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Why is India's Female Labour Force Participation Falling? The Role of Agricultural Mechanisation and Security Risks

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Abstract: Despite remarkable economic progress in India, aggregate female labour force participation rate remains low and has been declining since the late 1970s and traditional explanations such as decreasing fertility rates, rising wages and education levels could not completely explain this trend. This article empirically examines the supply and demand dimensions of India's female labour force participation using time-series data from 1980. We find evidence that the share of agriculture in the GDP, the mechanisation of agriculture and security risks are the key determinants of female labour force participation.

Keywords: Labour force participation rates, India, Females, Agriculture, Mechanisation, Security risks.

Introduction

Since the middle of the 20th century, many countries throughout the world experienced significant increases in female labour force participation. India, however, is a unique example as it has one of the lowest and continuously declining female labour force participation in the world. This, despite the fact that India continue to experience high economic growth rates since the 1990s. The rigid nature of gender inequality in education, employment and income; culture, traditions, low sex ratio, poor quality education and mismatch of skills, and lack of employment opportunities are touted as major hurdles facing labour force participation in India (see for example Kapsos et al., 2014; Sorsa et al., 2015; Das et al., 2015). This low and declining female labour force participation has become a focal point of discussion among researchers and policy makers who are concerned with economic development and raises scepticism on the continued growth of the economy.

This article aims to revisit the factors affecting the aggregate female labour force participation in India since 1980. The key aim of our study is to investigate different dimensions of female labour force supply and demand. We focus on studying how sectoral transformation contributes to the decline in the female labour force participation. In doing so, we look at the structure of the Indian labour market, the status of women in general and also in rural and urban areas, education and health facilities, occupational segregation for men and women and the factors that influence women's decision making with respect to joining the labour force. Our basic premise is that labour force participation is not only an outcome of supply factors but just as importantly, demand for labour as well. This research is important because our findings could be used to help develop policies that would enhance female labour force participation, and that this increase in the participation of women can be a valuable contributor to India's continued economic growth.

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Specifically, we examine the role of Indian agriculture and its mechanisation in affecting the division of labour between the two sexes in the rural areas, as well as the extent to which awareness of security risks for females affect labour force participation – a first, to the best of our knowledge in this literature. We hypothesise that as India's agriculture sector transitioned from manual to mechanical and from traditional to modern methods of cultivation, demand for female workers decreased at the same time, females are forced to withdraw from the labour force in rural areas, contributing to low and declining participation. Further, as India's urban female labour force has been almost stationary since the last three decades, the net decline in the national female labour force participation comes from rural areas. We also hypothesise that increased awareness of security risks that discourage females from entering the labour force significantly affect the overall participation rate.

Literature Review

Female labour force participation has received considerable attention from labour, development economist and policy makers, especially since economic empowerment of women is considered crucial to growth (Klugman et al., 2014) and it is common consensus that education is the first step towards empowerment. The structural transition experienced by economies demands higher skills which in turn give higher returns, encouraging individual and institutions to invest in human capital (Heckman, 2000; Blöndal et al., 2002). Goldin (1995) argues that the correlation between economic development and female labour force participation changes with the level of development. She suggests that correlation would take a U-shape – that female labour force participation exhibits a downward trend in the beginning of the development process due to a transfer from home production or domestic duties to the formal labour market which require human capital skills. However, uneducated or low educated women can only do labour or manual work in their family farm, which carries a strong social stigma, e.g., manual work is socially undesirable, therefore women are more likely to opt out of the labour force. Further, during the early development stage, education opportunities expand for females, and this, along with increasing returns to education, encourages the illiterate and low skilled female labour force away from the labour market towards gaining an education. As the economy develops further with more females gaining education, increasing their ability to compete for higher positions, female labour force participation rate begins to rise and this contributes to the upward portion of the U-shape. Sundaram and Venneman (2008) find a positive relationship between literacy level of females and labour force participation.

Das and Desai (2003), Lahoti and Swaminathan (2013) and Gaddis and Klasen (2014) among others, raise questions on the validity of the U-shaped hypothesis. Das and Desai (2003) state that female labour force in India has not experienced feminisation like other South East Asian countries, since for several decades, they remained at the bottom of the U-shape despite substantial growth in GDP. They investigate the labour market behaviour of educated women aged 20-55 years in India, using data from the National Sample Survey (NSS) for 1993-1994. They test the structural opportunity hypothesis through socio-economic status, education level of villages and blocks, which are expected to affect the labour market decision of women. They use caste as a proxy for cultural values. They also use an interaction term for caste and education. The dependent dummy variable is employment status. Their results show that education has a negative effect on labour participation, while lower caste people with children under five years of age are more likely to be employed. These findings appear contrary to the general literature, but in India, lower caste women work because they need to. Further, women are less likely to be employed despite having an education due to increasing competition for

jobs. This is consistent with the previous literature and they imply that education must be accompanied by growth in employment opportunities. The interaction terms also show that lower caste educated women are less likely to be employed.

Gaddis and Klasen (2014), using data on female labour force participation from a variety of sources like the International Labour Organisation's estimates and projections and from different versions of the Penn World Tables (revisions 4th, 5th, and 6th of PWT versions 6.3 and 6.7), find that the U-shaped hypothesis motivated by secular patterns of structural change is weak or solely dependent on the data used for the analysis.

Similarly, Lahoti and Swaminathan (2013) re-examine the U-shaped hypothesis in the context of the Indian economy. They use state level panel data (1983-2010) to investigate the relationship between economic development and female labour force participation rate. Their methodology and estimation techniques are similar to Gaddis and Klasen (2014), and they found no evidence for the U- shaped relationship between economic growth and female labour force participation rate. Their results show that the decline in the female labour force participation in India does not show any sign of upturn with higher growth. They claim that economic growth is not accompanied by employment growth. Moreover, their results indicate that the Indian economy appear to have bypassed the manufacturing sector in its structural transition. India experienced a sharp decline in the share of value added by the agriculture sector while the manufacturing sector did not show any significant increase in its share. The service sector has emerged as the largest contributor to growth. However, the service sector requires skills for which majority of women are not trained due to social, cultural and traditional constraints. The unbalanced sectoral growth, lack of quality education, social and religious constraints are some hurdles in the way of not only a better socio-economic status for women, but participation in the labour market as well.

Klasen and Pieters (2015) attempt to identify the forces that cause the stagnation of female labour force participation rate in urban India since late 1987. They use micro level data from 1987 to 2011. They limit their sample to married women aged 25-54. They suggest that a combination of demand and supply side factors contribute to the stagnation of female labour force participation. Male income and education reduce female labour force participation. The positive effect of higher education (tertiary) is moderated by opposing factors like social constraints. They also claim that the counteractive effect of social stigma seems to decline from 2009. On the other hand, demand side structural change could not create enough employment opportunities to absorb a growing female working-age population. Employment growth in urban India is confined to construction and low-skilled services, which benefitted men due to the stigma effect for women in low-skilled jobs. Ghani et al. (2013) suggest that political empowerment of women is a useful tool to increase both the demand for and supply of labour market opportunities for women. It can be a potential policy tool to tackle the declining trend of female labour force participation in India. They examine the direct (allocating more employment to women in public works) and indirect (facilitating female labour force participation) effect of female political representatives on labour market outcomes. They claim that an additional year of exposure to female political representatives across all local government levels increase the female labour force participation by 17.5%. Moreover, having a female leader at district level increases this outcome by 8%.

Neff et al. (2012) examine the decline in female labour force participation in rural India from 2004 to 2010 using NSS data. They find that the working age 15-24 constitutes only 29% of the total labour force because most in this age group are in school/university. The same

trend is observed for urban women, and education appears to be a strong reason for the decline in labour participation. Their analysis further indicates that the income effect from male income reduces the supply of female labour. They find no evidence that employment opportunities and social and cultural factors affect the declining labour force participation; hence they conclude that the decline is mainly due to the income effect (from male income) and partially due to education.

Sorsa et al. (2015) state that employment opportunities in agriculture have declined in India, and other low skilled jobs benefit men. Moreover, education (except tertiary) and labour force participation rate are negatively related. The study analyses the various determinants of female labour force participation under four broad categories: individual characteristics, household characteristics, district characteristics and state characteristics by using various rounds of data conducted by the National Sample Survey Organisation (NSSO). Their regression results show that socio-cultural factors like marriage has a stronger negative effect on the labour force participation of women; Muslim women are less likely to enter the labour force while Christianity has a positive influence on female participation. The negative effect of a husband's income appears to diminish from 1987 to 2012 but remains negative, nonetheless. Household head with a university degree lowers the probability of female participation by five percentage points in rural areas, and by 13 percentage points in urban areas. Number of children and labour force participation are negatively correlated, but only for urban women. It is common that parents and parents-in-law decide the female's role in the family and the labour market, and the results show that the family has a strong negative influence on females' labour market decisions. Access to financial services like having a personal bank account and access to credit, etc. increases the female labour force participation by 0.22 percentage points.

Our analysis is based on the neoclassical model of supply and Becker's Household Model (Becker, 1991) to explain the behaviour of individuals and households in labour market supply decisions. We also apply Boserup's (1970) theory in understanding the role of women in economic development, which in turn helps determine the demand for labour.

Becker (1991) expanded the neoclassical model of labour supply in two ways by considering a household perspective and allowing for multiple uses of time and time usage for commodities. The model assumes the household as the decision-making unit, rather than the individual, and that division of labour by gender in all the societies is partly due to gains from specialisation and comparative advantage and partly due to biological differences. Women are biologically committed to production and feeding of children. Consequently, biological differences explain why women invest in human capital that raises household productivity with respect to caring for children. However, while the decision to work outside the home is a household decision, Sudarshan and Bhattacharya (2009) observed that safety concerns are also a key factor influencing female participation in the labour market. Due to numerous reports of crimes against women, women feel uneasy about joining the workforce and leaving the security of their home. Mobility and safety concerns are frequently cited as huge obstacles to working and must also be factored in the analysis. On the other hand, with respect to demand for labour, we posit that the demand for labour is affected by changes in the skills required for jobs. For example, in regions of plough cultivation, the division of labour between the two sexes was due to shifting cultivation practices. The main farming instruments, like the plough was used with big animals like the ox, were used by men and women were relegated to manual farm work without any tools or implements (Boserup 1970). Boserup also looks at reasons why employers prefer male workers in industries. Laws that provide obligatory benefits for female

workers, e.g., maternity leave, not permitted to work at night and in underground mines, result in preference for males in the bigger industries, because it appears more profitable to employ male workers (without as many mandated benefits) than female workers. Women also appear to prefer flexible working hours, which is possible in home or cottage industries where they are able to carry out domestic duties in between work hours. In many developing countries, working in home industries is also preferred to avoid contact with men from outside their own household. In India and Pakistan for instance, factory work is not regarded as respectable work for women. These cultural and personal preferences lower the position of women in the labour market.

Boserup observes that in many developing countries, women are rarely trained for skilled jobs while male workers undergo vocational and on the job training. Women are considered as the weaker sex in the society, so they are unsuitable for work in heavy industries and are unable to work for longer hours. As a result, men hold most of the skilled jobs in industry and trade. Women, having no modern skills for industries (in the urban areas) are therefore confined to domestic activities. Developing countries have launched programs to train women in crafts (e.g., hand-spinning in India) which may be first entry step into the labour market. However, this kind of program does not prepare women to compete in modern labour markets where employers seek more skills. This is particularly important as farming in India becomes more mechanised, farm labour in general tends to be displaced (see for example Reddy et al., 2014); and if females are less skilled in the use of farm machinery, then we would expect demand for female labour to decrease as a consequence.

Data

We analyse the aggregate female labour force participation rate in India by using data from the World Development Indicators (WDI) (Swanson, 2007), International Labour Organisation (ILO) and the National Crime Records Bureau of India (the data that support the findings of this study are available from the authors upon reasonable request). We use time series data from 1980 to 2013. Based on the previous review of literature, our analysis examines how the mechanisation of agriculture and the number of rape cases reported during the period of 1980-2013, which is a proxy for increased awareness of security risks, can be important determinants of female labour force participation in India, controlling for the percentage share of agriculture to GDP, the ratio of female to male secondary education, female labour force participation rate, male labour force participation rate and real GDP per capita as important determinants of female labour force participation.

The dependent variable

Female labour force participation rate (*FLPR*) is at the centre of our analysis. We collected labour force data from ILO and WDI. According to ILO, the labour force participation rate is calculated by expressing number of persons active (employed or looking for work) in the labour market as a percentage of the working age population. In our analysis, the age range is 15-64 years. The female labour force participation rate in India has declined from 47.11% in 1980 to 28.5% in 2013.

The independent variables

The main independent variables of interest relate to the role of Indian agriculture and its mechanisation in affecting the division of labour between the two sexes in the rural areas, as well as the extent to which awareness of security risks for females affect labour force participation.

Agriculture value added as percentage of GDP (*AVA*). The *AVA* data is obtained from the World Bank database (Swanson, 2007). The share of agriculture in India has declined by 19% since 1980. The average growth rate during this period is 3.5% which is mainly driven by the mechanisation of agriculture and use of high yielding crop varieties.

Mechanisation of Agriculture (*MECH*). We use the number of tractors as a proxy for the mechanisation of agriculture. The data is consolidated from WDI (Swanson, 2007) and Mehta et al. (2014).

Number of Rape Cases Reported (*RISK*). We include the number of rape cases reported as a proxy for awareness of security risks and safety concerns facing working women. That is, the larger the number of rape cases reported, the more aware individuals are of the risks of working outside the home. We assume that increased reporting of rapes as a suitable proxy for awareness of risks because these incidents are the root cause of fear and create a feeling of insecurity in society for females. The more rape cases females hear about and are aware of, the more worried they get about working outside the home. This increased awareness of security risks leads the households to constrain women from entering the labour market. The data is available from the National Crime Records Bureau of India.

We also include the following control variables in our analyses: male labour force participation rate (*MLPR*), ratio of female to male secondary education (*EDU*) and the real GDP per capita (*RGDPC*). We believe that more males in the labour market negatively affects female labour force participation rate. Moreover, the employed male could also indicate some information about these household head's income which is negatively correlated with *FLPR*. We also use the ratio of female to male secondary education to capture the effect of male and female education on *FLPR*. The literature suggests that female education (up to secondary schooling) has a negative effect on male education. On the other hand, the rising number of educated males indicates that males are able to capture more opportunities as evidenced by the dominance of males in the labour market and preference of employers for male employees. The number of females in secondary education is lower than males but it is improving due to rising returns to education. The ratio rose from 49% in 1980 to 95% in 2013.We also include income to control for the general economic condition of India.

Methods

Testing time series properties

A simple plot of the level of variables over time suggested that the variables exhibit a trend and could possibly be non-stationary. Therefore, we test the time series properties of our variables accordingly. Elder and Kennedy (2001) also suggest that regressing two variables with unit roots give us spurious results with misleading t-statistics and R-squares and very low Durbin- Watson statistics. To avoid misleading results, we test the variables for unit roots. The results from the Augmented Dickey-Fuller (ADF) tests (Table 1) show that all the variables are non-stationary and integrated of order one (I(1)) and their first differences are I(0).

Table 1: ADF Unit Root Test Results

Variable	Levels	First Difference	Order
lnAVA	-1.845	-3.295**	I(1)
lnFLPR	-0.688	-2.822**	I(1)
lnMLPR	-0.214	-3.196**	I(1)
lnEDU	-1.642	-9.472***	I(1)
lnRISK	-1.889	-4.126**	I(1)
lnMECHAGRI	-2.884	-5.620***	I(1)
lnRGDPC	-0.761	-3.564	I(1)

Notes: ** and *** reject the null hypothesis at the 5% and 1% significance level based on MacKinnon (1991, 2010) asymptotic critical values.

Cointegration and VAR estimation

Hendry (1980) warns about using OLS for non-stationary series. OLS requires all variables to be stationary otherwise the results will be spurious regressions. There is a possibility that two unrelated series are highly correlated and significant, but one must remain cautious of an irrelevant relation between them. Since all the individual variables are non-stationary, we subsequently check for cointegration using Engle and Granger's two-step method (Engle and Granger, 1987).

This method is based on ADF test and OLS regressions. The residuals are obtained from the OLS regressions. ADF tests are then conducted on the OLS residuals. Our OLS model for labour force participation is as follows:

$$lnFLPR_t = \alpha_1 + \beta_1 \ln AVA_t + \beta_2 lnEDU_t + \beta_3 lnMLPR_t + \beta_4 lnRISK_t + \beta_5 lnMECH_t + \beta_6 lnRGDPC_t + u_t \quad (1)$$

$$u_t = lnFLPR_t \alpha_1 - \beta_1 lnAVA_t - \beta_2 lnEDU_t - \beta_3 lnMLPR_t - \beta_4 lnRISK_t - \beta_5 lnMECH_t - \beta_6 lnRGDPC_t \quad (2)$$

The obtained residuals are regressed on their lagged term as follows:

$$u_t = \alpha u_{t-1} + \varepsilon_t \quad (3)$$

The null H0: $\alpha = 1$ implies that u_t is I(1), i.e., there is no cointegration. Alternative H1: $\alpha < 1$ implies that u_t is I(0), i.e., cointegration exists.

The different lag selection criteria (LR, AIC, HQIC and FPE) suggest the use of two lags to test for cointegration.

The Engle Granger tests (Table 2) do not reject the null, implying that there is no cointegration between *LFPR* and the explanatory variables, hence, we use a Vector Auto Regression (VAR) model for estimating the female labour force participation rate in India. Since our variables of interest are I(1), we conduct our VAR analysis on first differences with two lags following the AIC and HQIC lag selection criterion. The following models are specified:

$$\Delta lnFLPR = \propto_1 + \beta_{11} \Delta \ln FLPR_{t-1} + \beta_{12} \Delta lnFLPR_{t-2} + \beta_{13} \Delta lnMLPR_{t-1} + \beta_{14} \Delta lnMLPR_{t-2} + \beta_{15} \Delta lnEDU_{t-1} + \beta_{16} \Delta \ln EDU_{t-2} + \beta_{17} \Delta lnAVA_{t-1} + \beta_{18} \Delta lnAVA_{t-2} + \beta_{19} \Delta lnRISK_{t-1} + \beta_{110} \Delta \ln RISK_{t-2} + \beta_{111} \Delta lnMECH_{t-1} + \beta_{112} \Delta lnMECH_{t-2} + \beta_{113} \Delta lnRGDPC_{t-1} + \beta_{114} \Delta lnRGDPC_{t-2} + \varepsilon_{1t} \quad (4)$$

$$\Delta lnAVA = \propto_2 + \beta_{21} \Delta \ln AVA_{t-1} + \beta_{22} \Delta lnAVA_{t-2} + \beta_{23} \Delta lnMLPR_{t-1} + \beta_{24} \Delta lnMLPR_{t-2} + \beta_{25} \Delta lnEDU_{t-1} + \beta_{26} \Delta \ln EDU_{t-2} + \beta_{27} \Delta lnFLPR_{t-1} +$$

$$\beta_{28}\Delta lnFLPR_{t-2} + \beta_{29}\Delta lnRISK_{t-1} + \beta_{210}\Delta lnRISK_{t-2} + \beta_{211}\Delta lnMECH_{t-1} + \beta_{212}\Delta lnMECH_{t-2} + \beta_{213}\Delta lnRGDPC_{t-1} + \beta_{214}\Delta lnRGDPC_{t-2} + \varepsilon_{2t} \quad (5)$$

We specify a similar model for the rest of the variables.

Equation (4) is our model of interest. We expect female labour force participation rate (*FLPR*) to be negatively correlated with the ratio of female and male secondary education (*EDU*), male labour force participation rate (*MLPR*), past values of awareness of security risks (*RISK*) and the mechanisation of agriculture (*MECH*). On the other hand, we expect positive coefficients on real GDP per capita (*RGDPC*) and the share of agriculture in GDP (*AVA*) because the agriculture sector contribution to GDP is rapidly declining.

Table 2: Engle Granger Test for Cointegration

Variable	Test statistic	1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-2.588	-6.499	-5.617	-5.193

Notes: Critical values are from MacKinnon (1991, 2010).

Granger causality

We perform Granger causality tests to investigate reverse causality in the variables of interest. The results from the Granger causality tests (Table 3) show that the changes in the share of agriculture, male labour force participation and real GDP per capita (dln*AVA*, dln*MLPR* and dln*RGDPC* respectively) do not help us predict (i.e. does not Granger-cause) the lagged difference of female labour force participation. On the other hand, we find that education, awareness of security risks, and mechanisation of agriculture Granger-cause female labour force participation. However, the results show that jointly, causality runs from all the explanatory variables to female labour force participation. The models for the changes in the share of agriculture, education and male labour force participation (dln*AVA*, dln*EDU* and dln*MLPR* respectively) show that causality runs from the change in female labour force participation to the change in share of agriculture in GDP, education and male labour force participation.

Results and Discussion

Estimation of the VAR model (Table 4) for female labour force participation rate shows that the sign of the coefficients on the lagged dln*AVA* are contrary to our hypothesis and they are not significant. The coefficient on the education variable (dln*EDU*) at lag one is negative, as expected, and significant at the 5% level. We find that a 1% change in the ratio of female and male secondary education causes a 26% decline in the change in female labour participation rate. The relationship between male and female labour force participation rate is negative but it is marginally significant at the 10% level. Mechanisation of agriculture has a negative impact on female labour force participation rate. A 1% change in mechanisation causes a 25% decline in the change in female labour force participation rate in India. This finding is consistent with the results of a study by Reddy et al. (2014), which show that mechanisation in the farm replaces labour. We find that initially, increased reporting of rape risks leads to increased labour force participation, i.e. a 1% change in increased reporting leads to a 9% increase in female labour force participation. However, over time, labour force participation declines (12.7% decrease).

Table 3: Granger Causality Test Results (H_0: no causality)

Equation	Excluded	Chi2	Df	Prob>chi2
dlnLFPR	dln*AVA*	4.8258	2	0.090
dlnLFPR	dln*EDU*	11.228	2	0.004
dlnLFPR	dlnRISK	8.3857	2	0.015
dlnLFPR	dlnMLPR	5.2721	2	0.072
dlnLFPR	dlnMECH	35.202	2	0.000
dlnLFPR	dlnRGPDC	3.0016	2	0.223
dlnLFPR	ALL	75.196	12	0.000
dln*AVA*	dlnLFPR	16.06	2	0.000
dln*AVA*	dln*EDU*	0.9086	2	0.635
dln*AVA*	dlnRISK	0.9550	2	0.620
dln*AVA*	dlnMLPR	2.6067	2	0.272
dln*AVA*	dlnMECH	4.2176	2	0.121
dln*AVA*	dlnRGPDC	0.6938	2	0.707
dln*AVA*	ALL	23.341	12	0.025
dln*EDU*	dlnLFPR	8.5752	2	0.014
dln*EDU*	dln*AVA*	0.1785	2	0.915
dln*EDU*	dlnRISK	35.784	2	0.000
dln*EDU*	dlnMLPR	1.7474	2	0.417
dln*EDU*	dlnMECH	0.8043	2	0.669
dln*EDU*	dlnRGPDC	5.6244	2	0.060
dln*EDU*	ALL	55.671	12	0.000
dlnRISK	dlnLFPR	1.0931	2	0.579
dlnRISK	dln*AVA*	2.5473	2	0.280
dlnRISK	dln*EDU*	1.0245	2	0.599
dlnRISK	dlnMLPR	2.0557	2	0.358
dlnRISK	dlnMECH	3.1987	2	0.202
dlnRISK	dlnRGPDC	1.7832	2	0.410
dlnRISK	ALL	18.195	12	0.110
dlnMLPR	dlnLFPR	9.3229	2	0.009
dlnMLPR	dln*AVA*	3.2435	2	0.198
dlnMLPR	dln*EDU*	8.4563	2	0.015
dlnMLPR	DlnRISK	9.5863	2	0.008
dlnMLPR	dlnMECH	12.248	2	0.002
dlnMLPR	dlnRGPDC	4.4719	2	0.107
dlnMLPR	ALL	44.435	12	0.000
dlnMECH	dlnLFPR	0.07432	2	0.964
dlnMECH	dln*AVA*	0.77239	2	0.680
dlnMECH	dln*EDU*	1.0405	2	0.594
dlnMECH	dlnRISK	0.9177	2	0.632
dlnMECH	dlnMLPR	0.20659	2	0.902
dlnMECH	dlnRGPDC	2.5984	2	0.273
dlnMECH	ALL	8.3297	12	0.759
dlnRGDPC	dlnLFPR	2.6859	2	0.261
dlnRGDPC	dln*AVA*	5.6544	2	0.059
dlnRGDPC	dln*EDU*	1.2876	2	0.525
dlnRGDPC	dlnRISK	10.682	2	0.005
dlnRGDPC	dlnMLPR	4.8787	2	0.087
dlnRGDPC	dlnMECH	18.63	2	0.000
dlnRGDPC	ALL	37.474	12	0.000

Our results show support for both the demand and supply side hypotheses in explaining female labour force participation.

- *Demand side Hypothesis*: That the declining share of agriculture in GDP leads to lower employment opportunities for females, and as the agricultural sector transitioned from manual to mechanical and from traditional to modern methods of cultivation, demand for female workers decreased at the same time. Although we do not find support that declining share of agriculture lead to less female labour force participation, we however find that there is less demand for females who perform manual work because of the mechanisation of agriculture. Our study supports this mechanisation hypothesis.
- *Supply side Hypothesis*: That awareness of security risks that limit freedom of movement of females (e.g., fear of being raped while on the way to/from work) discourages female labour force participation. Moreover, both male and female education and male labour force participation rates have negative impacts on female labour force supply. The research presented above supports the security risks and education effect hypotheses.

Table 4: VAR results

Dependent/ Independent Variables	dln*LFPR*	dln*AVA*	dln*EDU*	dln*RISK*	dln*MLPR*	dln*MECH*	dln*RGDPC*
L.dln*LFPR*	0.986***	-1.598***	-0.529*	-0.654	0.064**	0.126	-0.407
	(0.161)	(0.447)	(0.269)	(0.642)	(0.021)	(0.468)	(0.281)
L2.dln*LFPR*	-0.086	-0.024	0.754**	0.170	-0.023	-0.078	-0.002
	(0.159)	(0.441)	(0.266)	(0.633)	(0.021)	(0.462)	(0.277)
L.dln*AVA*	0.022	-0.518**	-0.026	0.389	-0.015	0.159	-0.270*
	(0.070)	(0.195)	(0.117)	(0.279)	(0.009)	(0.204)	(0.122)
L2.dln*AVA*	-0.142	0.108	0.034	-0.109	-0.011	-0.038	0.034
	(0.071)	(0.196)	(0.118)	(0.282)	(0.009)	(0.206)	(0.123)
L.dln*EDU*	-0.265**	0.096	-0.782***	0.357	0.025*	-0.164	0.172
	(0.089)	(0.247)	(0.149)	(0.354)	(0.012)	(0.258)	(0.155)
L2.dln*EDU*	-0.044	-0.101	-0.302*	0.207	0.029*	0.059	0.115
	(0.078)	(0.218)	(0.131)	(0.312)	(0.010)	(0.228)	(0.137)
L.dln*RISK*	0.090*	-0.099	-0.391***	0.095	0.006	0.101	-0.251***
	(0.044)	(0.122)	(0.074)	(0.175)	(0.006)	(0.128)	(0.077)
L2.dln*RISK*	-0.127*	0.098	-0.192*	0.142	0.020*	0.070(0.1	0.050
	(0.055)	(0.153)	(0.092)	(0.220)	(0.007)	61)	(0.096)
L.dln*MLPR*	-2.480*	5.210	-1.970	6.622	0.163	0.656	4.099*
	(1.173)	(3.257)	(1.962)	(4.672)	(0.154)	(3.410)	(2.046)
L2.dln*MLPR*	-0.141	-0.894	1.895	-1.056	0.236	-1.302	-2.665
	(0.990)	(2.750)	(1.656)	(3.943)	(0.130)	(2.879)	(1.727)
L.dln*MECH*	-0.253***	-0.095	0.070	-0.062	0.026**	0.010	-0.189
	(0.065)	(0.180)	(0.109)	(0.259)	(0.009)	(0.189)	(0.113)
L2.dln*MECH*	0.423***	-0.508	0.099	-0.652	0.019	-0.012	-0.638***
	(0.093)	(0.257)	(0.155)	(0.369)	(0.012)	(0.269)	(0.161)
L.dln*RGDPC*	-0.069	-0.232	-0.399*	0.080	0.007	0.470	0.166
	(0.100)	(0.279)	(0.168)	(0.400)	(0.013)	(0.292)	(0.175)
L2.dln*RGDPC*	-0.105	0.087	0.123	-0.442	-0.024*	-0.172	0.166
	(0.085)	(0.236)	(0.142)	(0.339)	(0.011)	(0.248)	(0.148)
constant	-0.008	-0.013	0.090***	0.112*	-0.007***	0.067	0.095***
	(0.014)	(0.037)	(0.022)	(0.054)	(0.002)	(0.039)	(0.023)

Notes: Standard errors in parentheses; * p<0.05, ** p<0.01, *** p<0.001

We find that mechanisation of agriculture has a strong negative impact on the demand for female labour force in many ways. Agricultural machinery replaces manpower and animal power in the agriculture sector. The introduction of the tractor is always accompanied by other allied machinery. Most of the manual jobs, like weeding and winnowing, for females have disappeared from the agriculture sector. The dominance of men in using equipment (see for example Boserup, 1970) in agriculture forces females to withdraw from the labour force when mechanisation ensues. Our results show that the change in female labour force participation declined by 25% (Table 4) due to mechanisation. It is evident that gender inequality in the society reduces employment opportunities for women (Das and Desai, 2003). Mechanisation was also accompanied by the introduction of high yielding crop varieties, modern means of irrigation, pesticides and use of electric power for irrigation. These changes enhance the productivity of labour (particularly male labour force) and societal belief that females are less productive reduces the demand for female labour in the agriculture sector. Further, the agriculture sector in India has transformed from subsistence to commercial. Increased production of crops (grains) and commercialisation strengthen the economic position of households. Rising household income leads to less work or reduction in labour supply (income effect) particularly for females in the Indian society which constrains female labour force participation to preserve the social status of the family. The results from the VAR model for male labour force participation rate clearly indicate that mechanisation has a highly statistically significant positive effect on male labour participation rate and *MLPR* increases by 2%, consistent with the findings in other studies (e.g., Boserup,1970).

Agriculture and its mechanisation are at the centre of our argument. We propose that changes in the agriculture sector have a dominant role in explaining the decline in the overall female labour force participation rate in India. We note that 67% of India's total population live in the rural areas where agriculture and its allied occupations (poultry farming, dairy farming) are the major economic activities. In India, urban female labour force participation rate has stagnated and remain very low (around 20%) since 1987 (Klasen and Pieters, 2015). On the other hand, rural female labour force participation has declined from 52% in 1993 to 39.9% in 2010 (Neff et al., 2012). This implies that the overall decline in female labour force participation can be attributed largely to the decline in rural (agricultural) labour force participation. Further, jobs in urban areas, particularly in the fastest-growing service sector still could not generate enough employment opportunities to absorb a growing working age population, hence labour force participation remain stagnant in urban areas as mentioned previously. As well, the service sector is dominated by transport, trade, IT and financial services, all of which require skills that majority of females do not have. From the total female working age population, 37.7% is illiterate, 8% has completed senior secondary and only 6.8 % has a bachelor's degree or higher. It is even more shocking to see that only 0.04% of working age females has a technical certificate or diploma (Census of India, 2011). For this reason, among others, employment opportunities in the growing service sector and industry largely benefit men due to the gender gap in level and quality of education between males and females in India.

Aside from constraints from the demand side (e.g., male workers are preferred over females because males can use farm machinery and/or are more educated than females), there are also many constraints from the supply side. We argue that increased awareness of security risks due to increased reporting of rape incidences, contribute negatively to female labour force participation rate in India. Social norms and traditions make security risks a hindrance for females in entering the labour market. We use the number of rape cases reported to proxy for increased awareness of risks in the VAR model and the results are statistically significant at

the 5% level. We find that the lagged first difference of the risk variable is positive, implying that an increase in rape cases reported leads to an increase in the change in female labour force participation. This positive impact may be attributed to the perception that although individuals are made aware of rape risks because of increased rape reporting, these reports could act as a deterrent. We do acknowledge that many incidences of rape often remain unreported and undocumented because of various social perceptions and misperceptions about rape (see for example Waterhouse et al., 2016). However, reporting crimes (relative to non-reporting) increases the chances of detection and apprehension and should therefore deter that brings these rape incidences to light, could act as deterrent to potential offenders, i.e., would-be-rapists as their acts are no longer hidden from the public (Goldberg and Norg,1980; Allen, 2007). For this reason, women may feel more empowered and more secure working outside the home, leading to the positive impact of reporting rape cases (particularly those that have been highlighted by media) on female. labour force participation.

However, we also find that the second lagged difference of the risk variable is negative, suggesting that over time, the more rape cases are reported, the lower the female labour participation is. Although rape reports may be perceived as a deterrent initially, over time, as rape reporting continues, females and their family members may feel that the incidence of rape continues despite these reports, and perceive that reporting rape cases has not actually deterred individuals from committing rape and therefore the risk of rape remains real. Weaknesses in the legal institutions, low conviction rates for these crimes along with the length of time taken to investigate cases (Bandyopadhyay, 2018; "What is behind India's rape problem", 2019), lead to much frustration, hence we find the second lagged difference to have a negative impact on female labour force participation. We find that awareness of these security risks (rapes in particular) because rape reports continue over time, cause an 11% decline in the change in the female labour force participation rate (Table 4). We do not make any assumptions regarding whether or not actual rape incidences have increased along with rape reporting. Our argument is simply that the more rape cases are reported, the more aware people are of such crimes continuously occurring, and the more at-risk they feel. Consistent with the findings of Sudarshan and Bhattacharya (2009), we find that awareness of such security risks is a key reason why women prefer to work in the home or small cottage industries near their place of residence rather than in a factory that is located in farther cities or provinces, as their families do not want them to have contact with unfamiliar men. They are practically constrained to working in nearby rural, agricultural areas, where there is also fewer work opportunities for females due to the mechanisation of agriculture.

Labour force supply is also negatively affected by family decisions and household income. We include ratio of female to male secondary education (dln*EDU*) and male labour force participation rate (dln*MLPR*) to capture the effect of education stigma, social stigma and household effect on female labour force participation rate in India. Our results show that male labour force participation has a substantial large negative impact on female labour force participation rate but it is marginally statistically significant at the 10% level. The negative effect of education on female labour force participation rate is consistent with the literature. The inclusion of the ratio of female and male education allows us to capture multiple effects on female labour force participation rate. The rising ratio can be interpreted as a move of the female population away from the labour market towards gaining education which we refer to as the education effect. The ratio of female to male secondary education can also indicate gender inequality. Although the ratio has been rising over the sample period, female school enrolment remains far below that of male enrolment. Educated males are more likely to join the labour force. The VAR model for male labour force participation rate shows that education

causes a 2% increase in male labour force participation rate (*MLPR*) which in turn increases the household head's income. Due to the (household) income effect, females tend to withdraw from the labour force. The results of this study are consistent with Neff et al. (2012) who find that rising household income lowers the female labour force participation rate. The family unit is a dominant and important institution in Indian Society. It is a tradition that women specialise in domestic duties. Families typically make labour market decisions for their members based on traditions like this. Our results are consistent with the argument that male education, that leads to higher male (household) incomes and female labour participation rates are negatively correlated.

Conclusions and Policy Implications

India has been experiencing rapid economic growth over several decades, yet female labour force still shows a declining trend over this rapid growth period. We explore the possible causes of this decline in labour force participation. Our results suggest that both demand and supply side factors contribute to the decline in female labour force participation rate, and that demand-side factors, like the mechanisation of agriculture, having a bigger impact.

We find that mechanisation of agriculture causes a decline in the demand for female labour force, as males are preferred over females to work with farm machinery, and thus leading to a decline in female labour force participation. It is therefore important to promote capacity building for women through skills training for various types of work, including but not limited to the use of farm machinery or other heavy equipment that women have not been traditionally exposed to.

Our findings also show the need for policy makers to review existing policies of gender equality and to examine how effective these policies are at the grassroots level in order to encourage more females to participate in the labour market. For example, employers should be directed at creating a more conducive workplace that allows workers, female workers in particular, to have the opportunity to take care of themselves and their families for instance by providing flexible working hours whenever practicable. We find that the education level of females remains far below that of males to enable females to meet the labour market requirements for more skilled workers. What is required is for both quantity and quality of female education to be raised. There is a pressing need in India to revamp the formal education system which follows an outdated centuries old structure that does not essentially meet the labour market requirements. Formal education does not guarantee jobs in the labour market. Education providers should promote adult education for males and females that develops and enhances technical skills that match current labour market requirements, including for instance training in the use of farm machinery for agriculture. As mentioned earlier, training opportunities should also be structured in such a way that these do not discriminate on the basis of gender. The reduction of inherent social restrictions in the society for females is also of utmost important for a country like India.

Policy makers should take advantage of information technology to educate females living in the remote areas and those whose mobility is restricted due to perceived security risks to enable them to participate in the labour market. Strict enforcement of laws that secure the mobility and safety of females and ensure justice for victims can also help encourage females to join the labour force. That is, individuals need to feel secure in the knowledge that reporting of crimes, rapes in particular, lead to a resolution that lead to actual reduction of rape incidences and other security risks.

Our study also points toward the need for rural and urban development to occur simultaneously. Rural areas (particularly agriculture and its allied occupations) provide employment opportunities to a large portion of the population. Moreover, female participation rate is highest in agriculture among all the sectors. Modernisation of agriculture needs to progress in such a way that it can generate equal employment opportunities for females and males.

Finally, it is important to note that determining why female labour force participation is declining in India is not a moot exercise. More importantly, knowing the challenges that women face can help in developing policies that would not only encourage female labour force participation, but also contribute to raising economic growth.

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Appendix 1: Variable list

Variable Name	Description	Source
FLPR	Female labour force participation rate number of active (employed or looking for work) females aged 15-64 in the labour market as a percentage of the working age population	International Labour Organisation (ILO) Available at: https://www.ilo.org/shinyapps/bulkexplorer7/?lang=en&segment=indicator&id=EAP_DWAP_SEX_AGE_RT_A World Development Indicators (WDI) Available at: https://databank.worldbank.org/source/world-development-indicators
AVA	Agriculture value added as percentage of GDP	World Bank database (Swanson, 2007) Available at: http://documents.worldbank.org/curated/en/336241468138277212/World-development-indicators-2007
MECH	Mechanisation of Agriculture number of tractors as a proxy for the mechanisation of agriculture	World Bank database (Swanson, 2007) Available at: http://documents.worldbank.org/curated/en/336241468138277212/World-development-indicators-2007 Mehta et al.(2014) Available at: http://un-csam.org/publication/PB201402.pdf
RISK	Number of Rape Cases Reported number of rape cases reported as a proxy for awareness of security risks and safety concerns facing working women	National Crime Records Bureau of India Available at: https://ncrb.gov.in/en
MLPR	Male labour force participation rate number of active (employed or looking for work) males aged 15-64 in the labour market as a percentage of the working age population	International Labour Organisation (ILO) Available at: https://www.ilo.org/shinyapps/bulkexplorer7/?lang=en&segment=indicator&id=EAP_DWAP_SEX_AGE_RT_A World Development Indicators (WDI) Available at: https://databank.worldbank.org/source/world-development-indicators
EDU	Ratio of female to male secondary education	World Development Indicators (WDI) Available at: https://databank.worldbank.org/source/world-development-indicators
RGDPC	Real GDP per capita	World Bank database Available at: https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?locations=IN

Appendix 2: Some notes on unit root, cointegration, VAR estimation and Granger causality

Unit root test

Analysis of the time series properties of the data is important because regressing two variables with unit roots lead to spurious results with misleading t-statistics and R-squares and very low Durbin- Watson statistics. To avoid misleading results, it is important to test the variables for unit roots – stochastic trend in the time series. Unit root tests are undertaken to determine whether the time series is stationary or non-stationary. A time series is stationary if its joint distribution is time invariant, i.e., the mean and variance do not depend on time. Stationarity is determined by order of integration (i.e., the number of times the series needs to be differenced in order to be stationary). If a variable is of zero order of integration, it is called stationary [I(0)]. On the other hand, if it is of higher order of integration, it is called non-stationary. There are several procedures for testing for unit roots, but the most frequently used unit root test in the empirical literature is the Augmented Dickey-Fuller (ADF) test (Dickey and Fuller, 1979).

Cointegration

Elder and Kennedy (2001) suggest that the presence of unit roots in the individual variables require an alternative approach for estimation. Their alternative procedure requires checking for cointegration and specifying the model accordingly. Cointegration is a statistical property of time series in long run relationship. A set of non-stationary variables that move together in the long run is interpreted to be cointegrated and in long run equilibrium. Most time series variables are non-stationary. Traditional econometric techniques suggest that we need to difference the variable to get stationarity. If the first difference is stationary, the original series is said to be I(1). The concept of cointegration was introduced by Granger (1981). Assume two time series y_t and x_t are non-stationary and of integrated order I(1). Cointegration exists if $y_t - \beta x_t$ is I(0). In other words, the series do not drift apart from each other over time and there is long run relationship between the series.

Engel and Granger's (1987) residual based test is commonly used test for cointegration. Consider an OLS regression

$$y_t = \beta x_t + u_t$$

Residual based test depends on u_t. If u_t has a unit root, then y_t and x_t are not in a cointegrating relationship. We use estimated values of u_t to test the presence of unit root using the ADF test.

VAR estimation

A Vector Auto Regression (VAR) system contains a set of variables each of which is a function of its own lags and all other variables of the same number of lags. In other words, VAR techniques assume that the current value of a time series variable is a function of its past values and the past values of other variables. VAR estimation requires stationary series, but because our variables of interest are I(1), we perform VAR analysis on first differences. Differencing converts a non-stationary series (i.e., I(1)) into stationary series. In VAR model, the maximum likelihood estimator reduces to the OLS estimator for each equation. The VAR model is a useful analytic tool to explain causal relationships among multiple variables over time. Moreover, the model also helps in the prediction of future relationships among the variables.

Granger Causality

Granger causality examines whether past values of one variable cause another variable. In other words, the test determines whether past values of one variable can help in the prediction of another variable in the model. The simplest form of Granger Test is as follows:

$$y_t = \alpha_1 + \sum_{i=1}^{p} \beta_i y_{t-i} + \sum_{j=1}^{p} \theta_j x_{t-j} + \varepsilon_t$$

The null hypothesis for the causality test is, "One variable does not Granger cause another variable."

$$H_0 : \theta_1 = \theta_2 = \ldots\ldots = \theta_p = 0$$

Rejecting the null implies that variable x causes variable y.