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## Understanding Portfolio Allocation Using Unsupervised Machine Learning Methods

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### ABSTRACT:

With the passage of time investors today are considered to be more confident and less reliant on their spouses, family, friends and peers in decisions pertaining to their investment option. Investment behavior of working women with respect to risk bearing capacity, empowerment to take investment decisions and monitoring of their investments. Traditionally, we observe that women investors are found to be more conservative in choosing their investment avenues which often are significantly less risky when compared to their male counterparts. It was found that working women have started doing investments slowly. It is known through the studies that the percentage of working women who take their own financial decisions for making investments was low as they rely on their husbands or parents to make investment decisions. Irrespective of the returns they earn through various investment avenues, women investors are often found to prefer more risk averse choices and found to be less deviant in nature. Thus, the factors responsible for them in making investment decisions may not be generalized which is often observed in the literature studies. Thus, the study was conducted to examine the various choices using an unsupervised learning method called association rules. This is a descriptive, not predictive, method often used to discover interesting relationships hidden in the datasets, which might help to understand the investment decisions of employed women investors in Bangalore city. The study was conducted using primary data collected from structured questionnaire. The respondents were employed women investors. In this study, responses of 54 respondents were considered and the data was analyzed using frequencies, percentages, and association rules techniques. The research confirms that, employed women investors are more independent and tend to make investments still in traditional investment avenues.

**Keywords:** Association Rules, Unsupervised learning, Investments

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## 1. Introduction

With the passage of time, progress in technology, man thinks himself to be the master of things trying to modify it on a large scale and control it remotely. It is rare to find a person who has enough money to fulfil every need or wish. As we all know the basic rule of economy that resources are scarce and wants are unlimited. Many times the existing financial ability proves inadequate to live up to the expectation. At this point, we realize the importance of financial awareness for day to day life (Kahneman, 1979). The need for creating awareness in society regarding investment has become crucial task (Ackert, Firm Image and Individual Investor Decisions. , 2006) for all round development (Maheshwari, 2003) (N S. J., 1974).

For most of the life, we will be earning and spending money. Rarely, though, will our current money income exactly balance with your consumption desires. Sometimes, we may have more money than we wish to spend; at other times, may want to purchase more than we can afford based on our current income (Ferber, 1974) (Zoghalmi, 2009). These imbalances will lead either to borrow or to save to maximize the long-run benefits from income. When current income exceeds current consumption desires, people tend to save the excess. They can do any of several things with these savings (Chadha, 1995). One possibility is to put the money under a mattress or bury it in the backyard until some future time when consumption desires exceed current income. When they retrieve their savings from the mattress or backyard, they have the same amount they have saved (Friend, 1978). Another possibility is that they can give up the immediate possession of these savings for a future larger amount of money that will be available for future consumption (Barber B. M., 2005). This trade-off of present consumption for a higher level of future consumption is the reason for saving. What a person does with the savings to make them increase over time is investment.

Those who give up immediate control of savings (that is, defer consumption) expect to receive in the future a greater amount than they gave up. Conversely, those who consume more than their current income (that is, borrow) must be willing to pay back in the future more than they borrowed (Baker, 1977) (Jayabal., 2008). Investments are built upon a common set of financial principles, such as the present value, the future value, the cost of capital) (Mayya, 2006). And very often investment and financing analysis for decision making use the same tools, but the interpretation of the results from this analysis for the investor and for the financier would be different.

The rate of exchange between future consumption (future rupees) and current consumption (current rupees) is the pure rate of interest. Both people's willingness to pay this difference for borrowed funds and their desire to receive a surplus on their savings (i.e., some rate of return) give rise to an interest rate referred to as the pure time value of money. This interest rate is established in the capital market by a comparison of the supply of excess income available (savings) to be invested and the demand for excess consumption (borrowing) at a given time (Heena, 2012, May-June).

Securities and Exchange Board of India (SEBI) and NCEAR (2000) survey on Indian investors reiterates these characteristics to play a vital role in choice of choosing investment portfolios. Irrespective of innumerable investment choices available to investors such as Bullions, bank deposits, life insurance, mutual funds, public provident funds, shares, debentures etc., the primary objectives of investments vis-à-vis capital appreciation, lesser risk, liquidity, stability and hedge against inflation still play a key role in investment decisions.

Major element of any investment is time and risk (Aggarwal, 2007) (Duright, Personal Investing: Advice Theory and Evidence, (1997)) (Prema Chandra, 2002). It purely depends upon individual capacity to give importance to either of the two elements, on the basis of one's need. There are plenty of areas where money can be invested like- government bonds, equities, gold, real estate, stocks, fixed deposits, etc (Banerjee, (2006)). Investment awareness is a part

of financial literacy. Financial literacy or awareness means the set of skills and knowledge that allows an individual to make informed and effective decisions through their understanding of finance. Investment and financial literacy is important to help individuals meet their life goals and objectives. A proper planning and analysis should be done in order to reach to a perfect decision of investment/ or portfolio management. One's skill improves with the timely investments (Ferber, 1974) (Bansal, 1996).

The Apex Financial Institution in our country SEBI i.e. Securities and Exchange Board of India is also contributing in the programme of financial awareness among the common citizens (Dr R. Sellappan, 2013). It has published a series of books in collaboration with NSE and such initiation by SEBI, aims to provide financial education to the common individual.

According to the economic survey of Karnataka for the period 2015-16, the Labor Force Participation Rate (LFPR) for persons aged 15 years and above is 57.8% (55.6% for India). Further categorization of the population shows that, LFPR is highest for 30 years and above category and is lowest for the age group between 15-17 years (who are assumed to be pursuing their education). But categorizing the population based upon the gender parameter, gives a different insight altogether. This LFPR rate is 81.7% for males in rural Karnataka which is fourth highest among the other states of India but is only 28.0% for urban female (LFPR is 19.7% for the country). The worker population ratio for urban male and urban female is 74.4% and 27.1% which is still higher than all India average of 71.4% and 17.5% respectively. According to recent article in Times of India<sup>1</sup>, employed women are just one-third of the total labor force in Karnataka. Of the 23.85 lakh employed citizens in the state, only 7.72 lakh are employed women (roughly 32 percent of the labor force). Among the districts, Bengaluru tops the list with 3.16 lakh women in the workforce (roughly 41% of the women labor force). Considering the preference of the employed women in the public and the private sectors in Bengaluru, around 82 percent of them are placed in private sector and remaining 18 percent in the government services. The National council of Applied Economic Research (NCEA) in the urban saving survey, observed that, irrespective of the demographics of the citizens of the country, saving for future was considered very important and making provisions for the future was the utmost priority for saving in the elderly citizens. Male citizens were observed to invest in riskier investment avenues compared to women investors and people with less education preferred to choose risk-free investment avenues.

## 2. Literature Review

In each life cycle stage, every individual desires his hard earned money to be invested in most secure and liquid avenue. However, the decision varies for every individual depending on their risk taking ability and the purpose for which such investment is to be done. Purpose of investment can be related with saving objective. Each individual investor selects the investment option for certain time period looking at their personal financial goals. Investment behavior of an individual investor reveals how he/she wants to allocate the surplus financial resources to various instruments for investment available.

Studies find that, women have less risk taking capability and hence choose not to venture into riskier investment avenues (Bruce, 1994) (Jianakoplos, 1998). Individual investors are today considered independent and confident and have significant amount of income at their disposable for making investment decisions while women tend to invest more conservatively than men (Sunden, 1998).

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Investors today are considered independent and confident and have significant amount of income at their disposable for making investment decisions while men hold more of fixed-income alternatives and less of risky assets than men (Hinz, 1997).

A majority of investors never want to invest irrespective of associated higher than normal expected returns in the riskier investments such as stocks (Kover, 1999). Even if, women investors choose to invest in stocks, the portfolio revisions done is significantly lower (Barber B. M., 2001). In the United States found that women take less investment risk. (Jianakoplos, 1998) Report results that lend further support to the hypothesis that a far lower percentage of women than men are willing to take any financial risk at all.

(Bajtelsmit V. L., 1996) Found gender is the third most important factor in determining the risk attitude. (Lewellen, 1997) Said that after age and income, gender was the third most important determinant of investor style. (Hinz, 1997) In a study the Federal Governments Thrift Savings Plan, conclude that women are less likely to hold risky assets and more inclined to use fixed-income alternatives (65 percent women versus 52 percent to men) rather than toward equities (28 percent women versus 45 percent to men).

(Kover, 1999) Found that fewer than half of women were unwilling to take more risk in return for higher expected return. The research on investment has focused attention on number of factors that highlights investors' perception about different investment avenues (Ranganathan K. , 2006) and it was found that mutual funds were not that much known during its introduction and growth stages to investors, still investor rely upon Gold , bank fixed deposits and post office deposits, Share market and Real Estate as means of investment knowledge was to very minimum (Devi, 1982). Individual investors are today considered independent and confident and have significant amount of income at their disposable for making investment decisions while women tend to invest more conservatively than men (Sunden and Surette, 1998) and hold more of fixed-income alternatives and less of risky assets than men (Hinz et.al, 1997). So, majority of them never want to invest irrespective of associated higher than normal expected returns in the riskier investments such as stocks (Kover, 1999). Even if, women choose to invest in stocks, the portfolio revisions done is significantly lower (Barber and Odean, 2001).

The rapid growth of the voluminous literature on not just a investing in a particular type or two but rather on portfolio selection is indicative of widespread interest both amongst academic and business communities (Baker, 1977). Nevins (2004) proposed a goals-based approach that may help reducing the friction between the practitioner's perspective, which is based on traditional investment principles and the investor's perspective, which is determined by goals and psychological makeup. It also recommended a disciplined process that is customized to each investor. According to this author, this approach that heeds the lessons of behavioral finance, contributes to understand the investor's aspirations and preferences while suppressing the biases that can lead to failed strategies.

Brunel (2003) suggested a framework in which investment strategies are matched to buckets assigned to four fundamental goals: liquidity, income, capital preservation and growth. Byrnes et al. (1999) summarize 150 studies from the psychology literature examining differences in risk taking among men and women, demonstrating that women, on average, take less risk than men. Byrnes (1998) assumes that restrictive parental of females during childhood likely to explain their resistance in engaging in risky behavior. Additionally, Flynn et al. (1994) find that social-political factors such as power and status favor men, resulting in an increase in their willingness to undertake higher risk.

According to Barber and Odean (2001), the poor performance is a result of the high level of trading which can be explained by the behavioral bias of over-confidence individual investors, which leads to excessive trading. They conducted a study of over 78,000 investors in a brokerage firm. They concluded that individual investors who hold common stocks directly pay a tremendous penalty for active trading. They divided the investors into five groups

according to the frequency of trading and they showed that the annual return for the group that traded most frequently was about 6% less, after transaction costs, than the return for the group that traded the least.

De Bondt and Thaler (1985, 1987) find that investors overreact to drastic or unexpected events or information. They find that portfolios of prior losers outperform that of prior winners in the long run. Since investors count on the representative heuristic, they become too optimistic about recent winners and too pessimistic about recent losers. Heena Kothari (2012) has carried out a study of the investment behaviour towards investment avenues in Indore city and perceptions of different age groups towards investment avenues. The study revealed that investors belonging to different age groups have different investment behaviour and selection of any investment avenue depends upon their age. R. Sellappan, S.Jamuna and T.N.R. Kavitha (2013) have carried out a study to identify the Investment attitudes of women towards different sources of securities using factor analysis approach. The study was done to know the impact of marital status and age factors on the investment attitude of women in the choice of the securities to invest. The study revealed that while age has no bearing on the investment attitude, marital status does influence the attitude of women towards different securities.

Yogesh patel and Charul Patel (2012) studied the investment perspective of salaried people in the private sector. They determined the factors affecting investment and behavioral pattern of salaried people working in the private sector. It was observed in the research that, youngsters tend to prefer the riskier options over the traditional investment avenues in the study.

### **3. Problem Statement**

As observed from literature, demographic and lifestyle characteristics played a very key role in portfolio diversification decisions among the investors, which significantly changed in scope and size with the liberalized approach of the governments and regulators to create an investor-friendly environment for residents and foreign investors. It was also observed that, there exists significant differences in investment decisions among the different genders, which might be more psychological than thought (risk-avoiding psychology) and irrespective of the advice provided by family, peers and others, women investors are more cautious in their decisions. Many studies have attempted to provide explanations for gender differences in investments but, failed to do so as the researchers can only observe the outcomes of decisions rather than the decision making processes themselves. Though there may be innumerable characteristics, the study tries to examine investment pattern using association rules among women investors in metropolitan city of Bengaluru.

### **4. Objectives of The Study**

1. To examine the various investment avenues which would tend to be purchased together.
2. To illustrate the investment habits of the women respondents based on which products they tend to buy.
3. To suggest various measures which can be taken by the companies in designing the products specifically meant for employed women investors based on the findings obtained.

### **4. Data Collection and Data Methodology**

#### **5.1 Data Collection**

This is a descriptive research involving the data collection from primary as well as secondary sources. In case of primary data collection, a well-structured questionnaire was prepared and data was collected from the investors using survey method.

## 5.2 Population

For the study, the population comprises of employed women investors of Bengaluru city. The employed women investors of the city were considered for collecting the responses.

## 5.3 Sample Size

Considering the 2015-16 data on labour statistics, Bengaluru has 3.16 lakh women in the workforce who are employed in both private and public sectors. Out of 100 questionnaires, only 54 filled forms were returned, representing a response rate of 54 percent which is optimal for this research.

## 5.4 Sampling Procedure

The sampling procedure followed in the study is non-probability convenient sampling method. The respondents were selected from the database available by using some key demographic variables such as educational qualification, occupation and residence. The choices made on investment avenues was assessed using association rules in R-software.

## 5.5 Data Methodology

In order to examine, among the various investment choices, which are those investment avenues which are most frequently invested and which avenues are frequently bought together, association rules method was followed. The context in which association rules algorithm is used would help in understanding the investment decisions from a business context point of view. Using association rules, patterns can be discovered from the data that allow the association rule algorithms to disclose rules of related investment products purchased. In Marketing, association rules are often used to discover patterns from the data that allow the association rule algorithms to disclose rules of related product purchases. Similarly based on those lines, in this study, association rules is used to find the related investment avenues.

Thus, in this study context, association rule learning is a method of finding association relationships that exist in frequently purchased items. Association rule is in the form of  $X \rightarrow Y$  where,  $X$  and  $Y$  are two mutually exclusive sets (investment avenues). Association rules is created using the investment pattern dataset collected from questionnaire.

The strength of the association between two mutually exclusive subsets can be measured using 'support', 'confidence' and 'lift'.

Support between two sets ( of investment avenues) is calculated using the joint probability of those events:

$$\text{Support} = P(X \cap Y) = \frac{n(X \cap Y)}{N}$$

Where,  $n(X \cap Y)$  is the number of times both  $X$  and  $Y$  is purchased together and  $N$  is the total number of transactions.

Confidence is the conditional probability of purchasing an investment product  $Y$  given the product  $X$  is purchased. It measures probability of event  $Y$  (investor investing in product  $Y$ ) given he/she has purchased product  $X$ .

$$\text{Confidence} = P\left(\frac{Y}{X}\right) = \frac{P(X \cap Y)}{P(X)}$$

The third measure in association rule mining is lift, which is given by

$$\text{lift} = \frac{P(X \cap Y)}{P(X) * P(Y)}$$

For the problem, the threshold levels of support, confidence and lift were assumed to 0.25, 0.5 and greater than 1 respectively.

The study chooses Apriori method, which is the most fundamental algorithms for generating association rules. The support is used for pruning the item sets and controlling the exponential

growth of candidate item sets. Shorter candidate item sets, which are known to be frequent item sets, are combined and pruned to generate longer frequent item sets.

For the sake of convenience, the investment avenues were abbreviated as shown in the table below:

Table 1: Abbreviation of the various investment avenues

Avenues	Saving Deposit in Banks	Fixed Deposit in Banks	Government Securities/ Money Market Securities	Corporate Bonds	PF/NSC/Insurance	Real Estate	Bullions/antiques and Jewelry	Shares	Mutual Funds
Abbreviation	SD	FD	MM	CB	PF	RE	BU	SH	MF

## 5.6 Data Analysis and Interpretation

The analysis of the data was conducted in two broad categories namely

- a. Analysis of Descriptive factors of the respondents
- b. Analysis of factors which play major role in investment decisions

### a. Analysis of Descriptive factors of the respondents

54 women investors were considered in the study. The individual demographic and family characteristics of the respondents was assessed and analyzed. Among 54 respondents, majority of the respondents (67%) were single followed by 19%, 11% and 4% of the respondents being married, divorced and widowed respectively.

Majority of the respondents considered in the study reside in their own houses. Around 72% percentage of the respondents lived in their own houses and rest in rented houses.

As observed considering the age of the respondents, majority of the respondents were within the age group of 21 to 50 years. It can be seen that, the respondents between the age group of 41-50 years were found to form the majority among the total respondents followed by 31 percentage of the respondents between the age group of 21-40 years. The employed women in the age group of more than 50 years formed 15 percentage of the total respondents in the study. Significant changes are observed in the lifestyle of the residents in metropolitan cities with majority of the families staying as nuclear families with only a small insignificant percentage as joint families. 70 percentage of the total respondent's family type is nuclear family while the remaining 30 percentage are part of joint family.

Bengaluru being the IT capital of the country provides employment mainly to graduates who are more skilled technically and professionally. Thus, being atleast a graduate is necessary to be in a dignified job which provides opportunity to save a fraction of the income for investments.

Among the respondents, majority of the respondents were graduates and many were well qualified individuals with post-graduation and PhD's. 17 percentage of the respondents were Chartered Accountants practicing in their own firms. Majority of the respondents are employed in private firms and only one-third of the respondents work in the government jobs.

72 percentage of the respondents have income exceeding 6 lakhs per annum annually. Around 41% of the total respondents earned between 6-10 lakhs per annum followed by 28% of the respondents earning less 5 lakhs per annum. Considering the saving level of the respondents, it would be encouraging to observe that, atleast 80 percentage of the respondents save more than 20 percentage of their income which can be used for investment purposes. As observed

in Table-11, it can be seen that 76% of the total respondents have 2 members in the family who are working.

**Findings of The Study**

Using the association rules, the data of 40 respondents choosing among 9 different investment avenues was considered.

The summary shows the most frequent items in the dataset includes avenues such as PF/NSC/Insurance, Bullions/ antiques and Jewelry, Fixed Deposit in Banks, Saving Deposit in Banks, Real Estate.

transactions as itemMatrix in sparse format with 40 rows (elements/itemsets/transactions) and 9 columns (items) and a density of 0.6083333					
most frequent items:					
PF	BU	FD	SD	RE (Other)	
38	36	35	29	23	58
element (itemset/transaction) length distribution:					
sizes					
3	4	5	6	7	8 9
5	6	9	10	7	1 2
Min. 1st Qu. Median Mean 3rd Qu. Max.					
3.000	4.000	5.500	5.475	6.250	9.000

Table 2: output obtained using apriori algorithm for frequent 1-itemsets

The apriori () function from the arules package was used to implement the Apriori algorithm to create frequent itemsets. For the study, we considered the minimum support threshold to be 0.2 based on our discretion.

The first iteration of the Apriori algorithm computes the support of each investment avenue in the dataset and retains those product that satisfy the minimum support. The algorithm as shown in Table 10, identifies 9 frequent 1-itemsets which is similar to the number of investment avenues considered. The summary of the itemsets shows that the support of itemsets ranges from 0.2000 to 0.95.

Because the maximum support of the 1-itemsets in the dataset is 0.95, to enable the discovery of interesting rules, the minimum support threshold would be set around 0.50.

set of 9 itemsets					
most frequent items:					
SD	FD	CB	PF	RE	(Other)
1	1	1	1	1	4
element (itemset/transaction) length distribution: sizes					
1					
9					
Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
1	1	1	1	1	1

**Table 3 :summary of the frequent 1-itemsets**

As observed in Table 11, inspect ( ) function was used to display the top 5 frequent 1-itemsets sorted by their support. Of all the transaction records, the frequent 1-itemsets were the nine 1-itemsets such as { PF/NSC/Insurance }, { Bullions/ antiques and Jewelry }, { Fixed Deposit in Banks }, { Saving Deposit in Banks }, and { Real Estate } all satisfy the minimum support. Therefore, they are called frequent 1-itemsets.

items	support	count
[1] {PF}	0.950	38
[2] {BU}	0.900	36
[3] {FD}	0.875	35
[4] {SD}	0.725	29
[5] {RE}	0.575	23

**Table 4: Top 5 frequent 1-itemsets sorted by support**

In the next iteration, the list of frequent 1-itemsets is joined onto itself to form all possible candidate

2-itemsets. As observed in Table 12, the top 10 most frequent 2-itemsets are displayed which are sorted by their support. Notice that, the rule with the highest lift is {FD} => {SD}.

	lhs	rhs	support	confidence	lift	count
[1]	{BU}	=> {PF}	0.850	0.9444444	0.9941520	34
[2]	{PF}	=> {BU}	0.850	0.8947368	0.9941520	34
[3]	{FD}	=> {PF}	0.825	0.9428571	0.9924812	33
[4]	{PF}	=> {FD}	0.825	0.8684211	0.9924812	33
[5]	{FD}	=> {BU}	0.800	0.9142857	1.0158730	32
[6]	{BU}	=> {FD}	0.800	0.8888889	1.0158730	32
[7]	{SD}	=> {PF}	0.700	0.9655172	1.0163339	28
[8]	{PF}	=> {SD}	0.700	0.7368421	1.0163339	28
[9]	{SD}	=> {FD}	0.650	0.8965517	1.0246305	26

**Table 5: Top 10 frequent 2-itemsets sorted by support**

As observed in Table 13, the top 10 most frequent 3-itemsets are displayed which are sorted by their support. Notice that, the rule with the highest lift is {FD,PF} => {SD}.

	lhs	rhs	support	confidence	lift	count
[1]	{FD,BU}	=> {PF}	0.750	0.9375000	0.9868421	30
[2]	{FD,PF}	=> {BU}	0.750	0.9090909	1.0101010	30
[3]	{PF,BU}	=> {FD}	0.750	0.8823529	1.0084034	30
[4]	{SD,FD}	=> {PF}	0.625	0.9615385	1.0121457	25
[5]	{SD,PF}	=> {FD}	0.625	0.8928571	1.0204082	25
[6]	{FD,PF}	=> {SD}	0.625	0.7575758	1.0449321	25
[7]	{SD,BU}	=> {PF}	0.600	0.9600000	1.0105263	24
[8]	{SD,PF}	=> {BU}	0.600	0.8571429	0.9523810	24
[9]	{PF,BU}	=> {SD}	0.600	0.7058824	0.9736308	24
[10]	{SD,FD}	=> {BU}	0.575	0.8846154	0.9829060	23

**Table 6: Top 10 frequent 3-itemsets sorted by support**

As observed in Table 14, the top 7 most frequent 4-itemsets are displayed which are sorted by their support. Notice that, the rule with the highest lift is {SD,PF,BU} => {FD}

	lhs	rhs	support	confidence	lift	count
[1]	{SD,FD,BU}	=> {PF}	0.55	0.9565217	1.0068650	22
[2]	{SD,FD,PF}	=> {BU}	0.55	0.8800000	0.9777778	22
[3]	{SD,PF,BU}	=> {FD}	0.55	0.9166667	1.0476190	22
[4]	{FD,PF,BU}	=> {SD}	0.55	0.7333333	1.0114943	22
[5]	{FD,CB,BU}	=> {PF}	0.40	0.8888889	0.9356725	16
[6]	{FD,CB,PF}	=> {BU}	0.40	0.9411765	1.0457516	16

Table 7: Top 10 frequent 4-itemsets sorted by support

### 5. Conclusions

The study was conducted to examine the investing pattern of the employed women investors in Bangalore city. The study was mainly conducted on employed women investors considering that, they will have the independence to take decisive steps and actions in choosing investment avenues and would be less dependent on the spouses and family as was observed in literature. The results of the association rules clearly indicate that the respondents are found to be more independent but, yet invest more conservatively considering long-term investment horizon. The investments mainly revolve around banking avenues and are made mainly due to compulsion of the system to invest. After having savings deposit and having put some money into Provident fund due to employer-employee compulsion and keeping in view the tax benefits, fixed deposit is the only important investment conducted by the respondents.

### Suggestions

The following suggestions can be made based on the findings and conclusions of the study as follows:

1. From the frequent item sets it is quite visible that, banking system can play a very important role in creating awareness about various investment products apart from risk-free instruments.

### Scope for Future Research

One major limitation of this study was that, it concentrated mainly on Bangalore city. It is important that future research can be undertaken by collecting the responses on various metropolitan cities in the country like Mumbai, Calcutta and Chennai. The research can also be conducted across metropolitan cities of different emerging economies.

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