i)$	Prior and conditional probabilities		Posterior probabilities	
				Wilful	Non-wilful	Wilful	Non-wilful
				$P(W_1).$ $P(C_jW_i)$	$P(W_2).$ $P(C_j/W_2)$	$P(W_1/.C_j)$	$P(W_2/.C_j)$
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1.	Operational size of holdings in acres	1	0.2820	0.0	0.2820	0.0	1.00
		2	0.4231	0.0641	0.3590	0.1515	0.8485
		3	0.1411	0.0513	0.0898	0.3636	0.6364
		4	0.1538	0.1538	0.0	1.00	0.0
2.	Annual gross income from agriculture	1	0.1282	0.0	0.1282	0.0	1.00
		2	0.4231	0.0	0.4231	0.0	1.00
		3	0.218	0.0641	0.1538	0.2945	0.7055
		4	0.2051	0.2051	0.0	1.00	0.0
3.	Income from other than agriculture	1	0.7564	0.0641	0.6923	0.0847	0.9153
		2	0.1025	0.0513	0.0512	0.5005	0.4995
		3	0.0641	0.0641	0.0	1.00	0.0
		4	0.0641	0.0641	0.0	1.00	0.0
4.	Amount borrowed from co-operative societies	1	0.2307	0.0	0.2307	0.0	1.00
		2	0.4358	0.0897	0.3461	0.2058	0.7942
		3	0.1666	0.0384	0.1282	0.2305	0.7695
		4	0.1538	0.1410	0.0128	0.9168	0.0832
5.	Amount borrowed from moneylenders	1	0.5128	0.2051	0.3077	0.4	0.6000
		2	0.3718	0.0128	0.3590	0.0344	0.9656
		3	0.1025	0.0385	0.0640	0.3756	0.6244
6.	Family consumption and other ceremonial expenditure	1	0.1411	0.0	0.1411	0.0	1.00
		2	0.5318	0.1154	0.4164	0.217	0.7830
		3	0.141	0.1282	0.0128	0.9092	0.0908
		4	0.0256	0.256	0.0	1.00	0.0
7.	Percentage of dependent members	1	0.0256	0.0256	0.0	1.00	0.0
		2	0.1025	0.0513	0.0512	0.5005	0.4995
		3	0.3206	0.1154	0.2052	0.36	0.6400
8.	Proportion of farm expenditure on seed, fertilizer and pesticides	1	0.2692	0.0513	0.2179	0.1906	0.8094
		2	0.5769	0.1923	0.3846	0.3333	0.6667
9.	Proportion of farm expenditure on labour	1	0.0769	0.0	0.0769	0.0	1.00
		2	0.4487	0.0769	0.3718	0.1714	0.8286
		3	0.4416	0.1923	0.2693	0.4166	0.5834
10.	Proportion of cash crops in the total operated area	1	0.3333	0.0897	0.2436	0.1601	0.8399
		2	0.2435	0.0256	0.2179	0.1051	0.8949
11.	Level of education	1	0.3206	0.0513	0.2693	0.1601	0.8399
		2	0.2051	0.0897	0.1154	0.4373	0.5627
12.	Caste	1	0.0799	0.0	0.0799	0.0	1.00
		2	0.7692	0.1795	0.5897	0.2334	0.7666
		3	0.0826	0.0314	0.0512	0.3801	0.6199

The probability of becoming a wilful defaulter rises with a rise in farm expenditure on inputs, and also with a rise in consumption expenditure. Interestingly, the probability of wilful default is high among households with a low dependency rate.

Another interesting finding is that the chances of becoming a non-wilful defaulter were high (0.6283), the higher the percentage of illiterates in the family. This implies that the literates were capable of evading repayment of loan by taking advantage of the loopholes in the loan administration.

Caste too emerges as an influencing factor in this block. It is seen that the lower the level of caste, the higher the chances (0.7781) of becoming a non-wilful defaulter and vice versa.

Madukkur Block

The results pertaining to this block are presented in Table III. Broadly, the direction of results is similar to that of Kollidam block, but the magnitudes of the variables for observed probability levels differ. Nevertheless, the characteristic of operated size of holdings deserves comparative analysis. Blocks 1 and 2 differ with respect to irrigation endowment. Thus the first Kollidam block is better irrigated, permitting most farmers to grow two or even three crops of paddy with minimal risk. The second block (Madukkur) is located in a tail-end area with inadequate water supply. Farmers in this block are exposed to higher risks because most of them grow the second crop (groundnut) under unirrigated conditions.

One would have expected that better access to water and higher productivity levels would have induced the farmers in the first block (especially medium and large farmers) to be associated with high probability levels for non-wilful default. On the contrary, we find that the probability of wilful default is high even among small, medium and large farmers in this block.

CONCLUSION

In this short note, we classified the defaulters of co-operative crop loan overdues in two blocks of Thanjavur district into wilful and non-wilful defaulters, and identified some important socio-economic characteristics associated with wilful default using Bayes' Rule of probabilities as an analytical tool. Broadly, our results suggest that the high probability of wilful default to occur is associated with large farm size, large farm and non-farm (consumption) expenditures, and high educational status. High probability of non-wilful default is associated essentially with small size of holdings, and low educational and caste status.

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