Crime against Women:
Women vulnerability index and female labour force participation

Rashmi Sajwan

Abstract—The paper aims to examine women vulnerability across 29 different states and 7 union Territories from period 2001-2014 in India. A Women Vulnerability Index (WVI) is formed by using Principal component analysis (PCA) based on different factors i.e. Rape, Cruelty by husband , Insult to Modesty, Dowry Deaths, Kidnapping and Abduction and relatives, Assault with an intent to outrage modesty, Immoral Trafficking and Dowry cases. It assesses the exposure of women to crimes in different states. A higher value on the index shows higher crime susceptibility. The paper also aims to evaluate the impact of female Labour force participation (LFPR) on the WVI by regressing WVI on female labor force participation along with other control variables i.e. sex ratio, GER, growth rates, poverty etc. so as to obtain a significant impact of female LFPR on WVI.

Index Terms— Assault with an intent to outrage her modesty, Crime against women, Cruelty by husband and relatives, Deaths, Dowry deaths, Female Labour Force Participation (LFPR), Immoral Trafficking , Insult to Modesty , Kidnapping and Abduction, Principal Component Analysis (PCA), Rape, Regression Analysis, Women Vulnerability Index (WVI).

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1 INTRODUCTION

Violence against women is a manifestation of historically unequal power relations between men and women, which have led to domination over and discrimination against women by men and to the prevention of the full advancement of women' -Kofi Annan, Former Secretary-General of the United Nations

The aim of this research is to create Women Vulnerability Index (WVI) using Principal component analysis (PCA) across 29 different states and 7 union Territories from period 2001-2014. The paper also aims to reflect on the contribution of different factors to the final index. And then regressing WVI on female labor force participation along with other control variables i.e. sex ratio, GER, growth rates, poverty etc so as to obtain a significant impact of female LFPR on WVI.

Women Vulnerability Index (WVI) refers to crime caused to the women of India like Rape, Kidnapping and Abduction, Dowry Deaths, Cruelty by husband and relatives, Assault with an intent to outrage etc. and is one of the most important reason for the declining female labor force participation all over the world, especially in developing countries. It hinders women from exercising freedom of choice and also controls their participation in the development process of society. India is not alone in this concern of rising crime against women but this treat is real to the worldwide.

Our research is based upon two evident factors concerning women in India. First, India is a country where women are worshipped women as goddess, yet the number of crimes against women is rising rapidly. On the other hand, the other hand female's labor force participation rate (LFPR) has been declining over the last three decades. India has undergone fairly major socio-economic transformation in the last twenty five years. India has experienced continuous economic growth, structural shifts in the economy accompanied by high rates of urbanization, increase in educational attainment levels, and declining fertility rates among other factors. But during the same period there has been a gradual and persistent fall in women's economic activity.

In India, the National Crime Record Bureau under Ministry of Home Affairs collects the crime statistics at annual basis since 1950 [1]. It is also quite evident that thousands of cases for crime against women are registered under Indian Panel Code every year.

In India, the National Crime Record Bureau under Ministry of Home Affairs collects the crime statistics at annual basis since 1953. It is also quite evident that thousands of cases for crime against women are registered under Indian Panel Code every year. The Crime under Indian Penal Code (IPC) & Crime under special Local laws (SLL) [2]:

I.   Rape (Section 376 IPC)

II.   Kidnapping and abduction for specified purpose (Section 363-373 IPC)

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III.   Homicide for dowry, Dowry death or their attempts. (Sec. 302/304-B IPC)

IV.   Immoral Traffic (Prevention) Act, 1956.

V.   Assault on women to outrage her modesty (Section 354):

VI.   Insult to the modesty of women (Section 509):

VII.   Indecent Representation of Women (Prohibition) Act, 1986.

VIII.   Cruelty by husband or his relatives (Section 498a, IPC):

In this paper, we will obtain the trends of crime against women and female LFPR and then investigate whether the trends are purely coincidental or whether female LFPR have played a role in keeping crime against women high in India.

There have been previous studies on crime against women. Chauhan, R., Baraik, V [3] examined crime against women from 2001- 2012 to examine the crime against women with its spatial, socio- economic and demographic associates. The study found that there exist spatial variations in crime against women. Thaikkat [4] found that Madhya Pradesh has been the state that had the most number of cases of crime against women followed by West Bengal. The states with minimal violations against women are Manipur and Sikkim. The findings from the "Safe Cities Free of Violence against Women and Girls Initiative," conducted by [5] reveal that two out of three women reported being subjected to sexual harassment more than once a year. Robert and Witt [6] used a time series econometric technique to build a relationship between crime rate and female labor force participation rate. This study differentiates the time period into short term effect of female LFPR and long term female LFPR on crime rate. It was found that long run effects of female labor force participation rate are smaller than the short term effects. The long run effect of a one percent point rise in the female labor force participation rate increases the crime rate by just over 5% , which is smaller than the short term effects. A study by [7] founded that increase in GDP, literacy rate and sex ratio will decrease crime against women. Thus, there is a need for coming up with policies to establish a system to change the attitudes of criminals through education or imparting vocational training.

2   Data and Methodology

2.1 Data and Sources

The empirical work for this paper sourced from the National Crime Records Bureau of India, under the section "Crimes against Women" (Government of India) 2001-2014 which is available annually [8] . And the Female labor force participation data is extracted from annually published National Sample Survey Organization (NSSO) [9], [10], [11], [12].

Niti aayog provides a data for growth rates, telephone, roads, sex ratio poverty and Gross enrollment ratio for states annual.

WVI index – It has been calculated by using the data of NCRB (2001- 2014). The econometric technique which is used to construct WVI, is called principal component.

Female labor force participation rate data is sourced from NSSO. Female labor force is divided by the female population of the states and then multiplied by 100.000 to find female labor force participation rate per 100,000.

Telephone - Telephone measures the availability of telephone per 100 people. It is one of the indicators of infrastructure. The data for all the states is provided by the Niti Aayog.

Growth rates – Growth rates data is provided by Niti Aayog .

2.2 Methodolgy
Principle Component Analysis (PCA)

This study uses PCA (principle component analysis) to construct an index of Women Vulnerability Index (WVI). PCA is a variable reduction procedure which decomposes variations in the variables included in the analysis into components. A component is a linear combination of weighted explanatory variables, in such a way that the component accounts for a maximal amount of variance in the explanatory variables [13]. Since the first component captures the greatest proportion of total variation, it will be used in WVI in our analysis. The component is constructed based on factor scores which are used as weights for each explanatory variable to calculate an index which represents the degree of knowledge.

First, we normalize the selected 8 indicators of crime against women and make them proportionate to female population positively related in the following manner:
Step 1: Standardizing variables
X_{ik} = Crime Indicator/ Female population * 100,000
i= rape, kidnapping & abduction, dowry death , assault on women with intent to outrage her modesty , insult to the modesty of women ,cruelty by husband or relatives, immoral traffic(prevention)act, indecent representation of women(prevention)act etc … 8 indicators for k individuals.
The above indicator gives the value of crime against women per 100,000. We then compute the seven PCs by weighting normalized indicators with eigenvectors corresponding to eigenvalues$\lambda 1>\lambda 2>\lambda 3>\lambda 4>\lambda 5>\lambda 6>\lambda 7>\lambda 8$ in the following manner:
$P1K = XKF'1$,
.
.
.
$P8K = XKF'8$,
Where, Xk= [Xk1 , Xk2 Xk3 ….Xk8] a vector of standardized indicators for individual k.

The first PC accounts for the maximum variance of the original

indicators. The second PC accounts for the maximum variation of the remaining variance, and so on. Maximizing variances helps to maximize information involved among the set of indicators. We compute as many PCs as the number women vulnerability indicators and the total variation in all the selected indicators is accounted for by all PCs together. All the PCs are mutually orthogonal.

It is important to note that j= Var(Pj) and hence λ1 +λ2 +λ3 +λ4 +λ5 + λ6 + λ7 +λ8 =total variance in knowledge index.

Therefore, λj/∑λjis equal to the proportion of total variance accounted for by Pj.

Finally, Women Vulnerability Index is computed as a weighted sum of seven PCs, where weights are the variances of successive PCs

$$WVI_k =$$

$$\frac{λ1P1K \ +λ2\ P2K +λ3\ P3K +λ4\ P4K +λ5\ P5K + λ6\ P6K + λ7\ P7K +λ8\ P8K}{λ1 \ +λ2 \ +λ3 \ +λ4 \ +λ5 + λ6 + λ7 \ +λ8}$$

WVIK = β1 X1k + β2X2k + β3X3k + β4X4k + β5X5k + β6X6k + β7X7k + β8X8k + ε (1)

where WVI_k represents the WVI for state/UT 'k', and X1k…….X8k are the proposed indicators corresponding to the state 'k' and ε is the error term. The error term (ε) captures the variation differentiating the states on the index that is not explained by the proposed indicators.

Correlation Matrix

	rape	kidnapabd	dowrydeath	assaulttomod	insulttomod	cruelty	immoralTraf	indecentrep
rape	1							
kidnapabd	0.5142	1						
dowrydeath	0.1363	0.406	1					
assaulttomod	0.734	0.661	0.2361	1				
insulttomod	0.4707	0.4388	-0.0722	0.5839	1			
cruelty	0.2437	0.5505	0.3977	0.4505	0.0268	1		
immoralTraf	-0.2457	-0.2015	-0.1818	-0.1882	-0.1024	-0.1624	1	
indecentrep	-0.0212	-0.0882	0.0188	0.1048	-0.1204	0.3801	-0.0118	1

Note- corelation matrix of factors of crime against women (2014)

Fig. 1: Correlation Matrix of Crime variables

Bartlett's Spherical test on these 8 indicators is significant at the 0.01 level (chi square = 94.764 , P value = 0.000) , indicating significant correlations. Measure of sampling adequacy is coming out to be 0.6788, which falls in the acceptable range.

We have computed the principal components (PCs) as follows.

Component	λ1	λ2	λ3	λ4	λ5	λ6	λ7	λ8
Eigenvalue	3.15579	1.49846	1.05833	0.899428	0.509432	0.468605	0.224581	0.185366
Difference	1.65733	0.440136	0.1589	0.389996	0.040828	0.244024	0.039215	.
Proportion	0.3945	0.1873	0.1323	0.1124	0.0637	0.0586	0.0281	0.0232
Cumulative	0.3945	0.5818	0.7141	0.8265	0.8902	0.9488	0.9768	1

Fig. 2: Eigen values for year 2014

| Factors	F1	F2	F3	F4	F5	F6	F7	F8
rape	0.4341	-0.2382	0.1033	-0.1252	0.6173	-0.3579	0.0339	0.467
kidnapabduc	0.4764	0.013	-0.1724	0.2485	-0.368	-0.1413	0.7252	-0.0059
dowrydeath	0.2426	0.4138	-0.5346	0.2444	0.3781	0.5187	-0.084	0.073
assaulttomod	0.5026	-0.1142	0.1969	0.0441	0.1756	-0.0144	-0.2165	-0.7847
insulttomod	0.331	-0.4873	0.2077	0.0066	-0.3254	0.6052	-0.2063	0.3084
cruelty	0.348	0.5089	0.1175	0.1198	-0.3945	-0.3344	-0.5142	0.2448
immoralTraf	-0.2005	-0.0734	0.3633	0.8882	0.1702	-0.0251	-0.0029	0.0626
indecentrep	0.0467	0.5069	0.6679	-0.2402	0.1384	0.3226	0.3346	0.043

Fig. 3: Eigen vectors for 2014
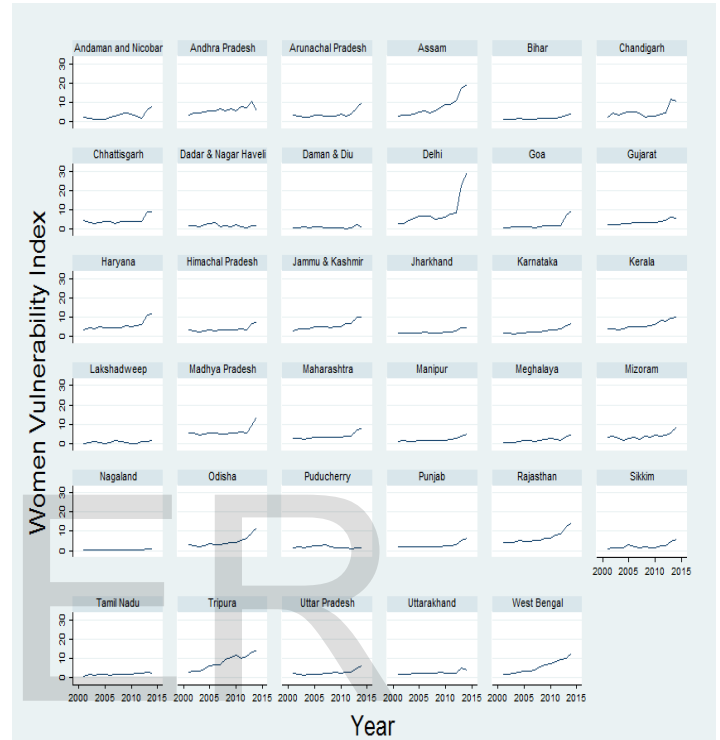
Fig. 4 : Pattern of WVI 2001-2014 for each state

From the above figure, it can be seen clearly that there is persistent rise in crime against women across almost all states except Nagaland, Daman and Diu, Dadar and Nagar Haveli, Puducherry. Crime against women witnessed rapid increase in Delhi, Assam and Tripura. Women vulnerability increased in Delhi from 2.62 to 29.09 from 2001 to 2014.

OLS Pooled Regression
OLS pooled regression has been used to determine the impact of female LFPR on crime along with other controls. The labour force participation pattern is identified by a literature review, descriptive statistics, and preliminary econometric estimates.

We hypothesize that crime against women or WVI Is a function of female labor force participation rate, growthrates, roads, ger, poverty, telephone, sex ratio, and police force.

Now by using regression analysis we will try to identify that these variables are significantly associated with crime or not.

Following is the regression equation for our model,

WVI$_i$=f(Female LFPR, Growthrates, Roads ,GER, Poverty, Telephone, Sex Ratio, Police Force) + Error$_i$

$$WVIK = \beta1\ LFPR1t + \beta2Growth\ rates_{it} + \beta3Roads_{it} + \beta4GER_{it} + \beta5Poverty_{it} + \beta6Telephone_{it} + \beta7Sex\ Ratio_{it} + \beta8Police\ Force_{it} + \varepsilon_{it}$$

In pooled OLS regression, we simply pool all observations and estimate the grand regression, ignoring the cross-section and time series nature of the data, in which case the error term captures everything.

Before starting with the panel data regression we will try running some basic tests to see if our data is suffering from the problems of like multi-collinearity, Heteroskedasticity and autocorrelation. On the basis of our theory ,we first try to set up our model irrespective of what regression results will be: We will use WVI for regression analysis. To check the significance of female LFPR on women vulnerability index we will regress female LFPR on WVI individually.

Regression Results
Female labour force participation on Women Vulnerability Index

	OLS	RE	FE	GLS
Female Labour Force Participation Rate	8.0053*	8.005	8.005*	8.00532**
	[4.61]	[5.180]	[3.996]	[2.737]
Growth Rates	-0.0482	-0.0482	-0.048	-0.0482
	[0.105]	[.11284]	[0.087]	[0.095]
Roads	0.0002	0.0002	0.0002	0.00027
	[0.00016]	[.0002]	[0.0001]	[0.00023]
Police Force	557.96*	557.96**	557.96**	557.967
	[315.24]	[196.38]	151.5	[367.23]
Telephone	0.009	0.009	0.009	0.009
	[0.027]	[.0298]	[0.023]	[0.02157]
Poverty	0.05149**	0.0514*	0.051**	0.051494**
	[0.02277]	[.0273]	[0.021]	[0.01972]
Sex Ratio	-0.0436	-0.043	-0.0436	(-0.043691)**
	[0.0285]	[.0389]	[0.03]	[0.01747]
Gross Enrollment Ratio	0.1097	0.1097	0.109	0.10975
	[0.12637]	[.1693]	[0.13]	[0.0719]
Constant	34.87	34.87	34.52	34.87**
	[25.45]	[24.01]	[27.16]	16.8133
Observations	51	51	51	51
Hausman P chi (2) value	-	1	1	
State Fixed Effects Included	Yes	Yes	Yes	Yes
Time Fixed Effects included	No	No	No	No
R-squared	0.8709			
within	-	0.625	0.625	
between	-	1	0.0127	
Overall	0.8709		0.0009	

Robust Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Fig. 5: Regression Results: Female Labour Force participation on WVI

From the above results, we conclude that [GLS] if there is one unit increase in Female labor force participation, women vulnerability index increases by 8.06247 units, which is significant at 5 % level of significance.

The variable poverty measures the Percentage of people below the poverty line in a state. When poverty is high, the opportunity cost of committing crime is much lower because people do not have jobs to provide them with income. Increase in poverty by one unit, there will be increases in crime by 0.0355 unit.

3 CONCLUSION

The major finding of the analysis shows that rising labour force participation of women impacts crime against women positively. Findings indicate that Delhi is the most unsafe

state among all the states with 29.09 WVI followed by Assam, Rajasthan and Tripura with 19.58, 14.39 and 14.15 respectively on index values. Whereas Daman and Diu and Nagaland are the safest states with least women crime vulnerability index with 0.60 and 1.01 respectively.
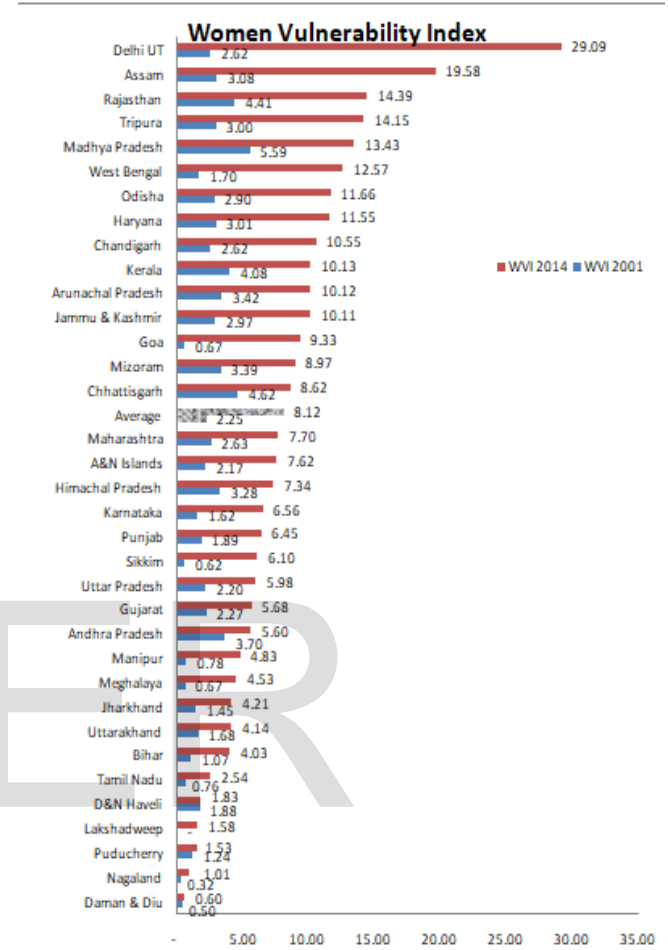

Fig. 6: Women Vulnerability Index in Indian States

Delhi showed a drastic increase in WVI 29.09 against the national average of 8.12 and hence stood at the top in term of crime against women. However, all the other states did not show much change in the ranking. The north eastern states generally expected to be low on women crime rates. This can be seen in these states i.e. Sikkim, Manipur, Meghalaya and Nagaland have very low crime rates with 6.10, 4.83, 4.53 and 1.01 respectively, which show the position of females in their societies with the greater mobility and visibility than women in other parts of India. These are below average of 8.12. The other north eastern states like Assam, Tripura, and Arunachal Pradesh, Mizoram have Crime index values of 19.58, 14.15, 10.12 and 8.97 which are relatively higher than the other north eastern states and India's average.

There are states whose ranks have also gone down significantly like Daman & Diu, Tamil Nadu, Maharashtra, Himachal Pradesh, Arunachal Pradesh, Uttarakhand, Madhya Pradesh.

From our analysis we can see that the Female labor Force participation does impact crime against women significantly and growth rates of state have a beneficial impact on crime against women. The higher the growth rate, lower would be the crime against women. On the other hand, Poverty is positively correlated with women crime. Higher the numbers of people below Poverty line, higher will the chances of women crime. When poverty is high, the opportunity cost of committing crime is much lower because people do not have jobs to provide them with income.

ACKNOWLEDGMENT

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