Application of Artificial Neural Networks for Evolving Effective Strategies for Enhancing Financial Inclusion

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ABSTRACT

There is a general agreement that financial development is a major factor influencing economic growth. Financial inclusion implies provision of affordable financial services by the formal financial system to those who are excluded. The strategies for financial inclusion through promotion savings need to consider different savings instruments. Such strategies need to identify unique features that influence different segments of the society to invest in different savings instruments. This paper uses Artificial Neural Networks to identify and rank the factors that influence investment in different savings instruments. These factors could be used to make strategies for enhancing financial inclusion more effective.

Keywords: Financial Inclusion, Artificial Neural Networks, Savings Instruments

1. Introduction

There is a general agreement among economists that financial development is one of the major factors influencing economic growth. Theoretically, financial development creates enabling conditions for growth through either a supply-led or a demand-pull process. A large body of empirical research supports the view that development of the financial system contributes to economic growth (Rajan and Zingales, 2003). Documented evidence indicates that various measures of financial development such as stocks, bonds, access to credit, liquidity, assets and liabilities of financial institutions are positively related to economic growth (King and Levine, 1993; Levine and Zervos, 1998). Other studies establish a positive relationship between financial development and growth at the industry level (Rajan and Zingales, 1998). Even the recent literature on growth, emphasizes the special role of finance in economic development (Mohan, 2006).

Financial inclusion is delivery of financial services at an affordable cost to the vast sections of underprivileged and low income groups. Financial inclusion implies provision of affordable financial services, such as access to payments and remittance facilities, savings, loans and insurance services by the formal financial system to those who tend to be excluded. It is important to recognize that in the policy framework for development of the formal financial system in India, the need for financial inclusion and covering more and more of the excluded population by the formal financial system has always been consciously emphasized (Agrawal, 2007). Financial exclusion, defined as individuals' limited access to or use of formal financial services, is a problem all over the world. It was estimated that more than 3 billion people are financially excluded around the world. India has the second largest number of financially

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excluded households estimated at 135 million (Boston Consulting Group, 2007)

Historically, the Government of India (GOI) has been evolving various strategies for enhancing financial inclusion through increase in banking penetration starting with the creation of State Bank of India in 1955. The nationalization of commercial banks in 1969 and 1980 were major policy initiatives in this direction. In order to bring more rural population into the ambit of financial services, special policy initiatives were introduced. Some of these are the Lead Bank Scheme in 1970, setting-up of Regional Rural Banks (RRBs) in 1975, introducing a Self-Help Group (SHG)-Bank Linkage Programme in 1992 and formulating the Kisan Credit Card scheme in 2001. In November 2005, banks were advised to make available a basic banking 'no-frills' account with low or nil minimum stipulated balances as well as charges to expand the outreach of such accounts to vast sections of the population. In order to ensure that persons belonging to low income group, both in urban and rural areas do not encounter difficulties in opening bank accounts owing to procedural hassles, the know your customer (KYC) procedures for opening accounts has been simplified. The Reserve Bank has directed banks to make available all printed material used by retail customers in English, Hindi and the local regional language (Agrawal, 2007). Again, In January 2006, banks were permitted to utilize the services of non-governmental organizations, micro-finance institutions and other civil society organizations as intermediaries in providing financial and banking services through the use of business facilitator and business correspondent models.

Bank nationalization in India marked a paradigm shift in the focus of banking as it was intended to shift the focus from class banking to mass banking. The rationale for creating Regional Rural Banks was also to take the banking services to poor people. The branches of commercial banks and the RRBs have increased from 8,321 in the year 1969 to 68,282 branches as at the end of March 2005. The average population per branch office has decreased from 64,000 to 16,000 during the same period (Agrawal, 2007). The banking industry has shown tremendous growth in volume and complexity during the last few decades. Despite making significant improvements in all the areas relating to financial viability, profitability and competitiveness, there are concerns that banks have not been able to include vast segment of the population, especially the underprivileged sections of the society, into the fold of basic banking services (Thorat, 2007a). So, this lead to the emergence of for Financial Inclusion as a strategy to bring so called excluded people in to the mainstream. As banking services are in the nature of public good, it is essential that availability of banking and payment services to the entire population without discrimination is the prime objective of the public policy. Although credit is the most important component, financial inclusion covers various financial services such as savings, insurance, payments and remittance facilities by the formal financial system to those who tend to be excluded (Mahendra, 2006).

Limited access to affordable financial services such as savings, loan, remittance and insurance services by the vast majority of the population in the rural areas and unorganized sector is believed to be acting as a constraint to the growth impetus in these sectors. Access to affordable financial services, especially credit and insurance, enlarges livelihood opportunities and empowers the poor to take charge of their lives. Such empowerment aids social and political stability. Apart from these benefits, financial inclusion imparts formal identity, provides access to the payments system and to savings safety net like deposit insurance. Hence financial inclusion is considered to be critical for achieving inclusive growth. The financially excluded sections largely comprise marginal farmers, landless laborers, self employed and unorganized sector enterprises, urban slum dwellers, migrants, ethnic minorities and socially excluded groups, senior citizens and women (Thorat, 2007b). Inclusive financial system can lead to faster and more equitable growth. Such a system allows poor households to save and manage their money securely, decreases their vulnerability to economic shocks and allows them to contribute more actively to their development. With the proliferation of micro finance initiatives, there is evidence that inclusive financial systems can empower poor households socially as well in other words financial inclusion is delivery of banking services at an affordable cost to the vast sections of disadvantaged and low-income groups (Thorat, 2007a).

Even after the institutional finance came in to being as banking sector emerged, the need for 'micro' credit for the poorer section of the society was unmet by the formal banking sector. The nature of formal banking sector, with its emphasis on 'collateral based lending' could not cater the needs of smaller borrowers, especially women, who were typically resource poor and possessed negligible assets to offer as collateral. Given the male dominated rural society, prior to 1990s there were hardly any credit schemes designed for rural women (Karmakar, 2002).

Fisher and Sriram (2002) point out that formal financial sector is unsuccessful in recognizing the divergence between the hierarchies of credit needs and credit availability. The result of this is the adverse use of credit. Credit use starts with consumption purposes, which are generally met through informal sources at high cost. Higher needs come into play only when the lower needs are satisfied. However credit (often subsidized rate) is usually available for new enterprises (i.e. for diversification). Money is fungible and hence loan taken for new enterprises or diversification is used in the lower rungs of hierarchy of credit needs. This implies that any appraisal of loan is not honored, resulting in the adverse usage and consequently adverse repayment performance. The success of few Non Governmental Organizations (NGOs) like Mysore Resettlement and Development Agency (MYRADA) in-group lending, made the government in changing the strategy of women development and empowerment under the Development of Women and Children in Rural Areas (DWCRA) programme through group based approach (Rajshekar, 2004). All these development resulted in a fall in the availability of credit from formal financial system, leaving informal sources as well as SHGs and MFIs to fill this gap (Fisher and Sriram, 2002).

The strategies for financial inclusion through promotion of savings need to go beyond the formal banking system. In addition to the banking products such as savings accounts and fixed deposits, the strategies for enhancing financial inclusion will have to look at other products such as insurance, post office related small savings and long term instruments such as provident fund and pension schemes. These strategies need to identify the special and unique features that influence different segments of the society to get attracted to different products. These factors could vary from product to product as well as from segment to segment.

2. Objectives

The objectives of the study are:

- To identify the factors that could influence financial inclusion of different demographic segments of the population
- to identify if there are significant differences of such factors across different segments
- to identify the relative importance of these factors
- to suggest appropriate strategies for improving financial inclusion based on the relative importance of these factors

3. Methodology

Many of the factors that were identified by previous studies such as gender, occupation, income groups, etc. are mostly either categorical or ordinal in nature. In addition, the financial inclusion itself is a categorical variable. One of the best statistical techniques available for analyzing the relationships between such variables is the Chi-square test (χ^2). While the χ^2 test is good for identifying the relationships between categorical and ordinal variables, it is not amicable to determine the relative importance of these variables. Consequently, the χ^2 test could not be used to prioritize the factors influencing financial inclusion. Hence an alternate approach is needed to prioritize the influencing factors after identifying the same. One such technique is application of Artificial Neural Networks.

The data for the study was taken from the National Data Survey on Saving Patterns of Indians. The survey was conducted with an objective of portraying the dynamics of the unorganized sector for the country as a

whole. The sample covered both the rural and urban areas of the country. The data contained various demographic characteristics such gender, age, marital status, household size, education, profession etc. as well as socio-economic characteristics such as caste, job description, asset ownership, media exposure etc. In addition, it contained information on coverage with respect to various financial products such as EPF, EPS, GPS, GPF, bank deposits, insurance related products etc. This database is used to analyze access to various types of financial products in order to identify the factors that have an impact on financial inclusion.

4. Sample Profile

The dataset covered a total of 40,862 respondents. More than 87 percent of them are male. At the same time these respondents are evenly distributed between rural and urban areas. The demographic characteristics of the respondents are presented in Table 1. Only 30 percent of the respondents belong to scheduled caste/ scheduled tribe category. The percentage of SC/ST respondents in the rural areas is more than that of the urban areas. More than 60 percent of the respondents had education up to "Plus Two" or graduation. At the same time a large majority of them are proficient in their respective regional language. As expected, the predominant occupations in the rural area are Agriculture, diary and labourer. Similarly, the predominant occupations in the urban areas are trading and labourer followed by salaried employment from government. A large majority of the respondents are currently married.

Table 1: Demographic Profile of the Respondents

Characteristic	**Level**	**Urban**		**Rural**	
		Male	**Female**	**Male**	**Female**
Age Group	Up to 30	4760	798	4777	833
	31-50	10513	1503	9859	1314
	51 & Above	2764	306	3163	272
Caste	SC/ST	4317	787	5743	1031
	Others	13720	1820	12056	1388
Education Level	Up to Primary	4976	1154	8382	1648
	Up to Intermediate	9598	888	8200	643
	Graduation & Above	3463	565	1217	128
Language	Read-English	254	20	177	13
	Write-English	4317	372	3294	226
	Speak-English	5174	792	2296	318
	Speak-Regional	2917	827	4524	1196
	Read-Regional	232	38	242	25
	Write-Regional	14362	1670	12598	1153
	Speak-Hindi	2999	653	3630	583
	Read-Hindi	380	37	284	16
	Write-Hindi	11762	1271	8079	549
Marital Status	Currently Married	15416	1621	15549	1674
	Never Married	2264	375	1769	227
	Widow/Widower	275	506	404	446
	Divorced	35	26	38	27
	Separated/Deserted	47	79	39	45
Occupation	Agriculture & Dairy	743	70	5775	360

Characteristic	Level	Urban		Rural	
		Male	**Female**	**Male**	**Female**
	Labour	4020	603	6002	1205
	Salaried Private	2777	388	964	178
	Salaried Government	3579	601	1536	244
	Trader	4330	337	2325	204
	Manufacturer	106	6	30	6
	Professional	273	28	96	10
	Self Employed	2209	574	1071	212

Table 2 presents the income, expenditure and assets of the respondents. As expected, majority of the urban respondents (about 80 percent) are landless while only 43 percent of the rural respondents are landless. Most of the respondents do own a residential house. While 61 percent of the respondents have an annual income of Rs. 50,000 or less, only a handful accounting for less than 2 percent have more an annual income of Rs. 2,50,000 or more. Their annual expenditure is more or less in tune with the annual incomes.

Table 2: Assets, Income and Expenditure of Respondents

Characteristic	Level	Urban		Rural	
		Male	**Female**	**Male**	**Female**
Agricultural Landholding	Landless	14228	2263	7406	1475
	Marginal	2378	228	5831	609
	Small	725	57	2147	176
	Medium	546	49	1813	120
	Large	160	10	602	39
Ownership of House and other Real estate	House	13838	1843	16329	2061
	Other Real Estate	1193	100	1005	80
Annual Income	Up to 50000	9064	1704	12246	2040
	50000 - 100000	5650	544	3934	267
	100000 - 250000	2878	317	1400	101
	250000 - 500000	329	35	167	6
	More than 500000	106	7	42	2
Annual Expenditure	Up to Rs. 50000	10736	1903	13627	2150
	50000 - 100000	5155	500	3161	210
	100000 - 250000	1931	185	920	57
	250000 - 500000	159	15	72	
	More than 500000	43	1	14	

Access to information is very important in the decision making process, especially with respect to savings decisions. Table 3 presents the respondents' exposure to different media. Television appears to be the most important medium in terms of exposure followed by radio and newspapers. Only a handful of the respondents accounting for less than 5 percent had been exposed to internet.

Table 3: Exposure to Various types of Media

Characteristic	Level	Urban		Rural	
		Male	Female	Male	Female
Exposure to Radio	Good	6263	666	6163	623
	Somewhat	5224	739	5169	684
	No	6550	1202	6467	1112
Exposure to TV	Good	9949	1593	10014	1445
	Somewhat	3935	497	3767	414
	No	4153	517	4018	560
Exposure to Newspaper	Good	6854	1154	6822	983
	Somewhat	3862	530	3897	531
	No	7321	923	7080	905
Exposure to Internet	Good	165	34	204	17
	Somewhat	664	75	668	92
	No	17208	2498	16927	2310

Table 4 presents the information on investible surplus as well as the primary savings needs. Almost 60 percent of the respondents have an annual investible surplus of up to Rs. 10,000. The most important need for saving is children's education and marriage followed by security for self and family. These two account the primary need for more than 60 percent of the respondents.

Table 4: Characteristics of Savings

Characteristic	Level	Urban		Rural	
		Male	Female	Male	Female
Annual Investible Surplus	No Surplus	4740	930	5977	1168
	Up to Rs. 10000	10846	1325	10540	1132
	Rs. 10000 - 50000	2200	307	1172	114
	Rs. 50000 - 100000	192	32	92	4
	> Rs. 100000	59	13	18	1
Primary Savings Need	Children's Education & Marriage	8750	1085	7089	864
	Self and Family Security	3576	510	3526	418
	Real Estate and Consumer Durables	891	113	913	86
	Social Obligations	236	44	218	21
	Business Needs	428	25	312	21
	Medical Emergencies	116	14	147	25
	No Specific Purpose	311	54	258	37
	Nil	5267	748	6111	599
	Low	3659	519	3783	523
	Medium	2522	285	1547	255
	High	2860	293	1022	95

5. Results and Discussion

The database contained information on all the avenues of savings used by the respondents. These included various instruments such as EPF, PPF, savings account, fixed deposits, recurring deposits, life insurance, accident insurance, National Savings Certificate, Kisan Vikas Patra etc. All these are grouped into four categories for the purpose of analysis. These categories are Long Term instruments (EPF, GPF, EPS, GPS, CPF, gratuity etc.), Banking Products (savings account, fixed deposits and recurring deposits), Small Savings (Post office oriented instruments (PPF, NSC and KVP) and Insurance products (life insurance, personal accident insurance, health insurance and non-life general insurance). The factors influencing each of these different categories are likely to be different and hence each category was analyzed separately.

Initially, the entire dataset was divided randomly into two sets – the training dataset containing 70 percent of the data and testing dataset containing the remaining 30 percent. A binary variable was created based whether the respondent had invested in any of the savings instruments. If the respondent had invested in any savings instrument, the variable takes on a value of 1 or 0 otherwise. This variable is used as the dependent variable. An artificial neural network (ANN) was trained using the training dataset with all the demographic, socio-economic and other variables as the independent variables. The prediction accuracy of the network is calculated for the training dataset as well as for the testing dataset. These two accuracy levels are compared and it was found that the difference in the prediction accuracy levels was less than 1 percent. This approach was to make sure that the ANN was not over-trained.

As a second step, different ANNs were trained for male and female respondents separately and again separately for urban and rural respondents. The prediction accuracies of each of these four ANNs are presented in Table 5. It can be seen from the table that the prediction ability of the ANNs is much higher with respect to the respondents who had used the savings instruments, as compared to those who had not used any savings instruments.

Table 5: Prediction accuracies of the ANNs – Urban and Rural and Male and Female

Actual	**Prediction**					
	Actual numbers			**Percentages**		
	Not used	**Used**	**Total**	**Not used**	**Used**	**Total**
	All Instruments-Urban					
Not used	5220	1779	6999	74.58%	25.42%	100.00%
Used	971	12674	13645	7.12%	92.88%	100.00%
Total	6191	14453	20644			
	All Instruments-Rural					
Not used	6924	2751	9675	71.57%	28.43%	100.00%
Used	391	10152	10543	3.71%	96.29%	100.00%
Total	7315	12903	20218			
	All Instruments-Male					
Not used	11429	2687	14116	80.96%	19.04%	100.00%
Used	2216	19504	21720	10.20%	89.80%	100.00%
Total	13645	22191	35836			
	All Instruments -Female					
Not used	2107	451	2558	82.37%	17.63%	100.00%
Used	387	2081	2468	15.68%	84.32%	100.00%
Total	2494	2532	5026			

Even though artificial neural networks use complex mathematical models to make predictions, the coefficients corresponding to the independent variables are not made available to the user. In that sense, ANNs fall under the category of "Black Box" methods of prediction. But the software packages provide some information on the sensitivity index or an index of relative importance of each of the independent variables used for prediction. The five most important independent variables for each of the four ANNs are extracted and presented in Table 6. These are the factors that have significant impact on the use of savings instruments.

Table 6: Five most important variables impacting the savings

Rural Respondents		**Urban Respondents**	
Factor	**Relative importance**	**Factor**	**Relative importance**
Primary Savings Need	0.4615	Primary Savings Need	0.3959
Occupation	0.4605	Occupation	0.3532
Annual Income	0.1047	Annual Expenditure	0.0886
Annual Expenditure	0.1033	Annual Income	0.0870
Agricultural Landholding	0.0986	Annual Investible Surplus	0.0724
Male Respondents		**Female Respondents**	
Factor	**Relative importance**	**Factor**	**Relative importance**
Primary Savings Need	0.5326	Occupation	0.3382
Occupation	0.3956	Primary Savings Need	0.3331
Language Proficiency [Local]	0.0819	Marital Status	0.0781
Agricultural Landholding	0.0819	Language Proficiency [English]	0.0697
Annual Income	0.0817	Exposure to TV	0.0654

It is interesting to note that agricultural landholding is an important factor in the rural areas where as annual investible surplus is important in the urban regions. This is the main differentiating factor between the rural and urban respondents. On the other hand, the two factors that are common between male and female respondents are occupation and primary savings need. Proficiency in the local language, agricultural land holding and annual income are important factors with respect to male respondents where as marital status, English language proficiency and exposure to television are the important factors with respect to the female respondents. Identification of these factors will help in creating specific and unique strategies to attract different target groups by focusing on gender and regional differences.

As mentioned earlier, different avenues of savings used by respondents are grouped into four different categories. Different ANNs were tried and tested to identify the factors that would influence the savings in these four different categories. The prediction accuracies of each of the four categories are presented in Table 7. The actual number of respondents who had savings under post office related instruments was only 1293 out of the total respondents of 40862 leading to the common problem of minority classes. The problem of the minority classes can be summarized as the situation where the minority class (where the number of observations is very small as compared to the majority class) gets overwhelmed by the majority class. There are a number of techniques available to address the problems of minority classes (Anuj Kumar and Nagadevara 2006). Over sampling technique is used to address this problem in this particular case.

The minority cases are replicated 10 times so that they can no longer be overwhelmed by the majority classes.

Table 7: Prediction accuracies of the ANNs-Four different categories of savings

Actual	Prediction					
	Actual numbers			Percentages		
	Not used	Used	Total	Not used	Used	Total
	Post Office					
Not used	36910	2659	39569	93.28%	6.72%	100.00%
Used	7080	5850	12930	54.76%	45.24%	100.00%
Total	43990	8509	52499			
Long-term						
	Actual numbers			Percentages		
	Not used	Used	Total	Not used	Used	Total
Not used	33649	528	34177	98.46%	1.54%	100.00%
Used	791	5894	6685	11.83%	88.17%	100.00%
Total	34440	6422	40862			
Banking Products						
	Actual numbers			Percentages		
	Not used	Used	Total	Not used	Used	Total
Not used	14166	5431	19597	72.29%	27.71%	100.00%
Used	2352	18913	21265	11.06%	88.94%	100.00%
Total	16518	24344	40862			
Insurance Products						
	Actual numbers			Percentages		
	Not used	Used	Total	Not used	Used	Total
Not used	25968	3605	29573	87.81%	12.19%	100.00%
Used	4476	6813	11289	39.65%	60.35%	100.00%
Total	30444	10418	40862			

The sensitivity analysis given by the software package is used to identify and rank the factors that will influence the savings in the four categories. The five most important independent variables for each of the four ANNs are presented in Table 8. These are the factors that have significant impact on the use of these specific categories of savings instruments.

Table 8: Five most important variables impacting the four categories of savings instruments

Factor	Relative Importance	Factor	Relative Importance
Post office		**Long-term**	
Language Proficiency [Hindi]	0.1437	Annual Income	0.1577
Language Proficiency [Local]	0.1426	Annual Investible Surplus	0.1563
Occupation	0.1260	Awareness of Alternative Investment Options	0.1560
Marital Status	0.1207	Education Level	0.1482

Factor	Relative Importance	Factor	Relative Importance
Primary Savings Need	0.1158	Exposure to Internet	0.1473
Banking Products		**Insurance Products**	
Primary Savings Need	0.3839	Occupation	0.3329
Occupation	0.3579	Primary Savings Need	0.2692
Marital Status	0.0714	Marital Status	0.1088
Agricultural Landholding	0.0677	Language Proficiency [Local]	0.1024
Language Proficiency [Local]	0.0673	Language Proficiency [English]	0.0824

There is a significant difference in the factors that influence the four different categories of savings. The factors that influence savings in long-term instruments such as provident fund are completely different from those which influence the other three categories. These long-term savings are influenced by annual income, annual investible surplus, and awareness factors such as exposure to internet, education level and awareness of alternate options. The other three categories have four factors in common. These common factors are type of occupation, primary savings need, local language proficiency and marital status. The differentiating factors are Hindi language proficiency for post office related savings instruments, agricultural landholdings for banking products and English language proficiency for insurance products. These factors which are specific to a particular category of savings instruments can be used to promote specific products thereby enhancing the financial inclusion. For example, promotion of banking products need to concentrate more on agricultural landholding. Focusing on primary savings needs, occupation or marital status will end up competing with the other two categories of instruments. On the other hand, the promotion of long-term savings instruments could be made effective by creating more awareness of alternate investment options and concentrating on the educational level of the target group.

6. Concluding Remarks

There is a general agreement among economists that financial development is a major factor influencing economic growth. Theoretically, financial development creates enabling conditions for growth through either a supply-led or a demand-pull process. Financial inclusion is delivery of financial services at an affordable cost to the vast sections of underprivileged and low income groups. Financial inclusion implies provision of affordable financial services, such as access to payments and remittance facilities, savings, loans and insurance services by the formal financial system to those who tend to be excluded. The strategies for financial inclusion through promotion of savings need to go beyond the formal banking system. In addition to the banking products such as savings accounts and fixed deposits, the strategies for enhancing financial inclusion will have to look at other products such as insurance, post office related small savings and long term instruments such as provident fund and pension schemes. These strategies need to identify the special and unique features that influence different segments of the society to get attracted to different products. These factors could vary from product to product as well as from segment to segment. Artificial Neural Networks are used to identify and rank various factors that influence the investment in different types of savings instruments by different segments of the society. Specifically, the factors that are important to rural and urban population as well as male and female segments are identified and ranked. In addition, the factors that are specific and unique to different categories of savings instruments are also identified and ranked. It is possible to develop specific strategies based on these factors to bring a larger segment of the financially excluded population into the ambit of various savings instruments thereby enhancing the financial inclusion.

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