SEX RATIO, FEMALE LABOUR FORCE PARTICIPATION AND CRIME: EVIDENCE FROM INDIAN DISTRICTS

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To my loving parents, parent-in-laws, husband, sister, sister in law, brother-in-laws and Prisha, Pravit and Anaaya.

Thank you for all your support all along the way.

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DECLARATION

I declare that the thesis entitled "Sex Ratio, Female Labour Force Participation and Crime: Evidence from Indian Districts" submitted by me for the award of the degree of **Doctor of Philosophy** of Jawaharlal Nehru University is my own work. The thesis has not been submitted for any other degree of this university or any other university.

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CERTIFICATE

We recommend that this dissertation be placed before the examiners for evaluation.

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Table of Contents

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

APC:	Agricultural Prices Commission
CSR:	Child Sex Ratio (Age 0-6)
FAO:	Food and Agriculture Organization of the United Nations
FCI:	Food Corporation of India
HYV:	High Yielding variety
ICRISAT:	International Crops Research Institute for the Semi-Arid Tropics
IHDS-II:	Indian Human Development Survey – II
IV:	Instrumental variable
NCAER:	National Council of Applied Economic Research
NCRB:	National Crime Records Bureau
OLS:	Ordinary Least Squares
ORGI:	Office of the Registrar General & Census Commissioner
PCPNDT:	Pre-Conception and Pre-Natal Diagnostic Techniques
SC:	Schedule Caste
ST:	Schedule Tribe
UNSD:	United Nations Statistics Division

CHAPTER 1: INTRODUCTION

1.1 Female Socio-Economic Status in India

Statistics for India indicate wide disparities in gender roles and socio-economic status of males and females. High rates of economic growth have led to an increase in total workforce participation from 36 percent in 1981 to 39.8 per cent in 2011 (Census of India). The gender gap in workforce participation has however remained persistent through the decades. Female workforce participation has increased marginally from 19.8 percent in 1981 to 25.5 percent in 2011. Male workforce participation on the contrary, has remained significantly higher at 52.7 per cent and 53.3 per cent in 1981 and 2011 respectively, as compared to females. Female literacy rate in India has remained equally low at around 65 percent as compared to 82 percent for males (Census, 2011). Though India has shown an annual GDP growth of about 8 percent on average between 2000-2001 and 2010-2011 (Planning commission, Government of India), development indicators for females are a cause of concern. Female infant mortality rate is at an average of 61 as compared to infant male mortality of 57 between 2000 and 2011 (Census). As per the Department of Secondary and Higher Education (Ministry of Human Resource Development, India), 72 percent of females drop out of school as compared to 66 percent males. The statistics indicate acute neglect of females, not only in economic domains, but also in provision of health and education.

Low expected returns from investment in daughters is known to be a probable cause for low levels of investment in girl's education and health (Qian, 2008). Poor human capital investment reduces female competitiveness in the labour market. Disparities in gender roles and socio-economic status in India have generated a vicious cycle of gender discrimination, absence of females from productive roles and worsening of socio-economic representation. Adult economic activity rate[1] for women in India is found to be 29 as compared to 81 for males in 2011 (UNSD). Females derive their social value from their

[1] Adult economic activity rate, refers to the percentage of the population aged 15 and over, which is economically active. It defines as economically active, all employed and unemployed persons, including those seeking work for the first time. It covers employers operating unincorporated enterprises, persons working on their own account, employees, unpaid contributing family workers, members of producer cooperatives and members of the armed forces.

economic value. In case of India, the culture of patrilocality[2] and patrilineality[3] and existence of dowry[4] has made it culturally acceptable to consider women as liability.

A biased environment against females, with daughters perceived as liability and sons as assets has caused acute imbalances in demographic structure with adverse impact on social and economic variables. Sex selective abortions triggered by poor economic values of females has led to imbalances in sex ratio. Sen (1990) noted that in parts of the developing world, more than 100 million women were missing due to gender discrimination. Literature suggests that low sex ratio should have an effect on the crime outcomes. Acute shortage of females leads to distortions in the marriage market. Increased competition for women and greater stress associated with shortage of females in the marriage market may trigger criminal engagements (Dreze and Khera, 2000). Poor physical representation of females is also associated with poor social and economic representation and greater oppression. As females participate in social, political and economic roles, it brings acceptability, equality and increased tolerance. This change in societal attitude acts as strong deterrent of crime, especially crime against women. Iyer et. al. (2000) argue that increased female political representation increases reporting of crime. Besides crime, increase in female socio-economic status is likely to have positive effects for social and economic outcomes. If a rise in female education and workforce participation empowers women with greater decision making, this is likely to increase human capital investment among children, girls in particular, raise female bargaining power in the marriage market and provide incentives for greater investment in human capital by men due to increase in competition, both in the labour and marriage market (Lundholm and Ohlsson, 1998; Anderson, 2004).

1.1.1 Sex ratio in India

Sex ratio (females per thousand males) in India, varies widely across different states ranging from 1084 in Kerala to 879 in Haryana and 618 in Daman and Diu (Census of India, 2011). Child sex ratio (0-6 years) declined from 927 females per thousand males in

[2] Patrilocality means, residence of a couple, especially of the newly married with the husband's family or tribe

[3] Patrilineality relates to tracing descent through the paternal line

[4] Dowry is net transfer made by the bride's family to the groom's family at the time of marriage. This could either be just a one-time payment or might involve a stream of several payments over a period of time. Dowry is also referred as *'groom price'*.

2001 to 919 females per thousand males in 2011. Literature attributes the decline in child sex ratio to neglect of female child and technological advancement that enabled sex selective abortion (Arnold, Kishor and Roy, 2002). In India, relative economic values of males and females has been an important determinant of sex ratio. Patriarchal culture constrains females to non-economic roles such as household chores and child rearing. Inability to participate in economic and financial decision making, reduce female social and economic value. Patrilocality constrains daughters from supporting parents after marriage in India. Sons are therefore perceived as a social security and daughters a liability. Amartya Sen in his study estimated about 37 million missing women in India (Sen, 2003). This bias against females has led to undesirable social outcomes. Distortions in sex ratio creates a pool of surplus unmarried men in the marriage market. Edlund et. al. (2007) argue that surplus men in the marriage market are more likely to engage in illicit activities to seek monetary gains and raise marital prospects. This causes an increase in incidences of crime. In an uncertain and unsafe environment, sons are perceived as source of protection and daughters as liability. Rise in crime therefore encourage girl foeticide and infanticide (Kaur, 2012; Arya & Khurana, 2014), further worsening the sex ratio.

1.1.2 Female Education, Workforce Participation and Dowry in India

Low expected returns from human capital investment among females, has led to low levels of education and workforce participation among women, in India. Female literacy rate is 65.45 percent as compared to 82.14 percent for men according to the Census of India, 2011. In 2014-15, approximately 5 percent of girls dropped out of primary school and nearly 17 percent out of secondary education. Around 30 percent of the girls quoted *'engagement in household activities'* as the reason for school drop-out[5]. Low education levels either constrain females out of the productive labour force or the roles are limited to low skilled-low paying jobs. Females that comprise nearly 50 percent of the population have a workforce share of meagre 25.5 percent according to Census of India, 2011. The figures on urban-rural divide suggest that 31 percent female workforce is in rural areas and merely 11.6 percent in urban areas. This indicates that a major share of female workforce participation is from the rural and agriculture sector that requires low skills and suffer from

[5] Source: MHRD, Department of School Education and Literacy, Statistics Division, 2018

low productivity. Low human capital investment and inadequate employment opportunities limit female participation to traditional roles. Participation in productive labour force and representation at social, political and economic arenas is a strong determinant of economic values of a cohort (Schlegel & Barry, 1986). Low opportunity cost of female time and effort have caused distortions in other related markets, such as the marriage market besides the labour market. Low levels of female literacy and workforce participation widens the gap in ability difference between potential grooms and brides in the marriage market. Anderson (2007) argues that dowry acts as an equilibrating mechanism in the marriage market. It is function of differences in ability of the groom and bride. Anderson (2003) shows that countries have exhibited a fall in dowry with rise in industrialization and modernization. However, India characterized by strong patriarchal norms and societies stratified by caste and religion, has shown a rise in groom price. Dowry is a reflection of low social and economic values of females. NCRB reports around 8,200 cases of dowry deaths on an average in India, which is approximately 1.4 dowry deaths per 100,000 women. Social norms require bride's family to bear a disproportionate share of marriage related expenses. It also expected from the girl's family to transfer lump-sum amounts as dowry to the boy's family at the time of marriage (and sometimes over a period of time, post marriage). Parents of daughters therefore, often tend to substitute investment in daughters' education to save for future marriage related expenses. Inability to sustain liabilities associated with a girl child, parents are encouraged to resort to sex selective abortions. Among other outcomes of poor female economic representation such as health and education, crime is a natural social outcome of low sex ratio and poor socio-economic value of females. Low status of females and distorted sex ratio could increase crime through distortions in marriage market and have adverse implications in the labour market. Crime could also possibly increase with low female representation due to the adverse impact on social standards such as gender parity and moral standards, which are inherited by the future generations.

1.2 Crime in India

According to a report published by National Crime Record's Bureau, there has been an increase of 1.1 percent in total cognizable crimes (Indian Penal Code, IPC), per 100,000 persons between 1953 and 2006. Heinous forms of crime such as murder and kidnapping have reported an increase of 7.4 percent and 48 percent respectively over the time period. Statistics show stronger trends for crimes committed against women. Nearly 70 percent of women are reported to face domestic violence. Rapes are documented to have doubled between 1990 and 2008. 8,391 dowry death cases were registered in 2010 in India. A rise in criminal activities could be attributed to various factors in developing economies, such as India. Literature suggests that increase in unemployment rates increase the probability of criminal engagements (Ehrlich, 1973). Education is found to be a strong deterrent of crime (Ehrlich, 1975; Lochner and Moretti, 2004). Development associated with increased urbanization is also shown to lead to increase in crime rates. Further certain sections of the society and minority groups are more vulnerable to victimization. In this thesis, we propose that socio-economic representation of females is another important determinant of crime but insufficiently studied in literature. Most of the studies on association between crime and female representation either study crime against women or crime committed by women. We argue that if rise in female representation in non-traditional roles increases competition in the marriage and labour market, it would affect the crime rates, in general. Also, changes in perception, tolerance and acceptability of women in a historically patriarchal society would reduce crime rates. Dreze and Khera (2000) show that in India murder rates increase with a fall in sex ratio (females per thousand males). Embracing social system with females in non-traditional roles reduces crime not only by increasing female bargaining power, but also through positive social externalities such as gender parity, greater acceptability of women in non-traditional roles and reduced tolerance for crime.

1.3 Objective of the Study

This study examines three research questions. First, 'Does there exist contemporaneous and persistent effects of son preference on crime in India?' Patriarchal norms and strong preference for sons, aided with medical advancement and ease of technological access has led to a significant rise in sex-selective abortions, severely distorting the sex ratio in favour of men. The study uses child sex ratio[6] (CSR) (age 0-6 years) as a proxy for son preference. The analysis provides estimates for the contemporaneous, short run (10 years later) and

[6] Males per 1000 females

long run (20 years later) consequences of son preference in India. Sex ratio data is taken from the census of India between 1961 till 2001 at the district level (Districts are the third geographic tier in the Indian administration). The existing literature that studies the association between sex ratio and crime focuses only on the marriage market. On one hand, the studies suggest that shortage of females leads to an increase in their marginal value. This rise in marginal value of females would lead men to invest more in themselves to gain competitiveness in the marriage market (Becker, 1974; Angrist, 2002). Human capital investment raises the apprehension and conviction cost of illicit engagements and would cause a reduction in incidences of crime. Further, shortage of females would also mean women being valued more, would receive more protection and face lesser violence. Recent literature however, on the other hand argue that relative shortage of potential brides in the marriage market leads to increased competition for them, potentially resulting in increased violence, such as murders (Dreze and Khera, 2000).

Using survey data from the Indian Human Development Survey (IHDS-II), we explore the channels through which CSR may affect contemporaneous and short run crime. First, a marriage squeeze caused by an increase in the sex ratio should reduce the stigma cost of committing crime since it improves the chances of finding a groom for an unmarried daughter outside the known network of people. Second, in an institutional setting where family of the female bears a disproportionate share of marriage-related expenses, a high pre-marital sex ratio would lower dowry expectations and consequentially lower foregone expected earnings (Anukriti et. al., 2018). This should cause a fall in labour hours and increased consumption, both associated with increased crime rates. Another main aim of the study is to propose an identification strategy to deal with potential endogeneity, due to reverse causality and omitted variable bias. We use instrumental variable estimation to address endogeneity bias. The IV exploits exogenous district level variation in historical (1961) area under wheat and rice cultivation and across time variation in relative producer prices of wheat and rice. We argue that females derive their social values from their economic values (Bardhan, 1974). Districts that have historically been wheat producing are seen to be more patriarchal, with acute neglect of females and high sex ratio. Production of wheat as compared to rice requires immense physical strength, making it intensive in male labour. Thus, the relative socio-economic value of males is found to be higher in wheat producing districts than rice producing and hence there exists a stronger preference for sons.

The second research question that the study examines is: ‘Is there an association between female education and marital assortative mating in India? And if this association is weaker or stronger in dowry prominent districts?’ Literature suggests that marital assortative mating or ‘who marries whom’ is determined by the characteristics of grooms and brides and the respective households. Using IHDS-II survey data, we estimate the association between years of schooling of husband and wife. Existing studies argue that men choose to marry females with higher education in expectation of greater wage income in future. We propose that in developing economies, such as India, which are characterized by low female labour force participation and poor returns to female education, female years of schooling is a non-monetary rather than a monetary trait. Education levels of potential bride has countering effects on the groom’s household utility. On one hand, a bride with higher education brings down the post marital household cost of production and positively affects utility. On the other hand, if a rise in female education increases female bargaining power in the marriage market, it leads to a fall in dowry payments. A reduction in dowry causes a fall in groom’s household utility. Marital assortative mating based on education would thus be determined by its net effect on groom’s household utility, due to reduced household costs and due to fall in dowry. The empirical estimates not only show the association between the education levels of husband and wife, but also assess if this association differs in districts with higher dowry norms. We further provide a simple theoretical model to derive the conditions under which positive assortative mating would be optimal.

The third research question examined is: ‘What is the effect of female workforce participation on crime in India, contemporaneously and in the long run?’ Literature suggests that employment has significant effects on crime outcomes. On one hand, an increase in employment raises income and increases the cost of apprehension and conviction. A rise in employment should therefore lead to a potential fall in crime. On the other hand, as the workforce participation rate rises, more people are exposed to risk outside the safe boundaries of home and this leads to an increase in victimization rate. According to the census of India, workforce participation rate has increased from 36 percent in 1981 to 39.8 percent in 2011. Female workforce participation rate increased marginally from 19.8 percent to 25.5 percent between 1981 and 2011, as compared to 52.7 percent and 53.3 percent among males over the same period. Among other social and economic outcomes, these trends have significant effects on crime outcomes. National Crime Records Bureau data shows a 1.1 percent increase in total cognizable crime under IPC (Indian Penal Code) and a 7.39 percent increase in murder rates from 1953 to 2006. We examine the effect of female workforce participation on violent and non-violent crime. Female workforce is likely to affect crime due to at least four reasons. First, as more females enter the labour force, it increases competition in the labour market. This may lead men to invest more in skill and education which is suggested in literature to be a strong deterrent of crime. Second, if greater female workforce participation empowers women, they are more likely to report crime (Iyer, et. al., 2011). Increased reporting of crime would increase the probability of apprehension and conviction. Higher opportunity cost of criminal engagements should reduce crime rates. Third, increased female workforce participation may provide females with greater bargaining power in the marriage market. This may lead men to invest in human capital to attract a bride with higher ability and receive higher dowry (Anderson, 2007; Dalmia, 2004). Fourth, we can also expect increased female workforce participation to have long run effects on crime if it has social externality effects. There is evidence of changes in social norms with increased participation of females in the workforce. It is shown to be positively associated with investment in children's education, particularly among girls, gender parity, greater acceptability towards role of females in non-traditional tasks and rise in moral standards (Qian, 2008). This change in societal behavior and attitude with increased female workforce participation would lead to a fall in crime rates in the long run (Akerlof, 1980). The existing studies either, only provide evidence on effects of female workforce participation on crime, or crime committed by women. However, this study estimates how female workforce participation may alter opportunity cost of criminal engagement in general and affect crime rate, and not crimes specifically associated with women. We use census data from 1961 till 2001 to derive estimates using pooled OLS with district and year fixed effects.

1.4 Structure of Chapters

The rest of the thesis is organized as follows: Chapter 2 studies the persistent effects of son preference on violent and non-violent crimes. We proxy for son preference with child sex ratio (age 0-6 years), where sex ratio is defined as number of males per 1000 female. The estimates are derived for all the districts of India between 1961 and 2001. Since the boundaries and classification of administrative districts have changed substantially over the period, the chapter discusses the methodology used to generate a balanced panel. We also discuss instrumental variable estimation as the identification strategy.

Chapter 3 studies the association between female education and marital assortative mating in India and analyses if this association is weaker or stronger in dowry prominent districts. The study argues that due to poor returns to female human capital investment in the labour market and low female workforce participation, positive marital assortative mating based on education, in expectations of higher future wage income with increased female education, might not hold for India. This chapter provides a basic theoretical model for the conditions under which positive marital assortative mating on education would be optimal. The model explains the empirical findings from IHDS-II data. Estimates are derived for association between husband and wife's years of schooling and the difference in impact for dowry prevalent districts.

Chapter 4, discusses the relationship between female workforce participation and crime. We provide estimates for the contemporaneous effects of female workforce participation on both violent and non-violent crime rates in India. The empirical strategy discusses the potential endogeneity due to reverse causality for contemporaneous results. Estimates are derived for decade lagged effects of female workforce on crime to circumvent potential reverse causality bias. Persistent effects of increase in female labour market opportunities on crime are also discussed. Robustness and validation checks for the results are provided.

Chapter 5 summarizes the empirical findings and concludes the thesis.

CHAPTER 2: THE PERSISTENT EFFECTS OF SON PREFERENCE ON CRIME IN INDIA: EVIDENCE AND MECHANISMS

2.1 Introduction

According to the 2011 census of India, the child sex ratio (CSR), defined as the number of boys in the age group 0 to 6 for every 1000 girls, is severely skewed at 1094, making it the lowest since independence. There were about 7.1 million fewer girls than boys under the age of six in India. This gap has grown substantially overtime; the 2001 census found 6 million fewer girls, while in 1991 there were approximately 4.2 million fewer girls than boys under age six. Child sex ratios are skewed prenatally due to sex determination and sex selective abortions and postnatally through neglect of the girl child which leads to higher female mortality.

Any imbalances in the CSR are likely to be a consequence of deep-rooted son preferences which is common across several Asian economies. Son preference in India can be explained by a combination of economic, religious and socio-cultural factors. Despite improvements in education and labour market conditions for women, female labour force participation has been declining steadily in India. Thus, it is not surprising that sons considered the main income earners while daughters carry the burden of dowry. The tradition of patrilocality implies that parents expect sons to provide financial and physical care in their old age while daughters join the husband's family when she marries. Moreover, inheritance rights are in favour of sons and several religious rites in Hinduism are performed only by sons.

Skewed sex ratios are also common in other developing countries. Sen (1990) famously noted the magnitude of the problem that in parts of the developing world, more than 100 million women were missing due to gender discrimination. This led to renewed interest in studying the economic and social implications of a skewed sex ratio since much of the early work on sex ratios had focussed on demographic trends, transition and causes of sex ratio imbalances.

Though there are several adverse implications of an unbalanced sex ratio, crime outcomes are one of the most researched[7]. The early literature on the effect of skewed sex ratio on crime focused on the marriage market channel. This literature argued that as sex ratios increased, the marginal product of wives would increase. This increasing marginal product would thereby lead men to invest in themselves to increase their earning potential (Becker, 1974; Angrist, 2002). Females, due to their relative scarcity, will be valued more, leading to greater protection and less violence.

Contrary to this, recent empirical evidence suggests that sex ratio is positively related with reported crime (Dreze and Khera, 2000). The relative shortage of women leads to increased competition for them, potentially resulting in increased violence. Imbalances in sex ratios are found to have accounted for a one seventh increase in crime in China (Edlund, 2013). In India, South et. al. (2014) estimate an association between sex ratio and self-reported victimization cases of theft, breaking, entering and assault. Their findings also suggest that a higher sex ratio is associated with frequent harassment of unmarried females. More recently, Amaral and Bhalotra (2017) find strong effects of an increase in the 20-24 age-specific sex ratio on violence against women in India.

These studies have focussed on the effect of population sex ratio, i.e. the total number of males for every 1000 females in the entire population or in a certain age range of adult population, on crime. But the population sex ratio in a region may change with migration, relative mortality rates, cross-border marriages and anti-female biases in provision of nutrition and health care facilities. While sex ratio at birth favours males, females across all age groups have a lower mortality rate. This is because, if men and women receive similar nutritional and medical care, women tend to live noticeably longer than men. At the same time, males are at a greater risk of premature mortality due to higher propensity to engage in risky behaviours such as alcohol, drug and tobacco consumption or violence.

[7] In the recent paper, Grosjean and Khattar (2018) use historical data on arrival of male convicts to Australia and find that the consequences of uneven sex ratios on cultural attitudes, labour supply decisions, and occupational choices can persist in the long run, well after sex ratios are back to the natural rate.

Thus, it is not surprising that the demographic trends in India show an improvement in overall sex ratio but a worsening of child sex ratio[8].

In this chapter, we are interested in studying the contemporaneous, short run and long run consequence of son preference in India. Using district level data from India, spanning across five census years since 1961, we study the effect of an increase in the CSR on contemporaneous crime, and crime reported 10 years (short run) and 20 years (long run) later.

Ordinary Least Square (OLS) regression of CSR on crime will be biased due to the endogeneity of sex ratio itself. First, omitted variables such a cultural and societal norm that lead to a preference for sons may also determine tolerance towards crime. Second, while a skewed sex ratio may lead to more crime, an unsafe environment in turn may affect son preference. We deal with this identification problem by using instrumental variable (IV) strategy. The IV exploits exogenous district level variation in historical (1961) area under wheat and rice cultivation and across time variation in relative producer prices of wheat and rice[9].

We argue that variation in child sex ratios can be explained by differences in women's economic value - that is driven by the intensity of female participation in agricultural activities (Bardhan, 1974). The higher demand for female labour in rice producing areas makes them more valuable than in wheat producing areas, thus contributing to less discrimination against girls in rice-growing regions. Further, the exclusion of women from production leads to their exclusion from holding property rights, thereby resulting in a stronger preference for the male child (Miller, 1997). Qian (2008) shows that adult income affects the desirability of daughters relative to sons through changing both the consumption and investment value of having a girl relative to a boy. In non-unitary households, a change

[8] India does not compute sex ratios at birth. Thus, child sex ratio is the best proxy available for son preference.

[9] Dreze and Khera (2000) use the labour force participation of women in India as an instrument for sex ratios. However, this may not be an appropriate IV as it may affect crime directly violating the exclusion restriction. In the context of China, the One Child Policy assists with identification by introducing some exogenous variation in sex ratios.

in adult income can also affect the relative desirability of girls by changing the bargaining power of parents (Browning and Chiappori, 1998).

Our data is based at the district level in India, and comes from different sources. The crime data is obtained from the National Crime Records Bureau (NCRB), which processes crime statistics at the national level. The sex ratio and the district level control variables come from the decennial Census statistics from 1961 to 2011. Data on crop-production comes from the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) while the time series data for producer food prices was obtained from the Food and Agriculture Organization of the United Nations (FAO).

Results suggest that an increase in CSR by one boy per 1000 girls under age 6 leads to a significant increase in violent and non-violent crime in the short run (contemporaneous and 10 years later). The results are not robust to alternate specifications in the long run (i.e. 20 years) suggesting that this increase in crime is not driven by the relative shortage of brides leading to more competition and violence.

Using survey data from the Indian Human Development Survey (IHDS-II), we explore the channels through which CSR may affect contemporaneous and short run crime. Our results point to the role of stigma and dowry expectations in explaining the sex ratio and crime relationship. First, a marriage squeeze caused by an increase in the sex ratio should reduce the stigma cost of committing crime since it improves the chances of finding a bride (groom) for an unmarried son (daughter) outside the known network, caste or geography. Consistent with this theory, we find that in districts with high pre-marital sex ratio, marriages are being arranged outside the community/known network. Second, in an institutional setting where the female side of the family bears a disproportionate share of marriage-related expenses, a high pre-marital sex ratio would lower dowry expectations and consequentially lower expected foregone earnings. Consistent with this, we find that an increase in pre-marital sex ratio is correlated with lower work hours and higher consumption.

Our results have significance in the backdrop of trend of masculinization of the sex ratio. In fact, there has been a literature that documents India's missing women but relatively less is known about the consequences of a skewed sex ratio at birth. While much of the literature has focussed on competition and violence due to shortage of brides, to the best of our knowledge, this is the first study that empirically shows the role of social norms and institutions in explaining the sex ratio and crime nexus.

The remainder of the chapter is structured as following. The next section explains the identification strategy and discusses threats to identification. In section 2.3 we present the data and descriptive statistics. Section 2.4 shows the results and sensitivity analysis. Section 2.5 discusses mechanisms driving the results using IHDS-II data and we conclude the discussion in section 2.6.

2.2 Empirical Strategy

Consider the following regression:

$$Crime_{it} = \gamma SR_{it} + \delta X_{it} + S_s + T_t + \epsilon_{it} \quad (2.1)$$

Where SR refers to the population sex ratio (for instance, the sex ratio for the 16-24 or 16-39 age group as is commonly used in the literature) in district i at time t defined as the number of males to 1000 females. X_{it} is a vector of time and district specific controls. S is a state fixed effect and T are time dummies. The population sex ratio composition in a region may, however, change with migration, relative mortality rates, cross-order marriages, anti-female biases in provision of nutrition and health care facilities (Agarwal 1986; Basu 1992; Murthi et. al. 1995; Kaur 2004). Identifying the effect of population sex ratios on crime is thus confounded by the potential self-selection bias in migration and marriage decisions.

On the other hand, any imbalances in the CSR are more likely to be a consequence of deep-rooted son preferences. Since we are interested in studying the long run implications of son preference, we estimate the following regression:

$$Crime_{i,t+s} = \alpha_1 CSR_{it} + \beta_1 X_{i,t+s} + S_s + T_t + \epsilon_{it} \quad (2.2)$$

Where CSR_{it} refers to the child sex ratio at time t in district i, where t ranges over five census years from 1961 to 2001. $Crime_{i,t+s}$ are the reported crime outcomes in district i at time period $t+s$ where s=0,1 or 2. Since we are using decennial census data, s=0 corresponds to contemporaneous crime, s=1 corresponds to crime reported 10 years later and s=2 corresponds to reported crime 20 years later[10]. We control for observable determinants of crime including proportion of scheduled tribe and schedule caste, proportion of population living in the urban areas and the percentage that is literate. Heteroskedasticity robust standard errors are clustered at the state level[11].

This choice of specification also allows us to study the effect of age specific sex ratio on crime. If the 0-6 sex ratio in a district is skewed, we expect the 10-16 and 20-26 age-specific sex ratio in that district to also be skewed 10 and 20 years later, respectively, although subject to a measurement error. This allows us to separately study the effect of imbalances in pre-marital (10-16) and marital-age (20-26) sex ratio on crime.

An OLS regression of sex ratio on crime will be biased due to the endogeneity of CSR owing to two reasons. First, omitted variables can affect both sex ratio and crime. For instance, cultural and societal norms that lead to a preference for sons may also determine tolerance towards crime. These norms may even vary at the district level. Second, while a skewed sex ratio may lead to more crime, an unsafe environment in turn may affect son preference. To address this identification challenge, we use an IV strategy.

2.2.1 Instrumental Variable Strategy

The IV exploits district level variation in historical 1961 area under wheat-rice cultivation and across time variation in relative producer prices of wheat-rice. In particular, we interact the 1961 ratio of wheat-rice area for each district i with the ratio of producer prices in India for wheat relative to rice at time t[12]. Thus, the instrument takes the form;

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[10]Though there is annual crime data in India, sex ratio is only available in the decennial census. We choose not to interpolate sex ratio between census years as has been done by Amaral and Bahlotra (2017) since the sex ratio variable is endogenously determined.

[11] There are 34 states in our sample. Our main results hold when we cluster by state interacted with time, i.e. if we increase the cluster size

[12] A similar identification strategy has been used recently by Nunn and Qian (2014), Peri (2012), Dube and Vargas (2013) and Hanna and Oliva (2015) to study different economic relations. Christian and Barrett (2017) have criticized the use of an IV that exploits temporal variation in an exogenous variable and cross-sectional variation in an endogenous variable. Our IV is not subject to this criticism as we show, in the next subsection, that both variables in our specification (international prices of wheat-rice and historic wheat-rice area) are arguably exogenous.

$$z_{it} = \left(\frac{Area\ under\ wheat}{Area\ under\ rice}\right)_{i,1961} * \left(\frac{producer\ wheat\ price}{producer\ rice\ price}\right)_{t}$$

The following regression show the first stage relation between the instrument and CSR:

$$CSR_{it} = \alpha_2 Z_{it} + \beta_2 X_{it} + S_s + T_t + S * T + \epsilon_{it} \tag{2.3}$$

The use of our IV rests on the literature in psychology and sociology that shows the relation between historical agricultural practices and gender inequality. For example, Ester (1970) argued that societies that traditionally practiced plough agriculture (a relatively male intensive technique of production) - rather than shifting cultivation - developed specialization of production along gender lines. In more recent work, Alesina, Giuliano and Nunn (2013) argue that societies that practiced plough farming hold beliefs that are less gender equal portraying poor participation of females in political, social and financial arenas. Plough farming is intensive in body strength and grip as compared to rice farming which is more labour intensive but requires less strength. This gave males a greater say in financial and social arenas, leaving females to more traditional roles in wheat growing areas. Moreover, these societies have a greater prevalence of attitudes favouring gender inequality[13].

We argue that variation in child sex ratios can be explained by differences in women's relative employment, across districts in India, in rice versus wheat farming. As shown in the maps in Appendix (2A.2 and 2A.3 and 2A.4), Northern and North-Western states of India are found to experience more acute neglect of females as compared to Eastern and Southern states. A predominant reason of this is the regional differences in female workforce participation in agricultural activities. States of East and South are mainly paddy growing states that are intensive in female labour as compared to dry states of North and North West that are mainly wheat producing and use more male intensive methods of

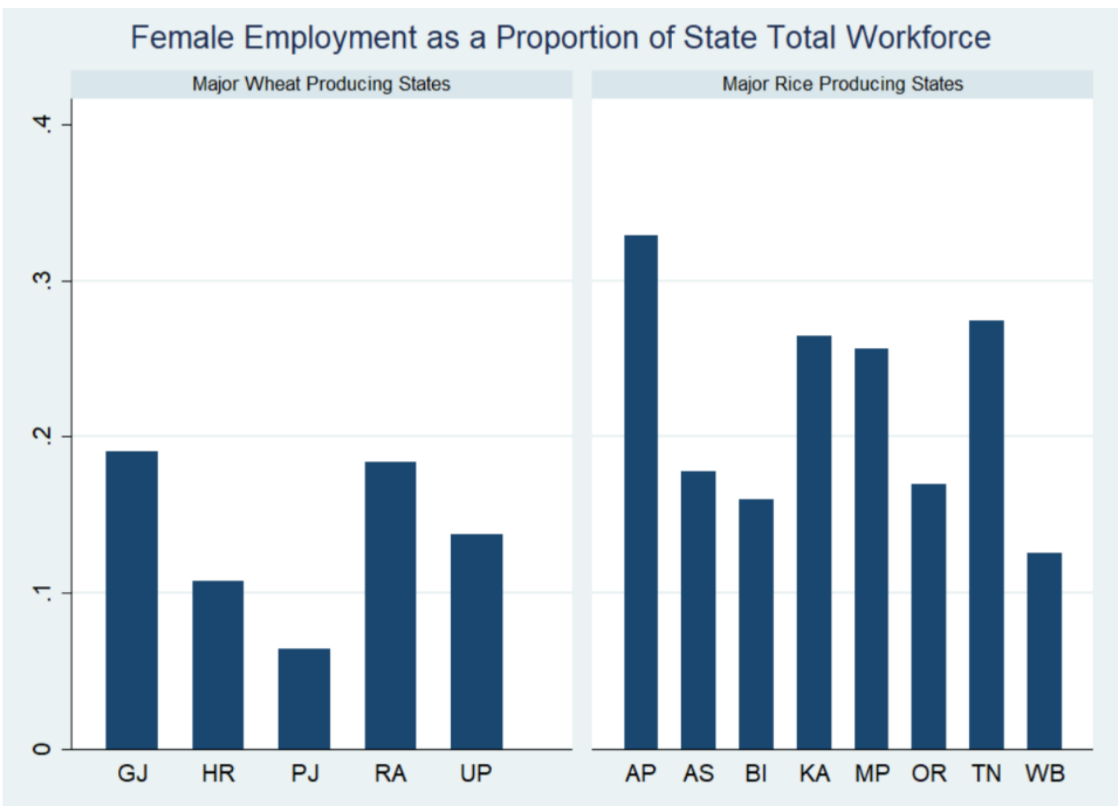
[13] The appendix provides a visual description of regional variation in sex ratio. North and North-West India states in India that are found to experience more acute neglect of females as compared to Eastern and Southern states. The latter are mainly paddy growing states that are intensive on female labour as compared to dry states of North and North West that are mainly wheat producing and more intensive on male labour.

production. This preference, therefore, is an important factor that drives the sex ratio differentials.

Figure 2.1 shows the female employment as a proportion of total state workforce for the major rice and wheat producing states of India[14]. The major rice producing states include Andhra Pradesh (AP), Assam (AS), Bihar (BI), Karnataka (KA), Madhya Pradesh (MP), Orissa (OR), Tamil Nadu (TN) and West Bengal (WB). The wheat producing states include Gujarat (GJ), Haryana (HR), Punjab (PJ), Rajasthan (RA) and Uttar Pradesh (UP). As is evident from the figure, female employment shares, on an average, tend to be higher in rice producing states relative to wheat producing states.

We test this hypothesis by regressing male-female employment ratio on the wheat rice ratio (in area hectares) controlling for all variables described in equation 2.2.

Figure 2.1: Female Employment for rice and wheat producing states



[14] The employment data is from the decennial census while the crop production data is from ICRISAT. The next section describes this data in details.

As shown in the first column of Table 2.1, models with state and time fixed effects yield positive and highly statistically significant results (at 1 per cent level). This suggests that as the area under wheat production increases relative to rice production, the proportion of males relative to females in the workforce increases. Column (2) regresses CSR on the ratio of male to female employment. Proportion of males to females in employment is positively correlated with CSR. Though these estimates are not causal, they are suggestive of a channel through which the IV affects CSR.

Table 2.1: Child Sex Ratio (0 to 6), Male-Female Employment, and Wheat-Rice Area

	Dependent Variable	
	Male/Female Employment	Sex Ratio (0 to 6 Age Group)
Wheat-Rice (Area) Ratio	54.742**	
	(20.589)	
Male to Female Employment		1.722***
		(0.534)
Proportion Schedule Caste	-6.192	49.944
	(11.572)	(58.937)
Proportion Schedule Tribe	-7.405*	-67.373***
	(3.761)	(24.314)
Proportion urban	16.477*	28.988*
	(9.374)	(16.612)
Proportion Literate	-22.619	13.921
	(17.890)	(36.310)
Observations	1542	1589

Dependent variable is proportion of males to females in workforce as a percentage of district population.
All regressions include state and time fixed effects
Robust Standard errors in parentheses * significant at 10%; ** significant at 5%; *** significant at 1%

The available literature suggests that there has been substantial change in the area under wheat and rice cultivation, specifically in South Asia (Huke and Huke, 1992). Byerlee (1992) finds that increasing supplies of irrigation water made a major contribution to increasing areas under cereal production in 1960s and 1970s in most of South Asia. Tong, Hall and Wang (2003) finds cultural-economic changes and government policies as major contributors to changes in land use in rice, wheat and maize production in China. In general, factors such as changes in land policies, migration, urbanization, agricultural product prices and world trade strongly affected use of land.

Though increasing irrigation facilities and improvement in agricultural technology such as hybrid seeds are less likely to have evolved simultaneously with crime rate, yet institutional changes and other socioeconomic factors that impacted land use could have influenced criminal engagements. Thus, area under cultivation, when used directly as an instrument, may not be completely exogenous to crime. To circumvent this problem, our instrument relies on exogenous cross-sectional variation in historical (1961) area under cultivation.

The choice of the year 1961 is driven by both the historical and institutional context and availability of data. In general, soil type, rainfall and altitude height are the key determinants of cropping patterns, which without significant technological advancement is unlikely to affect the natural patterns[15]. Banerjee and Iyer (2005) argue that the crop choices under the British government were strongly driven by the geographical advantages[16]. The British government appropriated a fixed amount of tax revenue from the landlords with the landlord rights on the remaining part of the revenue. This generated an environment of maximal extraction from the peasants with little investment. With little incentive by the government to invest in agricultural growth in landlord areas, the farmers produced localized crops. The area share of both rice and wheat were found to be higher in landlord areas as compared to cash crops that required systematic investment. Moreover, the establishment of landlord versus non-landlord system itself was exogenous as the choice of land tenure system was done for large adjacent areas with small information set on local characteristics. The provinces that were conquered earlier tended to have landlord system. Hence, an argument that revenue systems were established considering the social and geographical conditions that could have been related to sex ratio is unlikely.

The earliest post-independence district level crop data which can be mapped across recent administrative divisions of India is 1961[17]. With hardly a decade into independence and green revolution pacing in only in the late 1960s, the farmers had little choice in the interim

[15] Recent evidence by Carranza (2014) suggests that soil quality is an important determinant of agricultural practices. She uses the exogenous fractions of loamy and clayey soils across districts in India as instruments for relative female employment to show its effect on child sex ratio.
[16] The British left India in 1947.
[17] We discuss in the data section and in the appendix the methodology used to map districts using population weights.

years but to exploit the given geographical advantages in choice of crop farming. The government of India, faced with food-grain shortages from mid-1964, coupled with rainfall deficit in the mid-1960s, set up the Food Corporation of India (FCI) and an Agricultural Prices Commission (APC) in the latter half of 1960s. Thus, it was only after the mid-1960s that India embraced high-yielding varieties of wheat under the Green Revolution. Thus, the cross-sectional variation in 1961 area under rice and wheat cultivation should be exogenous to any other unobserved determinants of sex ratio.

2.2.2 Threats to Identification

Our identification strategy would be invalid if the IV affects crime measures through channels other than the sex ratio. In this section, we address some threats to this exclusion restriction by arguing that both international producer prices and historical area under wheat and rice cultivation are exogenous to factors, other than CSR, that could also influence district level crime outcomes.

Our instrument would be invalid if areas that historically produce rice are culturally different from wheat producing areas and those same cultural differences persist and affect crime rates. For instance, Talhelm et al. (2014) argue that a history of farming rice makes cultures more interdependent, whereas farming wheat makes cultures more independent, and these agricultural legacies continue to affect people in the modern world.

However, Roberts (2015) refutes the findings of this study on data grounds. Further, several researchers (Allik and Realo, 2004; Henrich, Heine and Norenzayan, 2010) show that individuals from America, in regions dominated by corn and wheat production own similar or even greater holistic attributes than China. Hence, historical area under wheat-rice production should not hold any significant relationship with social or psychological attributes such as empathy or universal approach. Moreover, even if the agricultural patterns are related to behavioural attitudes or institutions, these cultural and institutional factors should not vary significantly across districts within a state. Districts in India are relatively homogeneous within a state and most migration occurs within states (Dyson and Moore, 1983; Foster and Rosenzweig, 1999). Any inter-state differences are accounted for in the panel analysis where we control for state fixed effects. We also conduct a robustness exercise in section 2.4.3 where we include in the regression a proxy for cultural differences across rice and wheat producing areas. As we show later, our main conclusions are robust to this alternate specification.

The across time variation in the IV comes from international prices of agricultural commodities which is arguably exogenous to any other determinants of district level crime in India. One concern is that the Indian government policies provide minimum support to farmers that protects them against market volatility. Thus, it could be argued that agricultural production is not sensitive to global producer prices. Existing studies, however, suggest a strong positive association between global prices of staple cereals such as wheat and rice and domestic market prices. Moreover, the policy responses of government are closely driven by the volatility in the international markets (Dorosh, 2009; Jones and Kwieciński, 2010). Global producer prices thus offer a close proxy to agricultural prices in the domestic market.

In a particular year, adverse weather shocks may affect the production or prices of food-grains and prevailing economic conditions. These may affect crime through channels other than sex ratios. However, since prices are included with a 10 or 20-year lag, they are unlikely to be associated with current crime rates except when we study contemporaneous crime. Nevertheless, we include average district level rainfall in the census year as an additional control variable in all regressions to capture the effect of weather on crop yield as well as directly on crime. Controlling for rainfall also addresses a related concern. cross-district differences in the value of agricultural production may affect relative incomes and thus crime. For example, if the value of wheat production increases relative to rice, then incomes may rise relatively in wheat producing areas and that can have an independent effect on crime. We include rainfall in all regressions following the large body of literature that uses weather shocks as a proxy for household income at the district level (Iyer and Topolova, 2014).

Finally, there may be changes over time within a state in education, policing or other variables that might affect crime. Since the data varies across districts within a state, our main specification thus controls for state and time interactions as shown by the interaction term $S * T$ in the first stage equation 2.3 above.

2.3 Data

The analysis required data on crime and sex ratios at the district level since 1961, crop production data for the year 1961 across all Indian district and time series international producer food price data for India since 1961. Since the only source of data for district level sex ratios is the decennial census, we gathered information on sex ratio and other control variables from the five decennial censuses between 1961 to 2001. We also obtain data from the census on total population, proportion of schedule tribe and schedule caste, proportion of population living in urban areas and the proportion that is literate.

2.3.1 Mapping Districts

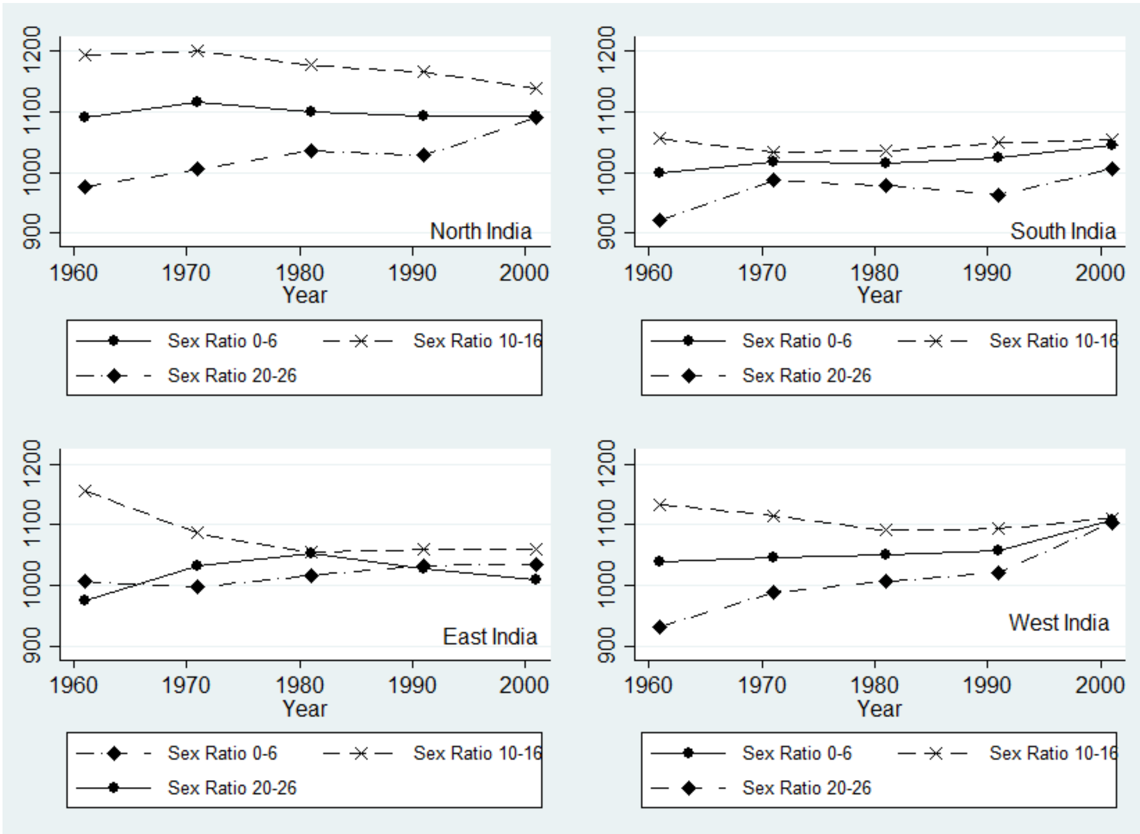
Districts in India are the third geographic tier for data dissemination after national and state-level tiers. Geographical structure of Indian districts has changed significantly since 1961. Not only has the number of districts increased from 340 in 1961 to 593 in 2001, but there have also been changes to the boundary of districts as a result of amalgamations and partitions within existing districts.

The changing boundaries of Indian districts across the census years make it difficult to control for historical, geographical and social characteristics relevant for the study. We create a balanced panel of districts over different time periods using district population weights to map districts. The weights are used to map districts for each period to the administrative divisions in 1971. This exercise leaves us with a balanced panel of 333 districts in each census year. More details of the methodology used to create a balanced panel is provided in the Appendix 2A.1.

2.3.2 Data on sex ratio

The age-specific sex ratio is measured as the number of males per 1000 females in the age-specific population. Figure 2.2 shows data on trends across regions of India in the CSR and age-specific sex ratios for ages 10 to 16 and 20 to 26 for the period 1961 to 2001. As noted earlier, states of East and South are mainly paddy growing states that are intensive on female labour as compared to dry states of North India that are mainly wheat producing and more intensive on male labour. In figure 2.2, we compare trends in sex ratio across the different regions of India[18].

Figure 2.2: Region wise trends in age-specific sex ratio (1961-2001)



There are few observations worth noting. First, the sex ratio for the 10 to 16 ages is higher than the CSR and 20-26 sex ratio across all regions, though the disparity is highest in North India. The skewed sex ratio for older children could be driven by gross neglect of the girl child after birth. If resources are limited, sons may get preferential treatment over daughters in household allocation of food and medical resources. However, it is also possible that there are gender differences in the incidence of illnesses. For instance, Anderson and Ray (2010) decompose male-female death ratios in developing countries by disease, and find

[18]There are only two Western states, Maharashtra and Gujarat. Northern states include Bihar, Punjab, Chhattisgarh, Delhi, Haryana, Himachal Pradesh, Madhya Pradesh, Punjab, Rajasthan, U.P. and Uttarakhand. States in East India include Arunachal Pradesh, Assam, Jharkhand, Manipur, Meghalaya, Mizoram, Nagaland, Orissa, Sikkim, Tripura and West Bengal. Kerala, Andhra Pradesh, Karnataka and Tamil Nadu form the Southern states.

that at younger ages, infectious, nutritious and reproductive ailments cause excess female deaths.

Second, the CSR has worsened over time for the entire country. In 1961, there were an average of 1049 boys per 1000 girls which increased to1071 boys per 1000 girls in 2001[19]. This could be due to the advancement in technology that allows for sex determination and sex selective abortions. On the other hand, the sex ratio for the general population has not changed much between 1961 and 2001. The regional decomposition shows that south and west India have witnessed an increase in the CSR, East India has seen a significant improvement while the CSR in North India has been stable across the years.

Another interesting observation is the trends in 20-26 age-specific sex ratio. Given the wide disparity between the CSR and the 20-26 sex ratio, it is evident that the 20-26 sex ratio is not a good measure of son preference. However, we also observe a gradual convergence overtime between the CSR and the age-specific sex ratios across all regions of India.

2.3.3 Data on crime and other variables

Crime data is obtained from National Crime Records Bureau (NCRB), India. The Bureau provides district level annual crime data since 1971. Violent crime is measured as the sum of murders, attempt to murder, rape, kidnapping, dacoity and riots. Non-violent crime comprises of robbery, burglary, theft, criminal breach of trust, cheating and counterfeiting. The crime variables are measured as per 100,000 persons in the district to account for population differences.

In Table 2A.3 we present the descriptive statistics for disaggregated crime. Crime rates are highest for theft followed by burglary and riots.

In Figure 2A.1, we present the region wise trends in crime in India between 1971 to 2001. For violent crime, trends are almost parallel across regions with an increase in violent crime between 1970s to 1990s and then a decline in the 1990s. In recent times, the Northern part of India had the highest rates of violent crime while the Western part of India has had

[19]In 2011, India's general sex ratio, which takes into account men and women of all ages, stood at 1060 per 1000 females while child sex ratio increased further to 1089.

lowest rates of violent crime since 1970s. On the other hand, non-violent crime is highest in Western India since the 1980s and gradually declining over time in North India.

Data on area under production for Wheat and Rice (in hectares) is obtained from International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). The time series data for producer food prices was obtained from the Food and Agriculture Organization of the United Nations (FAO). Figures 2A.3 and 2A.4 in the Appendix show the visual distribution of rice and wheat production across the country.

2.3.4 Summary Statistics

Table 2A.4 shows descriptive statistics for key variables used in the analysis by census year. The average CSR is 1068 males to 1000 females for the entire country. Note that the biologically normal sex ratio at birth is 1050 males for every 1000 females. Thus, the CSR is severely unbalanced in India suggesting the role of parental preferences in favour of male child. Average literacy over the past four decades is 39 per cent. The average rate of reported violent crime is 0.07 per cent while that for non-violent crime is 0.021 per cent. In terms of the trends, while the average CSR in 1961 was 1052 men for every 1000 women, this worsened to 1079 males by 2001. Literacy rates have steadily increased in India since 1961 with more than a twofold jump.

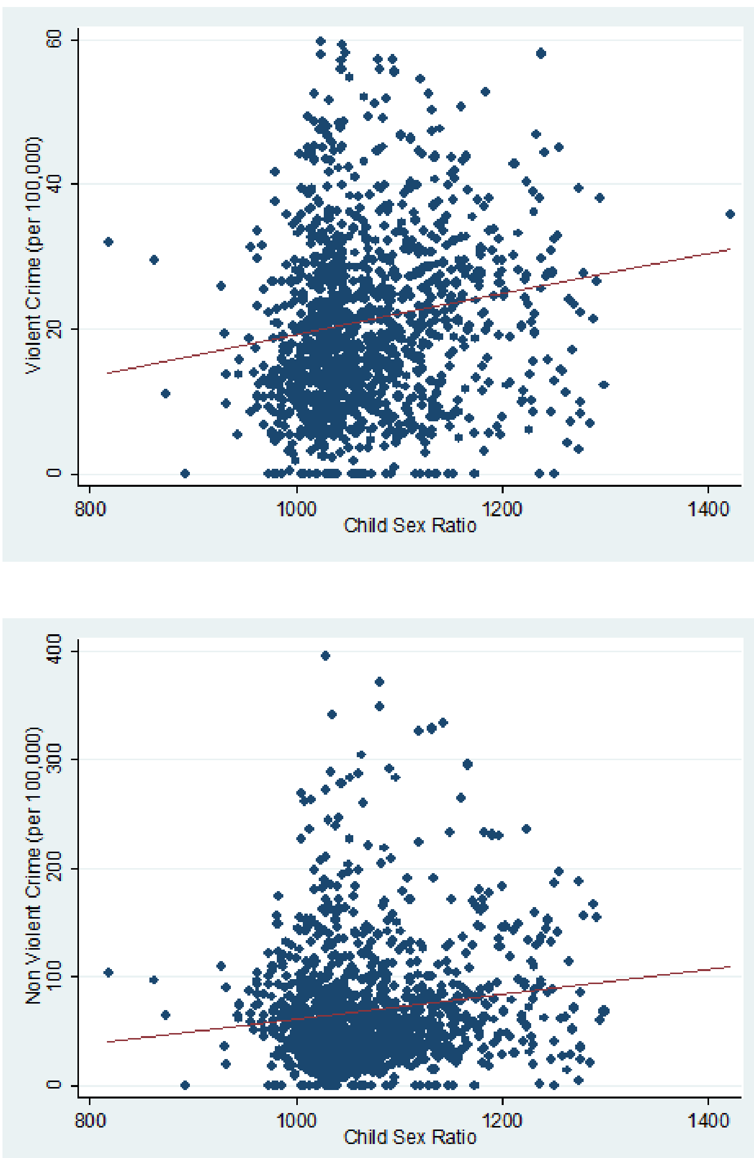
In line with the crime rates in the U.S., it is interesting to note that both violent and non-violent crime has declined dramatically in the 1990's with non-violent crime declining by almost 40 per cent and violent crime by 27 per cent[20]. When we look at the disaggregated crime data, much of the decline in violent crime is due to a decline in incidence of dacoity and murder. In the case of non-violent crime, there was a large decline in riots and property crime (burglary, robbery and theft). This time period also coincides with both economic liberalization in 1991 and the 73rd Amendment Act to the Constitution of India in 1991 which led to considerable political, administrative and fiscal decentralization. The Pre-Conception and Pre-Natal Diagnostic Techniques (PCPNDT) Act was also passed in 1994 which made prenatal sex determination illegal. It is worth noting that several major

[20]Levitt (2014) finds that in the US the dramatic decline in the crime rates in the 1990s can be attributed to increased incarceration, more policing, decline of drugs and legalized abortions.

political, social and economic changes took place in India in the 1990s which could explain the fall in crime rates.

A visual inspection of child sex ratio and crime rates in Figure 2.3 provides some preliminary evidence to show that higher CSR is associated with an increase in violent and non-violent crime. The first panel shows the correlation between violent crime and child sex ratio, while the second panel shows the correlation between non-violent crime and child sex ratio.

Figure 2.3: Child Sex Ratio and Crime scatter plot



2.4 Results

2.4.1 OLS Estimates

Table 2.2 shows results from OLS regressions corresponding to equation (2.2). Columns 1 and 2 show the results for the contemporaneous effect of CSR on aggregate measures of crime. Columns 3 and 4 show the effect of CSR on short run crime i.e. crime reported after 10 years later while the last two columns show the effect in the long run (20 years). The preferred specification with all control variables, state and time fixed effects and state-time interactions shows that CSR affects violent crime but the estimates are insignificant for non-violent crime. Moreover, the coefficients increase marginally over time ranging from 0.037 in column 2 for contemporaneous crime to 0.46 in column 6 for crime reported after 20 years. There is a drop in sample size in the last two columns since we are looking at crime outcomes in three census years (1981, 1991 and 2001) after lagging sex ratio data by two decades.

The magnitude of coefficients implies one more male per 1000 females in the 0 to 6 age group leads to a 0.18 percent to 0.21 percent increase in violent crime (Relative to a mean of 21 registered records of violent crime per 100,000 population). These results are consistent with Amaral and Bhalotra (2018) who find that an increase in the 20-24 age sex ratios leads to an increase in violent crime, but not property or economic crime.

Table 2.2: OLS estimates of the effect of Child Sex Ratio on Aggregate Crime Measures

	t=0 (Sex Ratio 0 to 6)		**t=1 (Sex Ratio 10 to 16)**		**t=2 (Sex Ratio 20 to 26)**	
	(1)	(2)	(3)	(4)	(5)	(6)
Non-violent Crime	0.087	-0.003	0.002	-0.007	0.002	0.004
	(0.090)	(0.071)	(0.025)	(0.021)	(0.029)	(0.033)
R-squared	0.43	0.51	0.43	0.51	0.55	0.54
Violent Crime	0.039***	0.037***	0.039***	0.042***	0.044***	0.046***
	(0.014)	(0.012)	(0.011)	(0.010)	(0.011)	(0.010)
R-squared	0.39	0.44	0.39	0.45	0.40	0.43
Observations	1018	1018	1006	1006	787	787
State & Time Dummies	YES	YES	YES	YES	YES	YES
State & Time Interaction	NO	Yes	NO	Yes	NO	Yes

Robust standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%
Crime is measured per 100,000 of population. Additional controls are proportion SC, ST, urbanization, literacy rate and rainfall

2.4.2 Instrumental variable Estimates

We now turn to the IV results. First stage estimates suggest that wheat-rice ratio has a positive effect on sex ratio. The coefficient on the instrument is negative and statistically significant at 5 % level. The F-statistics ranges from 22 to 39.

The IV estimates presented in Table 2.3 suggest that the OLS estimates are severely downward biased. This could be due to omitted factors that simultaneously affect CSR and crime. For instance, more prosperous districts have greater information and access to sex determination technology leading to a skewed CSR. At the same time, more prosperous districts may have lower rates of crime. Similarly, the same economic conditions in a district that lead to skewed CSR may also lead men to migrate out of districts looking for work. This would imply a lower working age sex ratio leading to an incapacitation effect on crime (Chiapa and Viejo, 2012).

The contemporaneous and short run effects on crime are positive and significant (at the 1% level) with or without including state and time interactions. The magnitude of the effect is largest for crime reported 10 years later. While the IV estimates are not sensitive to including state and time interactions in the contemporaneous and short run effects, the results change in columns 5 and 6 when we study the long run effect on crime. The 20-year post crime outcomes are positive and significant only with the inclusion of state and time interactions. This could possibly reflect that in the long run there might me changes in other economic variables that may also simultaneously affect crime.

Comparing the estimates with state and time interactions, we find that both contemporaneous and short run incidents of violent crime increased by approximately 0.25 when CSR increases by one male per 1000 females. This constitutes a 1.2 percent increase relative to a mean of 21 registered records per 100,000 population. In the case of non-violent crime, there is a 0.7 percent and 0.9 percent increase in contemporaneous and short run crime respectively. These numbers are relative to a mean of 68 registered records per 100,000 population for non-violent crime. The long run estimates imply an increase in violent crime by 0.8 percent and 0.6 percent for non-violent crime.

Table 2. 3: Instrumental variable estimates of the effect of Child Sex Ratio on Crime Measures

	t=0 (Sex Ratio 0 to 6)		t=1 (Sex Ratio 10 to 16)		t=2 (Sex Ratio 20 to 26)	
	(1)	(2)	(3)	(4)	(5)	(6)
Non-violent Crime	0.455***	0.476***	0.609***	0.581***	0.347	0.431**
	(0.163)	(0.133)	(0.130)	(0.137)	(0.311)	(0.188)
R-squared	0.33	0.37	0.20	0.30	0.34	0.40
Violent Crime	0.271***	0.248***	0.236***	0.243***	0.152	0.168**
	(0.046)	(0.044)	(0.041)	(0.040)	(0.093)	(0.071)
R-squared	0.01	0.05	0.01	0.05	0.29	0.29
Observations	1017	1017	1006	1006	787	787
State & Time Dummies	YES	YES	YES	YES	YES	YES
State & Time Interaction	NO	Yes	NO	Yes	NO	Yes

Robust standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%

Crime is measured per 100,000 of population. Additional controls are proportion SC, ST, urbanization, literacy rate and rainfall

Note that the crime data spans from the Census years of 1971 to 2001 for the short run effects and 1981 to 2001 for the long run effects. If we drop 1971 from the analysis, so that sample size is comparable across the three columns, estimates do not change and continue to be large and highly statistically significant in column (2).

To put the results in context, between 1961 and 2001, the number of boys per 1000 girls in the 0-6 cohort increased from 1053 to 1077; a 24-point increase. According to our estimates, this would have resulted in at least a 28.8 percent increase in violent crime and a 17 percent increase in non-violent crime over the last four decades. These numbers are comparable with previous estimates from India. South et. al. (2014) combine both the pre-marital and marital age-groups and estimate the effect of sex ratio among 15-39 year olds on self-reports of victimization rates. They find that over a 20-year period, (between 1981 to 2011) the fall in sex ratio amounted to an 8-11 percent increase in theft/house break-in and 11 percent increase in assault.

Table 2.4: Effect of Sex ratio on Disaggregated Crime Rates: OLS &IV Estimates

	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	IV	OLS	IV	OLS	IV
	t=0 (Sex Ratio 0 to 6)		**t=1 (Sex Ratio 10 to 16)**		**t=2 (Sex Ratio 20 to 26)**	
Murder	0.009***	0.060***	0.012***	0.051**	0.012***	0.051*
	(0.003)	(0.020)	(0.002)	(0.021)	(0.003)	(0.025)
Attempt to Murder	0.003	0.057***	0.006***	0.047***	0.010***	0.043**
	(0.002)	(0.011)	(0.002)	(0.007)	(0.003)	(0.017)
Rape	-0.001	0.005***	-0.000	0.005***	0.000	0.003
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.004)
Kidnapping	0.005*	0.030***	0.005***	0.031***	0.005*	0.021*
	(0.002)	(0.007)	(0.002)	(0.005)	(0.002)	(0.012)
Dacoity	0.005***	0.003	0.006**	0.006	0.001**	0.003
	(0.002)	(0.003)	(0.002)	(0.004)	(0.000)	(0.002)
Riots	0.014	0.067***	0.016	0.086***	0.018**	0.030**
	(0.008)	(0.010)	(0.011)	(0.015)	(0.007)	(0.012)
Burglary	-0.011	-0.141***	-0.014**	-0.195***	0.008	-0.066
	(0.016)	(0.032)	(0.006)	(0.028)	-0.009	0.049
Theft	-0.007	0.418***	0.011	0.543***	0.003	0.246**
	(0.043)	(0.096)	(0.015)	(0.107)	(0.018)	(0.101)
Robbery	0.007	0.060***	0.006**	0.076***	0.003	0.035***
	(0.006)	(0.008)	(0.003)	(0.016)	(0.002)	(0.004)
Counterfeiting	-0.000	-0.004	0.000	-0.005*	-0.001	-0.007**
	(0.001)	(0.002)	(0.001)	(0.003)	(0.001)	(0.003)
Cheating	-0.003*	0.014*	-0.002*	0.016	-0.002	-0.006
	(0.002)	(0.007)	(0.001)	(0.012)	(0.002)	(0.023)
Breach of Trust	-0.002	0.013	-0.001	0.016	-0.000	0.005
	(0.001)	(0.010)	(0.001)	(0.016)	(0.001)	(0.018)
N	1000	999	991	991	772	772

Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Crime is measured per 100,000 of population

Regressions also control for proportion SC, ST, urbanization, literacy rate and rainfall

State and Time fixed effects and interactions included

In Table 2.4 we show the effect of CSR on disaggregated crime. OLS is downward biased for most outcomes and the IV estimates suggest that in the short run, the CSR has a significant positive effect on arrests due to murder and attempt to murder, rape, kidnapping, theft, robbery and riots. There is a negative effect on arrests due to burglary. In the 20-year period, the negative effect is significant for murder (1 percent level), attempt to murder and riots in violent crime measures. There is also a positive effect on theft and robbery while the effect on counterfeiting is negative.

2.4.3 Robustness Checks

The IV uses producer prices of rice and wheat at time period t. It is possible that the relative economic value of females might be more sensitive to the long run relative price of crops rather than a one period price. We, therefore, create an alternate instrument that uses a five-year average producer price. The results are shown in Panel A in Table 2.5 and are robust with the new instrument.

Gender and marriage norms between rural and urban areas vary within India and this might affect labour market opportunities differentially between males and females. For instance, in rural areas shortage of brides may be more acute as families may be reluctant to send their daughters to the poorest districts. Moreover, it is not unheard of in India that women from the poorest districts are married off in richer districts. In Panel B we show results dropping the top 10 percent most urban districts and bottom 10 percent most rural districts. The coefficients for the contemporaneous and 10-year effects are much larger in magnitude for non-violent crime and continue to be highly statistically significant for violent crime. On the other hand, all estimates become statistically insignificant for the effect on long run measures of crime. This suggests that the effect of CSR on long run crime outcomes may be driven by differences in gender and marriage norms in the most urban and rural districts of India.

In Panel C, we drop districts with extreme values of historical (1961) wheat-rice ratio. The districts with no or very small values of wheat and rice production are deleted (those which lie below the 20th percentile of the wheat rice distribution) and we also exclude districts in the top end (95th percentile and above) of the 1961 wheat-rice ratio distribution. All estimates are robust to deleting extreme values of historical wheat and rice ratio.

Table 2.5: Sensitivity Analysis-I

	t=0 (Sex Ratio 0 to 6)	**t=0 (Sex Ratio 0 to 6)**	**t=0 (Sex Ratio 0 to 6)**
	Panel A: Using Average Prices		
	(1)	(2)	(3)
Non-violent Crime	0.495***	0.576***	0.474**
	(0.162)	(0.135)	(0.191)
Violent Crime	0.255***	0.258***	0.171**
	(0.046)	(0.039)	(0.071)
Observations	1017	1006	787
	Panel B: Omitting top 10% Urban & bottom 10% rural Districts		
Non-violent Crime	0.696***	0.985***	1.061
	(0.214)	(0.339)	(0.884)
Violent Crime	0.191***	0.230**	0.139
	(0.037)	(0.086)	(0.214)
Observations	837	833	657
	Panel C: Omitting districts with extreme values of historical wheat-rice ratio		
Non-violent Crime	0.492***	0.558***	0.536***
	(0.142)	(0.147)	(0.144)
Violent Crime	0.274***	0.253***	0.223***
	(0.033)	(0.026)	(0.026)
Observations	851	843	655

Robust standard errors in parentheses. Crime is measured per 100,000 of population.

Controls for SC, ST, urbanization, literacy rate and rainfall

State and Time fixed effects and state time interactions included

* significant at 10%; ** significant at 5%; *** significant at 1%

Next, we check whether our results are driven by any particular year in our sample. The results for contemporaneous and short run crime are robust while the long run effects are insignificant when we drop census year 1981 from the sample (See Table 2.6).[21]

[21] We also check the robustness of our results by including region fixed effects after dividing all states into four major regions of India. All estimates are robust to inclusion of region fixed effects. The coefficients are also robust to dropping one state at a time from the analysis.

Table 2.6: Sensitivity Analysis-II: Dropping years

	Dropping Year 2001			**Dropping Year 1981**		
	(1)	(2)	(3)	(4)	(5)	(6)
	t=0	**t=1**	**t=2**	**t=0**	**t=1**	**t=2**
Non-violent						
Crime	0.562***	0.464***	0.459***	0.170***	0.365**	0.077
	(0.176)	(0.105)	(0.156)	(0.061)	(0.172)	(0.049)
Violent Crime	0.347***	0.202***	0.160*	0.212***	0.331***	0.149**
	(0.046)	(0.037)	(0.083)	(0.032)	(0.074)	(0.061)
Observations	753	768	529	776	765	546
	Dropping Year 1991			**Dropping Year 1971**		
Non-violent						
Crime	0.574***	0.671***	0.977***	0.621**	0.665**	0.432**
	(0.166)	(0.197)	(0.333)	(0.234)	(0.239)	(0.188)
Violent Crime	0.177***	0.211***	0.205***	0.315***	0.250***	0.168**
	(0.043)	(0.038)	(0.070)	(0.076)	(0.085)	(0.071)
Observations	752	726	499	770	759	787

Robust standard errors in parentheses. Crime is measured per 100,000 of population.

State and Time fixed effects and state time interactions included.

Controls for SC, ST, urbanization, literacy rate and rainfall

* significant at 10%; ** significant at 5%; *** significant at 1%

A concern with our identification strategy is that omitted variables such as culture, attitude and preferences may affect the agricultural production and at the same time tolerance towards crime. Our instrument would be invalid if areas that historically produce rice are culturally different from wheat producing areas and those same cultural differences persist and affect crime rates.

Assuming that areas that produced more rice in 1961 were culturally different from areas that produced more wheat, we can divide all districts into four groups: regions that were primarily rice producing, primarily wheat producing, producing both and producing none. Based on this we define a variable that takes four values corresponding to the above four categories. We use the 1961 median area under rice cultivation (148948 hectares) and median area under wheat cultivation (22258 hectares) for the entire country to generate this variable. Thus, a district in 1961 will be primarily rice (wheat) producing if it utilizes more than the median area for rice (wheat) cultivation and less than median area for wheat (rice) cultivation. If the district is producing both rice and wheat and utilizing above median areas for cultivation of both, we identify it as producing substantial amounts of both commodities. Similarly, if the areas for rice and wheat in a district are lower than the corresponding medians, we identify it as a district that is not specializing in any particular commodity. We check the robustness of our main IV results to the inclusion of three dummy variables for this proxy for culture. In this specification, the identification comes from variation in wheat-rice ratio among districts within a state that are similar in their cropping patterns.

As shown in Table 2.7, the IV estimates show a significant impact of child sex ratio on contemporaneous and short run violent and non-violent crime, and the magnitudes of the coefficients are comparable to the main specification shown earlier. Once again, the long run results disappear upon inclusion of the proxy for culture. The results thus confirm that our contemporaneous and short run results are not biased due to some unobserved district specific effects.

Table 2.7: IV estimates of the effects of the Child Sex Ratio on Crime (Culture Robustness)

	(1)	**(2)**	**(3)**
	t=0	t=1	t=2
Non-violent Crime	0.524**	0.634***	0.406
	(0.242)	(0.166)	(0.274)
Violent Crime	0.257***	0.233***	0.138
	(0.081)	(0.068)	(0.106)
Observations	1017	1006	787
State & Time Dummies	YES	YES	YES
State & Time Interaction	Yes	Yes	Yes

Robust standard errors in parentheses. * significant at 10%; ** at 5%; *** at 1%

Crime is measured per 100,000 of population.

Includes proportion SC, ST, urbanization, literacy rate and rainfall

To sum up, the long run effects are not stable to alternate specifications suggesting that there are no long run effects of son preference on crime. On the other hand, we find that an increase in child sex ratio leads to a significant increase in both contemporaneous crime and crime reported 10 years later. In the next section, we discuss the possible mechanisms driving our result. We argue that while previous literature has largely focused on the effect of sex ratio at marriageable age on crime, in the Indian context, it is the imbalances in the pre-marital sex ratio that has serious social and economic implications.

2.5 Mechanisms

Theoretically and statistically, decades of son preference may affect crime for several reasons, both in the short run and long run.

First, cultural norms that lead to son preference may also determine tolerance towards crime. Oldenberg (1992) suggests that in a society predominated by crime, son preference arises as men in the family provide security against violence, while women are seen as a liability. These norms could have long lasting implications on crime. Note that if the exclusion restriction is met, our IV specification rules out this channel of causality. As we have shown in the robustness, cultural factors cannot explain the effects on crime that we find in this chapter.

Second, in its most extreme form, son preference is manifested in violent forms such as female infanticide and the prevalence of sex-selective abortions. If there is state dependence in criminal behaviour, we may see an increase in subsequent criminality. This would increase both short run and long run crime. The absence of long run effect of CSR on crime suggests that there is no such persistence in criminality.

Third, an unbalanced CSR may affect the ability of these excess males to find brides and subsequently lead to violence in the long run. Since the long run effects are not robust to several sensitivity tests, we can conclude that the marriage market channel cannot explain the relation between violence and CSR in the Indian context.

Fourth, in a recent paper, Cameron, Meng and Zhang (2017) find that growing up in a high sex ratio environment makes boys more risk-loving and slightly more neurotic and that this in turn makes them more likely to commit crimes in adulthood. However, we do not find evidence of such persistent effects into adulthood.

Fifth, a higher sex ratio may also lead to more crime if men are more crime prone than women. Chiapa and Viejo (2012) argue that the positive relation between sex ratio and crime can be explained by this incapacitation effect i.e. males are statistically more likely than females to commit or be the victims of crime. Since we are studying the effect of sex ratio for ages 0 to 6, there is no incapacitation effect in our analysis. Thus, this mechanism cannot explain our results.

To sum up, none of the above-mentioned channels can explain the effect of child sex ratio on crime that we see in the short run. We look at the existing literature for an alternate explanation of our results that goes beyond the incentives for crime traditionally studied by economists. One such social influence for criminal behaviour is stigma. Stigmatization imposes costs on offenders if it limits their social or professional interaction with others. Rasmusen (1996) explains that stigma can be either economic (in terms of lower wages) or social (for example, difficulty in finding a spouse). Similarly, civic norms may attach guilt and shame to criminal behaviour, thus increasing its opportunity cost (Buonanno, Montolio and Vanin, 2009).

The fear of not finding a prospective groom increases the social opportunity cost of committing crime. A marriage squeeze caused by an increase in the sex ratio should reduce the social cost of stigmatization since it improves the chances of finding a bride/groom for an unmarried son/daughter. Larsen and Kaur (2013) and Kaur (2010, 2012) document the relaxation of rigid marriage norms including cross-border marriages, marriages outside caste and clan in the northern states of India (where, sex ratio imbalances are starkest) as a consequence of the marriage squeeze. Theoretically, the relaxation of such social norms should decrease the opportunity cost of committing crime since it is easier to find a bride/groom for a son/daughter outside the known community/network of people.

There is an additional factor that could explain declining costs of crime. According to Becker (1968), individuals allocate time to criminal activities until marginal benefit from committing crime equals the marginal cost. The marginal cost of crime includes material costs, psychic costs, expected punishment costs and opportunity costs. In an institutional setting where the female side of the family bears a disproportionate share of marriage-related expenses (or have to pay a significant dowry), a high pre-marital sex ratio would lower dowry expectations. In India, the average cost of a daughter's marriage is estimated to be about six times the parents' annual income (Rao, 1993). Thus, a reduction in dowry expectations would imply lower expected foregone earnings. Theoretically, a fall in dowry expectations should, therefore, have a negative effect on labour supply and savings[22]. Recent work by Anukriti et. al. (2018) using survey data on actual dowry payments finds that adjustments to savings are stronger in girl families (owing to a positive dowry burden in India), and that the magnitude of savings increases with the expected future dowry payment. Moreover, they find that fathers of girls increase labour supply relative to fathers of boys as expected dowry burden goes up.

We show some suggestive evidence that (i) a high pre-marital sex ratio is correlated with relaxation of social norms, and (ii) an increase in pre-marital sex ratio is associated with a decline in labour supply.

To explore this further, we leverage Indian Human Development Survey (IHDS - II) data for 2011-12, collected by the National Council of Applied Economic Research (NCAER). This is a nationally representative, multi topic survey of 42,152 households across 1,503 villages and 971 urban neighbourhoods across India. We map this data with district wise sex ratio from 2011 census to test if district sex ratio alters the labour supply and financial behaviour of households.

We study the effect of the 10-16 age-specific sex ratio on measures of social norms regarding marriage based on the following four questions: (1) If the respondent had met her husband before marriage (2) Norms regarding permissibility in the community to marry daughter in the natal village (3) How long it takes (in hours) to reach natal home (4) If the respondent knew anyone in their community who has had an inter-caste marriage.

We study economic outcomes related to dowry expectations measured by the following variables in the survey, namely (1) Hours of work (in farm, business, wage or salaried

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[22] Recent studies suggest that when the sex ratio in the premarital cohort rises, families of the over-represented gender compete with each other to raise their savings rate in response to the rising pressure in the marriage market (Wei and Zhang, 2011; Horioka and Terada-Hagiwara, 2016).

employment), (2) Has bank savings (3) number of loans in the past 5 years and, (4) Total household consumption expenditure.

In order to interpret coefficients meaningfully, the sex ratio variable is defined as the number of boys in the age group 10 to 16 for every 100 girls. OLS regressions also include controls for the log of household income, highest education of the household head, urban/rural dummy, religion, caste and number of girls relative to boys in the household in age 0-14 years. This specification allows us to separately identify the effect on household behaviour of having young girls relative to boys in the family versus the externality effect of having more boys relative to girls in the district.

In Table 2.8, panel A shows estimates for variables related to social norms. An increase in the 10-16 sex ratio by 1 boy for every 100 girls is associated with a 0.4 percent decrease in the probability that a female had met her husband before marriage. Further, there is a relaxation of the social norms regarding marrying daughters within the village. Interestingly, increasing the sex ratio by 1 boy is associated with a 0.04 hour increase in the distance to a female's natal village. All these coefficients are significant at the 1 percent level. The results suggest that a marriage squeeze caused by an increase in the supply of males in the pre-marital cohort leads to an increase in the distance between the bride and groom's natal villages. Moreover, brides and grooms are less likely to have met before marriage, once again suggesting that marriages are being arranged outside the community/known network. Note that there is no significant effect of sex ratio on the probability of knowing someone in the village who has had an inter-caste marriage.

To show that dowry expectations have lowered with rising pre-marital sex ratios, panel B studies the effect on economic outcomes related to labour supply and savings. Though there is no significant effect on the probability of having bank savings, the effect of 10-16 age-specific sex ratio on annual hours of work is negative and significant at the 1 percent level. Parents, on average, are working 9 hours lesser per year (over a mean of 518 hours). Moreover, having pre-marital sex ratio is associated with higher consumption and lower number of loans in the past 5 years. Thus, foregone earnings are lower with an increase in pre-marital sex ratio.

Note that since the main right-hand side explanatory variable is at the district level while the outcome variables are at the individual level, there should not be any endogeneity issue. However, we are cautious in interpreting the results in Table 2.8 as causal since there may still be unobserved determinants of district sex ratios that are also correlated with social norms and individual labour supply outcomes.

Table 2. 8: Social Norms and Dowry Expectations (IHDS Data)

	(1)	(2)	(3)	(4)
Panel A: Social Norms				
	Met Husband Before Marriage	**Daughter Natal Permissible**	**Distance to Natal Village**	**Inter caste Marriages**
District 10-16 Sex Ratio	-0.004***	-0.011***	0.037***	-0.001
	(0.001)	(0.001)	(0.010)	(0.001)
Observations	21,119	21,942	20,619	21,104
Mean of Dependent Variable	0.245	0.543	3.118	0.287
R-squared	0.15	0.42	0.02	0.23
Panel B: Dowry Expectations				
	Bank Savings	**Work Hours**	**Consumption**	**Number of Loans**
District 10-16 Sex Ratio	-0.000	-9.158***	447.765**	-0.020***
	(0.001)	(1.382)	(193.254)	(0.005)
Observations	22027	21219	22090	22,022
Mean of Dependent Variable	0.587	518.6	125083	1.74
R-squared	0.16	0.11	0.31	0.12

Robust standard errors in parentheses.

* significant at 10%; ** significant at 5%; *** significant at 1%

Includes controls for log (household income), highest education of the household head, urban/rural,

Ratio of girls/boys in the household in age-group 0-14. Includes state, religion and caste fixed effects

2.6 Conclusion

Sex ratios may have both a negative and positive effect on crime. On the one hand, marriage is seen as a stabilizing factor on males. Thus, a skewed sex ratio, where more men are competing in the marriage market over fewer women, could be a source of conflict and violence. On the other hand, Guttentag (1983) in their seminal book argue that when females are in shorter supply, men invest more in marriage and family, which in turn leads to a stable society with lower levels of violent crime. Similarly, high sex ratio increases female bargaining power in the marriage market, shifting resources to favour women.

While the effect of sex ratio on crime can go in either direction, recent empirical evidence has supported the former view i.e. imbalances in sex ratio lead to more violence. However existing studies have not been able to obtain credible estimates controlling for the endogeneity of the sex ratio itself. Moreover, these studies have mostly emphasized only on the effect of sex ratio on crime directly through the marriage market. Finally, there are no credible estimates for the effect of son biasedness, measured by the child sex ratio, on crime in India. This chapter makes a contribution to this literature by measuring the long run effect of son preference on crime.

We address the identification challenge by exploiting district level variation in historical area under wheat-rice cultivation and cross time variation in relative producer prices of wheat-rice. We find that an increase in CSR leads to significant increase in both non-violent and violent crimes in the short run. The results are not robust to alternate specifications for the effect of sex ratio on crime reported 20 years later. These estimates suggest that the imbalance in the CSR in India between 1961 and 2001 led to a 28.8 percent increase in violent crime and 17 percent increase in non-violent crime over the 40 years period. Further, while much of the literature has focussed on competition and violence due to shortage of brides, to the best of our knowledge, this is the first study that empirically shows the role of social customs and institutions in explaining the sex ratio and crime nexus.

Improvements in education, labour market conditions and economic development have led to better opportunities for Indian women over the last two decades. Yet, there has been a downward trend in sex ratios at birth leading to an alarming demographic masculinization. According to World Bank projections, imbalances in sex ratio are likely to exacerbate by 2031 with only 898 girls in the 0-6 age group per 1000 boys. This decline in the sex ratio suggests that the availability and misuse of sex determination technology, particularly among the urban educated Indians, has overshadowed any improvements in status of Indian women through better labour market and education opportunities. Thus, any attempt to change patriarchal social norms must be accompanied with stronger implementation of existing law, for gender imbalances have implications on several socio-economic outcomes.

Appendix 2A

2A.1 District Definitions

District population weights are used to map districts across the years and the districts for each period are mapped to the administrative divisions in 1971. Mapping demands understanding of boundary changes and partitions through the decades. For each year, the districts are therefore characterized into three categories: districts with unchanged boundaries, districts created by partitioning any existing districts and current districts created from multiple districts in the previous period.

Approximately 38 percent of the districts over the period remained unaffected from the boundary changes. Nearly 22 percent were neat splits of boundaries; however around 40 percent, nearly 141 districts underwent intricate alterations and pose major challenge to a balanced panel.

The process of data mapping is aided by two sources. First, the national volumes for the general population and housing census for each census year provides the current territorial administrative units and changes from the previous census year. Second, the area and population figures released by the Office of the Registrar General & Census Commissioner, India (ORGI) are used as weights to map districts across time. The administrative information is supplemented by data on population proportions across the census years for district changes provided by Kumar & Somanathan (2009).

The following examples illustrate the methodology used to construct a balanced panel of districts mapped to census year 1971.

Table 2A.1: Proportion of Kameng district (Arunachal Pradesh) split across census years

State	1971 District	1981 District	Share of 1981 District from 1971	1991 District	Share of 1991 District from 1981	2001 District	Share of 2001 District from 1991
Arunanchal Pradesh	Kameng	West Kameng	58.44	Tawang	34.34	Tawang	100
				West Kameng	65.66	West Kameng	100
		East Kameng	41.56	East Kameng	100	East Kameng	100

As shown in Table 2A.1, district Kameng in Arunachal Pradesh in 1971, was split into West Kameng and East Kameng in 1981. West Kameng was further split into Tawang and West Kameng in 1991 and remained unchanged in 2001.

Mapping literate population in 2001 to the population in 1971 would therefore require aggregation of population of literates in Tawang, West Kameng and East Kameng to arrive at the final literate population figures for Kameng district in 1971.

The above example is a simpler version of districts mapping as compared to districts carved out of multiple districts in the previous census. For example, Vizianagaram formed a new district in 1981 taking shares of area and population from both Srikakulam and Vishakhapatnam from 1971. To map to Srikakulam in 1971, 51.59 percent of literate population from Vizianagaram is added back to Srikakulam and 48.41 percent to Vishakhapatnam as shown in the Table 2A.2.

Table 2A.2: Proportion of Vizianagaram district (Andhra Pradesh) carved between 1971 and 1981

State	1971 District	1981 District	Share of 1971 District in 1981
Andhra Pradesh	Srikakulam	Srikakulam	100
		Vizianagaram	51.59
	Vishakhapatnam	Vishakhapatnam	100
		Vizianagaram	48.41

Figure 2A.1: Trends in Violent and Non-violent Crime (1971-2001)

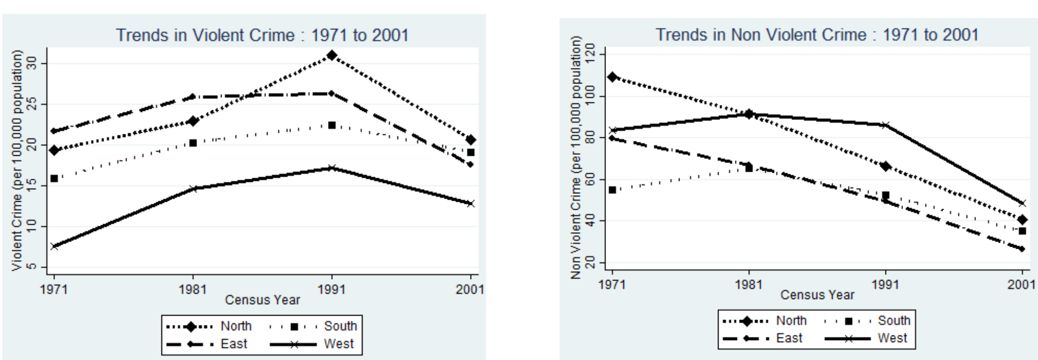


Figure 2A.2: Sex ratios in Indian states

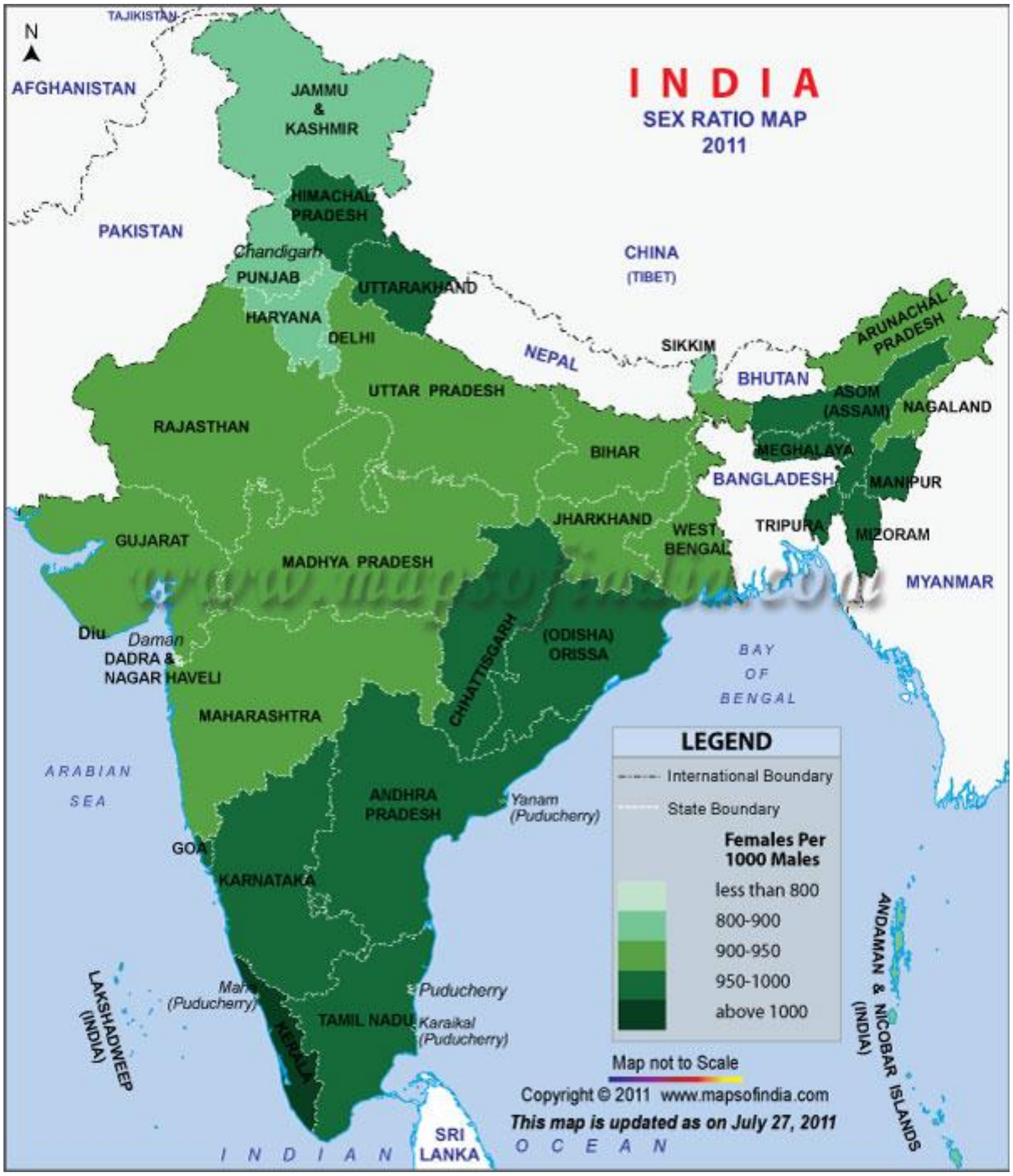


Figure 2A.3: Crop production: Rice

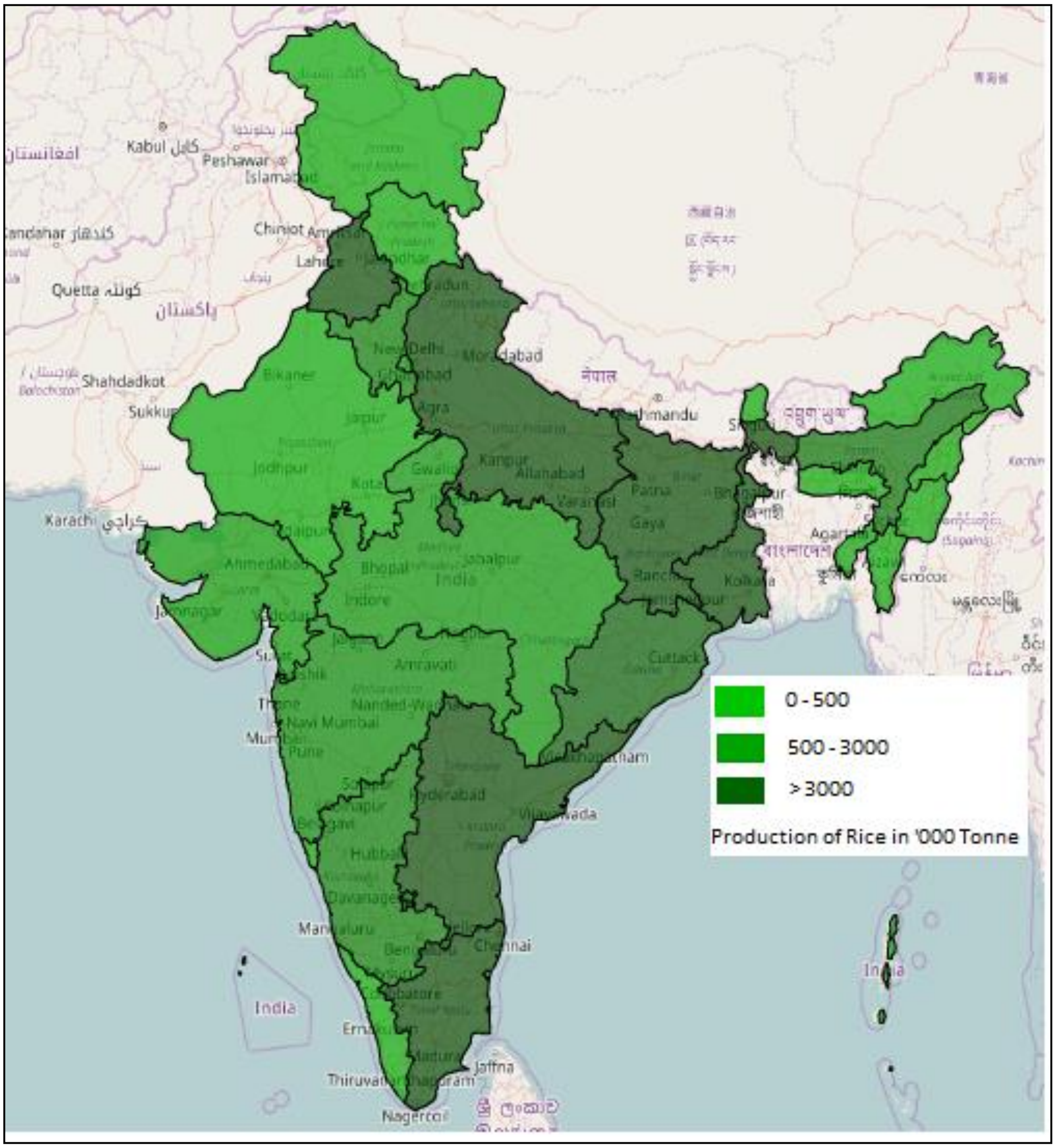


Figure 2A.4: Crop production: Wheat

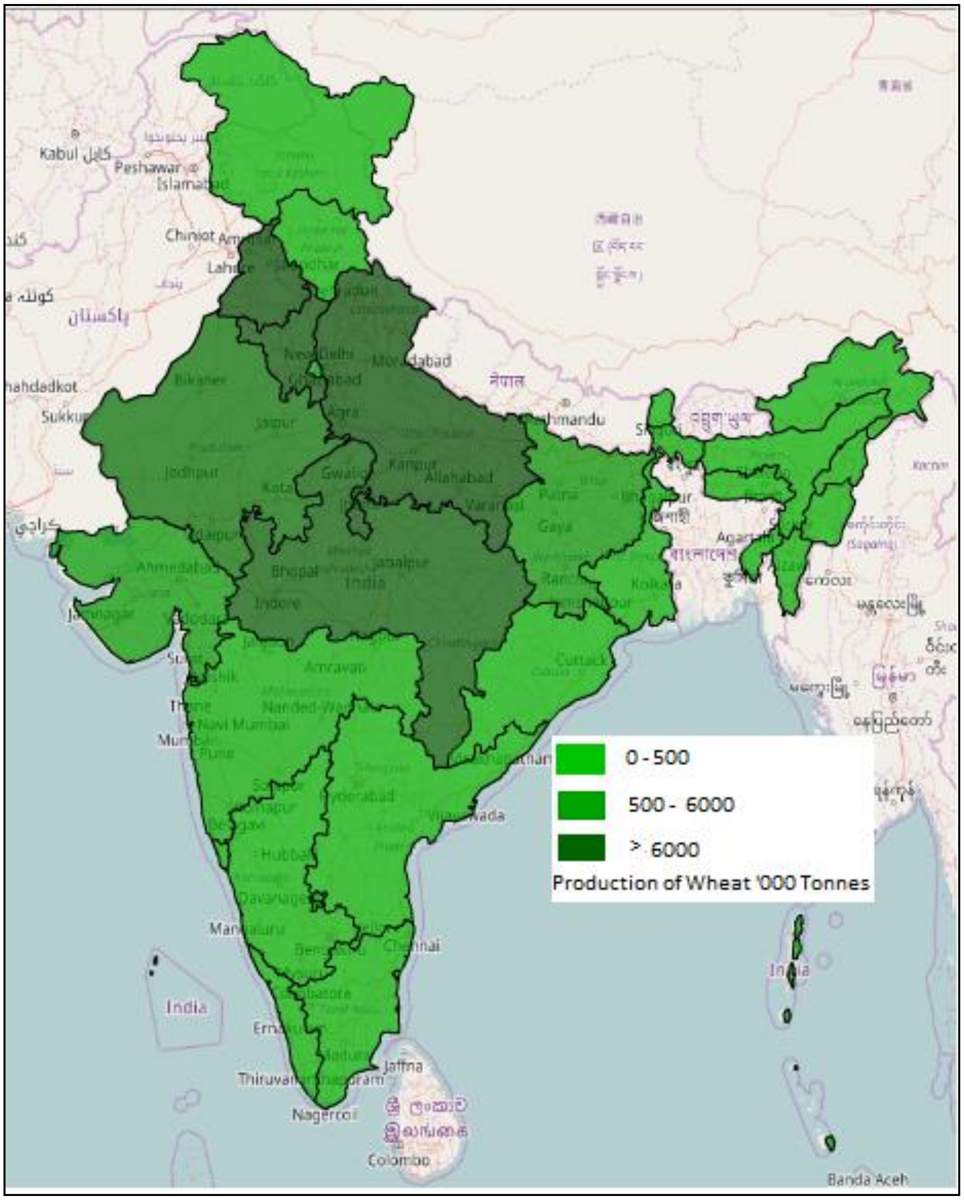


Table 2A.3: Descriptive Statistics for Disaggregated Crime Variables

	Obs	**Mean**	**Std. Dev.**
Violent Crime			
Murder	1277	3.59	2.57
Attempt to Murder	1290	2.08	3.03
Rape	1277	1.25	1.38
Kidnapping	1277	2.13	2.22
Dacoity	1283	1.29	2.05
Riots	1277	11.10	12.08
Non-violent Crime			
Theft	1277	41.00	41.80
Robbery	1277	2.88	3.85
Burglary	1277	20.32	17.29
Counterfeiting	1277	0.19	1.12
Cheating	1277	2.90	3.27
Breach of trust	1277	2.39	2.52

Theft, Robbery and Burglary are separately termed as property crime

Table 2A. 4: Descriptive Statistics by Census Years

	1961	1971	1981	1991	2001
Sex Ratio (Age 0-6)	1052.5	1067.3	1063.9	1064.7	1076.8
	(60.4)	(88.1)	(65.8)	(55.1)	(59.77)
Ratio of 1961 Wheat-rice area*Price	1221.6	1033.3	868.1	1075.1	1139.8
	(12686.8)	(10753.7)	(9034.7)	(11189)	(11862)
Proportion Literate	0.22	0.28	0.34	0.42	0.55
	(0.09)	(0.11)	(0.13)	(0.14)	(0.11)
Scheduled Caste Population	0.14	0.14	0.15	0.16	0.15
	(0.08)	(0.07)	(0.07)	(0.07)	(0.08)
Scheduled Tribe Population	0.10	0.10	0.11	0.11	0.09
	(0.19)	(0.19)	(0.19)	(0.19)	(0.15)
Urbanization Rate	0.16	0.18	0.21	0.23	0.22
	(0.14)	(0.15)	(0.16)	(0.16)	(0.17)
Violent Crime per 100,000 population	-	17.44	21.67	26.34	18.7
		(14.9)	(13.0)	(19.62)	(10.32)
Non-Violent Crime per 100,000 population	-	89.18	81.98	63.04	37.99
		(73.1)	(66.77)	(47.61)	(29.47)

CHAPTER 3: FEMALE EDUCATION, MARITAL ASSORTATIVE MATING AND DOWRY: THEORY AND EVIDENCE FROM INDIA

3.1 Introduction

Marriage is an inter-household social arrangement with an objective to maximise household utility. In a typical production function framework, household utility is a function of both monetary and non-monetary traits of the individuals and the households. Monetary traits such as wages are associated positively to household income and utility. On the contrary, non-monetary traits in terms of years of schooling, physical attributes and cognitive abilities determine efficacy in a household's cost of production. These characteristics though do not contribute to household income and assets directly, but raise the 'household output to cost ratio' with a reduction in the total cost of production. The ability of husband and wife measured through, for instance, education, cognitive skills and communication skills leads to time and effort reduction in production and generates synergies with increasing returns to scale. A household hence achieves greater utility with partners in the marriage market from a higher ability distribution.

In theory, household characteristics are also shown to be a strong predictor of marital assortative mating. Literature provides evidence of a strong positive association between household assets, age of the couples, height, etc. Rosenzweig and Stark (1989) show that household wealth and variation in risks to income determine the quality of marital matches. Deolalikar and Rao (1992) in empirical estimates from south-central India find a positive association between individual and household characteristics in marital sorting.

This chapter studies marital assortative mating based on female years of schooling in developing countries with reference to Becker's (1991) model on theory of marriage.[23]

[23] Marital assortative mating is defined as 'who marries whom'. Marital choices are based on individual and household characteristics such as education, income, physical appearance, etc. When individuals choose to marry from their own characteristic distribution, for example, a tall individual finds it optimal to marry someone who is also tall, is known as *positive* assortative mating. On the contrary, if a male with high wage finds it optimal to marry a female with lower wages, such that the male has a competitive advantage in labour market and female in managing household chores and children, this is known as negative assortative

Literature on assortative mating in education argues that men choose to marry females with higher education in expectation of increased household income. However, in developing countries such as India, where female labour force participation is as low as 27 percent[24], with poor female literacy and low returns to female human capital investment, an explanation for positive assortative mating based on education (found in empirical studies for India) lies beyond the wage market. This means that men with higher education see benefits other than future wage income from marrying females with greater years of schooling. Assortative mating in education may also reflect non-monetary returns to human capital. Potential brides with higher education bring down the cost of household production and contribute positively to household production, per unit of cost. High education level of potential bride adds positively to household utility as a non-monetary rather than a monetary trait.

Besides individual characteristics, marital choices are also determined by strong social and cultural norms. Marital decisions involve strong parental controls and marital transfers such as 'dowry', an important determinant of post-marital household utility levels. To the best of our knowledge, the literature so far does not assess the impact of female education on marital sorting with changes in relative bargaining powers of potential grooms and brides reflected in average dowry exchanges. In India, characterised by patriarchal norms, groom price or dowry exists as a social culture. It is a transfer made by the bride's family to the groom's family in cash or kind, or the excess marital expenditure borne by the bride's family relative to the groom. In economic theory, dowry in the marriage market is perceived as an equilibrating mechanism to compensate for the differences in the characteristics of the bride and the groom (Anderson, 2007). Any changes in the education level of females would alter the ability gap between the potential groom and the bride. This would affect the marital transfer equilibrium levels and assortative mating decisions. Marital assortative mating outcome of female education would thus be a net effect of

mating. Different individuals may find positive or negative assortative mating on a given trait optimal, depending upon how the trait enters into their utility function.

[24] Census of India, 2011.

positive marginal utility with reduction in cost of household production and fall in marginal utility with fall in dowry.

There are four main aims of this chapter. First, we study the presence of assortative mating by looking at the association between years of schooling of husband and wife in India, using data from India Human Development Survey II (IHDS-II). This is an important study for a country such as India with historical patriarchal norms and female gender biases, to see how female human capital investment is perceived in the marriage market. A positive association would indicate societal preferences for higher educated brides which would have further implications for socio-economic outcomes such as intra-household asset sharing, gender parity and household decisions. On the other hand, if the association is negative, it would indicate absence of net positive utility from bride's education levels in marital ties and a disincentive to invest in female education. Second, we study if assortative mating on education differs for districts with and without prominence of dowry. This may be true because dowry exists as a social norm in India and dowry may be correlated with assortative mating choices. Districts with higher prominence of dowry may view bride education and dowry income as substitutes, such that high amounts of dowry could substitute for lower bride's schooling years. Marital assortative mating outcomes should be weaker in such districts. Third, we study the complementarities or substitutability between spousal education levels and their association with dowry expenditure. If an educated bride's family is willing to pay a higher dowry for a higher educated son-in-law, there would exist complementarities in the bride and groom education levels, and would have a positive association with dowry transfers. However, if the bride's family is less willing to pay a dowry because the daughter is educated or the groom's family is willing to accept a lower dowry for an educated bride, husband and wife schooling years are substitutes in dowry. In this case dowry transfers would fall with incremental education years of husband and wife together. Fourth, we propose a basic theoretical model to explain the scenarios under which positive or negative assortative mating would be an ideal outcome.

There are several papers that study the association between husband and wife's level of education. Most of the literature argues that assortative mating based on education is determined by the labour market returns and monetary yields of human capital investment. Pencavel (1998) states that assortative mating by schooling strengthened since 1960. The chapter attributes the increase in similarity of schooling levels mainly to increased work opportunities for females. Greenwood et al. (2014) find similar results where Kendall's τ rank correlation[25] between the education of husband and wife is increasing between 1960 and 2005.

Average monetary returns to education however may not completely account for assortative mating patterns in developing nations. Female education is a human capital endowment with substantial non-monetary benefits besides labour market returns in terms of raising children, their education, health and sanitation, support to household, financial and social decisions. Mother's schooling has been shown to have substantial positive effects on children's schooling. The effects have in fact been found to be larger than father's schooling (Qian, 2008; Behrman, 1997).

Theoretically, assortative mating decisions could be analysed in the framework provided by Becker (1991). The model states that 'who marries who' is a function of joint marginal effect of traits of potential grooms and brides and their respective households. If the traits are complementary which means they offer increasing returns to scale in the household production, a household would find positive assortative mating to be desirable. Negative assortative mating in the marriage market may also be an ideal strategy if the traits of potential groom and bride are substitutes to each other.

This chapter suggests that education as a trait for potential brides and grooms may act as a substitute if years of schooling is a marketable characteristic, with similar returns in education to both male and female. In this case, both husband and wife may want to allocate more time in the labour market vis-à-vis household chores. This may generate substitution effects in the labour market. This argument gains support from Gihleb and Lang's (2016) study for the US where the estimates show that the educational homogamy has not increased in the country, thereby suggesting that male and female do not find it optimal to marry in similar educational distribution due to the presence of potential substitutability in

[25] Kendall's Tau is a non-parametric rank correlation based on the similarity of ordering of data ranked on each of the quantities. Calculations are based on concordant and discordant pairs.

labour work hours. In countries such as India, where market returns to female education are substantially poor and female workforce participation is as low as 27 percent and even lower for married women, i.e., 20 percent (Census of India, 2011), there exists a strong case for a nearly perfect segregation of roles between husband and wife in market and household work, respectively[26].

Societies based on patriarchal norms allocate higher weightage to female household roles, rearing of children and attach social stigma to female wage labour, such that husband and wife's education is viewed as a complement. If the husbands have a comparative advantage in labour market and wives in managing household and children, years of schooling generate complementarities in marital ties in such socio-economic environment. Boulier and Rosenzweig (1984) provide evidence for Philippines where with low female labour force participation, there exist positive payoffs for positive assortative mating in the presence of education as a human capital endowment with non-monetary returns. In contrast, Dalmia and Lawrence (2001) find that age was a stronger predictor of assortative mating in India, and education in the US. However, Anukriti and Dasgupta (2017) in a review of literature on economics of marriage market outcomes in developing countries observe strong homogamy in education. Empirical support on positive assortative mating in education in countries with very low female workforce participation indicates the presence of non-monetary benefits of education for households.

This chapter further recognises the association between female education and dowry, and its impact on assortative mating. Dowry may amount to a significant proportion of household wealth as a one-time transfer. Such inter-household transfers act as income insurance in low income countries (Rosenzweig and Stark, 1989). Anderson (2003) shows that with an increase in the average income and modernisation, there is a decline in average dowry payments. However, in India, where there exists caste hierarchy and diversification in the share of social and economic power, modernisation and rise in income is shown to have led to an increase in dowry payments. Rao (1993b) in estimating the rising groom

[26] IHDS-II 'Eligible Women' survey data suggests that about 40 percent of women are not willing to work even if found a suitable job. And nearly 40 percent of females denied being allowed to work if found a suitable job.

prices in South-Central India shows that dowry transfers rise with the widening gap in bride and groom characteristics such as age, height, land ownership and years of schooling. However, Edlund (2000) in a comment to Rao (1993b) argues that individual traits provide a better fit to dowry estimation as compared to the difference in traits. A positive shift in the potential brides' ability distribution and rise in female education is expected to raise female bargaining power in the marriage market. Sweeney and Cancian (2004) find significant results of a shift in marriage market equilibrium in favour of women with increased earning potential in the US. Therefore, a relative change in the characteristics of the potential brides and grooms either through education, workforce participation or other traits is believed to alter marriage market outcomes in terms of assortative mating and dowry. Anderson's (2007) model derives dowry as an equilibrating factor in the marriage market for gaps in characteristics of the potential groom and bride. The larger is the gap in desirable traits, the higher is the dowry payment.

According to this chapter, dowry may compensate for lower education levels of the potential bride. In the presence of low labour market returns to female education and substitutability between dowry and years of schooling, negative assortative mating in years of schooling may be an ideal outcome for the households. However, in the presence of non-monetary human capital endowments that generate positive marginal utilities in household production, positive assortative mating may be optimal if this effect is stronger than the substitution effect between female education and dowry. There exists a trade-off between dowry and household cost reduction with rise in female education. This chapter provides a simple theoretical model for assortative mating based on education in the presence of countering effects through dowry and efficiency in household costs. Empirical support on positive assortative mating suggests that positive marginal productivity of female education outweighs the negative effects of dowry substitution.

Given a comparative advantage in female education as a non-monetary rather than a monetary trait in developing nations, we test the proposition that brides and grooms with higher schooling marry with potential mates from a similar ability distribution. Marginal productivity of female education is higher than the marginal fall in dowry. The results may however be weak or in contradiction for districts with greater prominence of dowry. The substitutability between female education and dowry may be stronger where dowry persists as a strong social norm. We derive empirical estimates from IHDS-II 2011 data, a household level survey for the districts of India, and the results lend support to our hypothesis. Empirical findings are supported through a basic model of ideal marital sorting decisions with effects through dowry.

Following the introduction, rest of the chapter is organised as follows: theoretical model is discussed in section 3.2; data and empirical strategy are provided in sections 3.3 and 3.4 respectively; section 3.5 discusses the empirical results and validation tests; and conclusive comments are provided in section 3.6.

3.2 Theoretical Model

This section provides a basic theoretical model to explain marital assortative mating based on education and presence of dowry. This model is based on Becker's *Assortative Mating in Marriage* (1991) model which suggests that a household maximizes production per unit of cost subject to the budget constraint. The proposed model derives conditions under which positive or negative assortative mating would be optimal based on education and in the presence of marital transfers, such as dowry. In this case, groom's household is the decision-making household that maximizes production and determines in relation to the groom's education, whether to seek a bride with a higher education (positive assortative mating) or a bride with lesser education (negative assortative mating). Driven by the data limitations, household production function of the bride's family is not considered in this model.

The groom's household utility function is defined as a function of m market goods and services; x_i, and leisure; t_j of each male individual j[27].

Household Production Function

$$Z = f(x_1, \dots, x_m; t_1, \dots, t_j) \tag{3.1}$$

[27] The model assumes that only males participate in the wage market. Therefore, there is no division of time of females between leisure and labour work.

where,

x_i: various Market Goods and Services; $i = 1 \ldots\ldots m$

The household is constrained on budget such that the total expenditure on consumption goods and services, x_i, with price vector p cannot exceed the sum of income from labour l_j at a wage rate w_j for each male individual j in the household[28], property income v (given and constant) and dowry D. Dowry is assumed to be a one-time inter-household transfer and adds to the income of the post marital household (groom's household). Dowry is a function of male and female education in the post-marital household, S_m and S_f respectively.

Budget Constraint

$$\sum_{i=1}^{m} p_i x_i = \sum_{j=1}^{n} w_j l_j + v + D(S_m, S_f); \qquad (3.2)$$

where,

p_i: price of market goods and services

w_j: wages of male individual j

l_j: work hours of male individual j

v: property income

D: dowry

S_f: Education of female, Bride

S_m: Education of male, Groom

Time Constraint

$$l_j + t_j = T, \quad \forall j \qquad (3.3)$$

28

Substituting equation (3.3) in (3.2), the goods market and time constraints can be transformed into full income constraint as:

$$\sum_{i=1}^{m} p_i x_i + \sum w_j t_j = \sum w_j T + v + D(S_m, S_f) = I \quad (3.4)$$

where I stands for full income achievable with w_j as given in a perfectly competitive labour market.

In developing nations characterised by low female workforce participation and poor returns to female education, there exists division of work roles between males and females. Males take up larger roles in the labour market and females in household activities. The model therefore assumes that men participate in the labour market and females' education and other traits are non-monetary in nature. It is also assumed that wages are competitive across labour markets such that, $w_j = w$.

3.2.1 Household Cost of Production

Household production necessitates the employment of inputs in the production process. The household output is the amount of goods and services it could consume, assets it could raise and the quality of children it could rear[29]. Costs would involve time, effort and human capital required in the process of production. Cost of household production is a function of prices of consumption goods and education of household members. Rise in prices makes consumption expensive, raising the opportunity cost of leisure and cost of household production. Education raises individual efficiency through increased marginal productivity in production outcomes such as health, child education, etc., leading to lower costs of household production.

$$C = C(p, S_m, S_f) \quad (3.5)$$

With improved efficiency in education, marginal cost of the household is assumed to be decreasing in the education of both male and female such that:

[29] Children could be considered as consumption goods that generate positive utility with inputs required in terms of time and effort.

$$\frac{\partial C}{\partial S_m} \equiv C_m < 0$$

$$\frac{\partial C}{\partial S_f} \equiv C_f < 0$$

The household production could be represented as a proportion of household production to costs.

$$Z = \frac{Full\ Income}{Average\ Cost\ of\ Production} = \frac{\sum w_j T + v + D(S_m, S_f)}{C(\ p, S_m, S_f)}$$

$$= \frac{I}{C(\ p, S_m, S_f)}$$

The greater is the production per unit of cost, the higher is the utility of the household. As is evident from the household income per unit of cost, the education of the potential groom (S_m) and bride (S_f) impacts household production function both via a change in dowry income and a fall in the cost of household production. Education therefore enters the model as a non-monetary trait, such that it affects the household output to cost ratio only via reduction in the household cost of production and dowry, a one-time marital transfer[30]. A rise in male education raises the groom-price in the market with a corresponding increase in dowry transfers. Higher male education simultaneously brings down the cost of household production. The total effect of increased male education is thus positive on household production per unit of cost. However, a rise in female's education increases bargaining power in the marriage market and leads to fall in dowry transfers. This causes opposing effects on the production to cost ratio. On one hand, the groom's household would see a fall in dowry with rise in female education, reducing the post-marital income. On the other hand, an educated bride would lead to a fall in cost with positive effects on per unit returns. The net effect of female education on household production per unit of

[30] Labour market is assumed to be perfectly competitive. Wages are assumed to be independent of education.

cost is thus ambiguous. Mathematical explanations for the same are provided in the following sub-sections.

3.2.2 Impact of Education on Total Output

To study the effect of education levels of bride and groom on household production per unit of cost, we derive the first order partial derivatives. It is to be noted that education level of the bride is her education status at the time of marriage. We assume that the household decision on assortative mating based on education is not on investing in the education of girl after marriage, but on choice of a female with a given level of education among potential brides (with different education levels) in the marriage market[31].

First Order Partial Derivatives

With the assumption of constant wages in the labour market, education impacts total achievable income I, only through the effect on dowry.

$$\frac{\partial I}{\partial S_m} = \frac{\partial D}{\partial S_m} = D_m$$

$$\frac{\partial I}{\partial S_f} = \frac{\partial D}{\partial S_f} = D_f$$

A marginal increase in groom's education leads to an unambiguous rise in the production function.

$$\frac{\partial Z}{\partial S_m} = \frac{\partial\left[D\left(S_m, S_f\right)C^{-1}\right]}{\partial S_m}$$

$$= \frac{\partial D}{\partial S_m}C^{-1} - C^{-2}D\left(S_m, S_f\right)\frac{\partial C}{\partial S_m}$$

$$D_m - C^{-1}C_m\, D\left(S_m, S_f\right) > 0 \qquad (3.6)$$

The result from equation 3.6 would hold with the underlying assumptions of rise in dowry and fall in cost with male education respectively. This implies $D_m > 0$ and $C_m < 0$.

[31] We run a robustness test for empirical findings on assortative mating to eliminate any possibility of investment in bride education after marriage. The results are presented in section 3.5

Further, dowry that is the net transfer from bride's family to groom's family is (always assumed to be) positive such that $D(S_m, S_f) > 0$. A rise in male education therefore causes a definite positive effect on household income. Therefore, investment in human capital of sons leads to an unambiguous increase in household utility.

This could also be written in terms of elasticities:

$$\tau_m - \omega_m > 0 \qquad (3.7)$$

(Derivation in Appendix 3A.1)

where $\tau_m = \frac{\partial D}{\partial S_m} . \frac{S_m}{D}$ and $\omega_m = \frac{\partial C}{\partial S_m} . \frac{S_m}{C}$

Therefore, the total output would rise with male education if the male education elasticity of dowry (τ_m) and elasticity of household cost (ω_m) together cause equation 3.7 to be positive (which would always be the case since, $\omega_m < 0$). An increase in human capital investment by the male counterpart unambiguously leads to an increase in household production, both through an increase in dowry that adds to the income of the household and a decrease in the cost of household production.

Similarly, the marginal effect of female's education would result in an increase in total household output if:

$$D_f - C^{-1} C_f \, D(S_m, S_f) > 0$$

i.e.

$$\tau_f - \omega_f > 0 \qquad (3.8)$$

By assumption, since $\tau_f < 0$, thus the total output of the household would increase with female education, if the proportionate fall in household costs is greater than the proportionate fall in dowry.

$$|\omega_f| > |\tau_f| \qquad (3.9)$$

The independent effects of male and female education on household are easy to interpret. The model shows that a household always gains from investing in male's education since it is positive in both dowry and cost reduction. A female's education on the other hand leads to countering effects by negatively impacting dowry and positively on cost reduction. Thus, there exists a trade-off in decisions on the education level of potential brides. A household would be more acceptable of a bride with higher education if the efficiency gains in cost outweigh the loss in dowry component.

Assortative mating

Mate seeking in the marriage market is a function of different characteristics of the potential grooms and brides and their respective households.[32] On one hand where the household production is monotonic and increasing in education of males, assortative mating, i.e., who marries whom amounts to joint marginal effects on household production. As Becker (1991) explains in the paper, if increasing both S_m and S_f increases the total output, Z, by the same amount, as the sum of addition when each is increased separately (in the presence of constant returns to scale, CRS), all sorting of male and female would give same total output, Z. However, with increasing returns to scale (IRS), sorting of large S_m with large S_f and small S_m with small S_f would give greatest total output. Mathematically, positive assortative mating in education, mating of likes (highly educated marry the highly educated and those with lower levels of education marry the ones with lower education) is desirable if $\frac{\partial^2 Z(S_m, S_f)}{\partial S_m S_f} > 0$. And negative assortative mating of un-likes is desired if $\frac{\partial^2 Z(S_m, S_f)}{\partial S_m S_f} < 0$. A household would gain from positive assortative mating in education of male and female if the traits act as complements. Those with higher education would seek better educated spouses if the efficiencies achieved with higher education in cost outweigh the fall in dowry with higher female education. Dowry may increase with the education level of both male and female if the parents of the bride are willing to pay a higher dowry to secure a groom with higher education than the daughter's[33]. It would not

[32] Given the objective of the model, it is assumed that the characteristics of the households such as wealth, location, etc. are similar across the households.

[33] Owing to the cultural norms in developing countries such as India, it is preferred to marry a boy with higher traits such as education, income, etc. as compared to the bride.

be ideal for a groom with lower education to seek a better educated bride if the cost reduction is not sufficient to compensate for the fall in dowry.

Dowry compensation by the bride's family may offset the cost inefficiencies associated with lower education levels of the girl. In such scenario, households find negative assortative mating as the desirable strategy. The marriage market would thus witness larger gaps in the education levels of husband and wife.

The cross partial effects of male and female education would determine whether marriage sorting would be positive where males and females seek potential partners from similar ability distribution or different. Positive marriage sorting would require the cross partial derivative of Z to be positive, such that the total output increases with the education of both the male and the female in the household. Negative sorting would be an ideal decision for a household if an increase in female's education for a given level of male's education is causing the total output to fall such that the education traits are substitutes.

Second Order Cross Partial Derivatives

$$\frac{\partial^2 Z}{\partial S_m S_f} = C^{-1}D_{m.f} - C^{-2}D_m C_f - C^{-2}C_m D_f + 2C^{-3}C_m C_f D - C^{-2}C_{m.f}D \qquad (3.10)$$

(Derivation in Appendix, section 3A.2)

$D_{m.f} = \frac{\partial\left(\frac{\partial D}{\partial S_m}\right)}{\partial S_f}$ and

$$C_{m.f} = \frac{\partial\left(\frac{\partial C}{\partial S_m}\right)}{\partial S_f}$$

Since $C^{-1} > 0, D_m > 0, D_f < 0, C_m < 0$ and $C_f < 0,$ thus the effect of female education on marriage sorting would depend upon the relative magnitude and signs of $D_{m.f}$ and $C_{m.f}$

Education may have either reinforcing or offsetting effects on household cost of production and magnitude of dowry. The cost effects are reinforcing if the education of male and female act as complements, such that $C_{m.f} < 0$. However, such costs could be offsetting if the household costs of production fall at a decreasing rate, such that $C_{m.f} > 0$. For example, if a male is not competitive at managing household chores or children's education, marrying an educated female with greater productivity in household activities would bring down the household cost of production at a greater rate. However, if education makes a male better in managing household chores or children's education, then an educated female would act as a substitute. The costs though would fall due to the individual effect of female's education, but the rate of fall would be lesser.

Under the assumption of dowry as an equilibrating factor in the marriage market, the magnitude of dowry should fall with the rise in female education, i.e., $D_f < 0$. The marginal effect on dowry however with changes in both male and female education is less obvious. If male and female education are substitutes in dowry, an increase in male and female education would cause second order partial effect on dowry to be negative. Education would have offsetting effects such that $D_{m.f} < 0$. However, if the two are viewed as complements, the market would witness an increase in dowry with the education level of the groom and the bride. This could still hold under the assumption that $D_f < 0$. Though on an average, dowry may fall with the education level of the female, yet an educated female may be willing to pay a higher dowry for a better educated male. This may be supported by increased ability to pay a higher dowry through enhanced female education level and workforce participation. Female education may therefore generate complementarities in the marriage market for dowry such that $D_{m.f} > 0$.

The appropriateness of positive and negative sorting in the marriage market would determine whether the household costs and dowry are offsetting or reinforcing the education trait of potential grooms and brides.

Case I: Offsetting household cost and dowry in education of male and female, $\boldsymbol{C_{m.f} > 0}$ and $\boldsymbol{D_{m.f} < 0}$

In this case, equation 3.10 suggests that households in the marriage market would find positive sorting to be desirable, i.e.,

$\frac{\partial^2 Z}{\partial S_m \partial S_f} > 0$, if

$$2C^{-2}C_mC_fD \ - C^{-1}D_mC_f > C^{-1}C_{m.f}D + C^{-1}C_mD_f - \ D_{m.f} \tag{3.11}$$

This could also be written as

$$2\omega_m\omega_f - \tau_m\omega_f > \omega_{f.m}\omega_f + \ \omega_m.\tau_f - \ \tau_{m.f}.\tau_m \tag{3.11'}$$

where $\tau_m = \frac{\partial D}{\partial S_m}\frac{S_m}{D}$; $\omega_m = \frac{\partial C}{\partial S_m}\frac{S_m}{C}$; $\omega_{f.m} = \frac{\partial C_f}{\partial S_m}\frac{S_m}{C_f}$; $\tau_{m.f} = \frac{\partial D_m}{\partial S_f}\frac{S_f}{D_m}$

(Derivation in Appendix, Section 3A.3)

Under the assumptions of falling marginal costs in education ($C_f < 0, C_m < 0$) and rise in dowry with male education ($D_m > 0$), the left side of equation 3.11 is always positive. If the costs are offsetting such that $C_{m.f} > 0$, the marriage market can still achieve positive sorting where the likes get sorted in equilibrium if the multiples of direct effects of fall in cost and rise in dowry with education are stronger than the offsetting effects on cost and dowry. This would be true if the individual efficiencies in cost achieved with higher education are stronger than the offsetting effects on both cost and dowry. If the bride individually is able to bring down the household costs to an extent that it compensates both for the loss in dowry and any substitutions in the cost reductions from male education, positive assortative mating would be ideal even with offsetting education effects on costs and dowry. If direct elasticities of cost are greater than cross elasticities of cost and cross elasticities of dowry in male and female education, then positive assortative mating would be desirable for a household.

Case II: Offsetting household costs and reinforcing dowry effects in education of male and female, $\boldsymbol{C_{m.f} > 0}$ and $\boldsymbol{D_{m.f} > 0}$

With $C_{m.f} > 0$ and $D_{m.f} > 0$, households in the marriage market would find positive sorting to be ideal, i.e.,

$\frac{\partial^2 Z}{\partial S_m \partial S_f} > 0$, if

$$2C^{-2}C_mC_fD \ - C^{-1}D_mC_f + \ D_{m.f} > C^{-1}C_{m.f}D + C^{-1}C_mD_f \tag{3.12}$$

This could also be written as

$$2\omega_m\omega_f - \tau_m\omega_f + \tau_{m.f}.\tau_m > \omega_{f.m}\omega_f + \omega_m.\tau_f$$

The result of positive assortative mating gets strengthened when the dowry effect is reinforcing. Dowry effect may be reinforcing, i.e., dowry increases with the education of male and female together, with the willingness to marry daughter to a higher educated groom. Increased female education levels may also translate into higher ability to make dowry payments with increased probability of workforce participation. The household would achieve higher output with an increase in education levels of both the groom and the bride if not only are the individual cost reducing effects stronger than the offsetting effects on cost, but dowry increases with the education of male and female together.

Case III: Reinforcing household costs and offsetting dowry effects in education of male and female, $C_{m.f} < 0$ and $D_{m.f} < 0$

With $C_{m.f} < 0$ and $D_{m.f} < 0$, households in the marriage market would find positive sorting to be desirable, i.e.,

$$\frac{\partial^2 Z}{\partial S_m \partial S_f} > 0, \text{ if}$$

$$2C^{-2}C_mC_fD - C^{-1}D_mC_f - C^{-1}C_{m.f}D > C^{-1}C_mD_f - D_{m.f} \tag{3.13}$$

This could also be written as

$$2\omega_m\omega_f - \tau_m\omega_f - \omega_{f.m}\omega_f > \omega_m.\tau_f - \tau_{m.f}.\tau_m$$

It is possible that an increase in male and female education may have reinforcing effects on the cost of production where the education traits act as complements. However, with a rise in female education, not only does the dowry fall, but witnesses an offsetting effect. This is generally true as females begin to achieve a higher socio-economic status such that males, specifically the more educated, are willing to accept lower dowry for a girl with higher education. In such a scenario, for positive assortative mating to be a desirable outcome, it is required that the fall in costs—both direct and cross—should be strong enough to overcome the fall in dowry with a rise in female education and the corresponding offsetting effects.

Case IV: Reinforcing household costs and dowry effects in education of male and female, $C_{m.f} < 0$ and $D_{m.f} > 0$

With $C_{m.f} < 0$ and $D_{m.f} > 0$, the households in the marriage market would find positive sorting to be ideal, i.e.,

$\frac{\partial^2 Z}{\partial S_m \partial S_f} > 0$, if

$$2C^{-2}C_m C_f D - C^{-1}D_m C_f - C^{-1}C_{m.f}D + D_{m.f} > C^{-1}C_m D_f \qquad (3.14)$$

This could also be written as

$$2\omega_m\omega_f - \tau_m\omega_f - \omega_{f.m}\omega_f + \tau_{m.f}.\tau_m > \omega_m.\tau_f$$

In a scenario where both the household costs and dowry are reinforcing in to male and female education, positive sorting would have a stronger likelihood. In a country such as India, dowry is a cultural norm. Though it may vary and be determined by various factors, with the patriarchal structure and poor socio-economic status of females, a positive groom price is a social standard. On one hand where a rise in female education may lower the dowry component on average, the parents of the bride may be willing to pay a higher dowry for a better, higher educated groom. Bringing a bride with higher education in the family would thus add to the household production, both by reduction in cost and a rise in dowry.

The theoretical model of marital assortative mating and dowry implies that:

a. Education contributes positively to household utility as a non-monetary trait.
b. There exists a potential trade-off and substitutability between dowry and female education.
c. In patriarchal societies where dowry exists as a cultural norm, marital choices are governed by differences in marginal utilities between education and dowry.

3.3 Data

With an objective to examine marriage market sorting and marital decisions on the education level of potential grooms and brides in India, this chapter uses household level data from IHDS-II and Census of India. We use data from IHDS-II data available for the year 2011. IHDS-II is a nationally representative, multi-topic survey of 42,152 households across India for 2011-12[34]. The survey gathers extensive details on variables related to health, education, employment status, marriage and other components that are important indicators of economic and social well-being. This chapter maps data at the level of household, individual (belonging to the given household) and eligible women[35] (of the household). The data set on eligible women provides variables on education of the married woman, education of husband, age, expectation of expenses borne on marriage by the groom and the bride side and other forms of gifts received from the community in marriage. These variables are used to assess assortative mating decisions on education and variations in dowry with female education. Factors such as household income and average education level in the household are mapped from the household data. These variables are used as controls since they may play an important role in selection of bride. For example, a household with a higher education on average would prefer an educated bride. Further religious affiliation and caste categories[36] are also taken from the household data.

Marital decisions of an individual or a household are also governed by the socio-economic environment. Prominence of dowry and sex ratio (males per 1000 males) at the district level are used to control for this and taken from the Indian Census, 2011. Marriage expenditure net of expenses by the bride and groom's family provides for a close proxy of dowry. Marital expenditure by the groom's family was based on the following question from the head of the household, *"At the time of the boy's marriage, how much money is usually spent by the boy's family?"* Similarly, expenditure by the bride's family was based

[34] IHDS-I survey was conducted in 2005-2006. However, we use only IHDS-II since the other district variables are from Census of India, which is a decennial survey. These variables would have no variation across the two rounds of IHDS survey, 2005-06 and 2011-12.

[35] Ever married women in the household in the age group of 15-49 years are surveyed in a face-to-face interview.

[36] The Indian social system is characterised by the co-existence of multiple religious affiliations and hierarchy in castes with strong cultural and social beliefs that bear significant impact on socio-economic choices.

on the following question, *"At the time of the girl's marriage, how much money is usually spent by the girl's family?"* Dowry was calculated as the difference of average expenditure incurred by the bride and the groom's family. To avoid measurement bias due to differences in cost of living across states, the calculated dowry was weighted by consumer price index of each state in 2011.

Marital expenditure however may not be a good measure for dowry prominence in a district. Marriage expenditure may be determined by other factors also such as ability to pay and preferences of individuals besides the norms of the society on marital transfers. Dowry prominence was therefore generated as a dummy from proportionate number of dowry deaths in 2011 in a district based on data provided by National Crime Records Bureau (NCRB). Dowry deaths provide a good proxy for the prominence of dowry in a district, since it is likely to be reported with a high probability and with greater accuracy. Amount of dowry paid is highly probable to be misreported and with a lesser likelihood. A district is defined as more intensive on dowry culture if the percentage of dowry deaths exceeds 1.5 (average percentage of dowry deaths)[37]. Education levels of the husband and wife are measured as years of education completed.

The descriptive statistics for the variables from IHDS-II and Census 2011 are represented in Table 3A.1 in appendix. The descriptive statistics suggest that on an average, husbands are more educated than the wives. The net expenses borne on wedding by the bride's family are positive, indicating positive groom price and marital transfers from the bride to the groom's family. This may owe to relatively poor education levels and socio-economic status of the females in the country. On an average, the statistics are representative of sex ratio biased towards males, showing 1098 males as compared to females in the age group of 10-16 years old. Statistics also indicate high dispersion in the number of high schools across districts. Dowry deaths as a percentage of married females in a district range from 0 to 8.4 percent. On an average, the districts in India witness approximately 1.5 percent of dowry deaths as a proportion of married girls. Scatter diagram on the education level of

[37] Dowry deaths may be due to weaker institutional arrangements, such as poor governance, weak criminal institutions, greater tolerance to violence against women and could influence the results. However, given the paucity of data, this is the best available proxy as a measure for dowry prominence in a district.

husband and wife in Figure 3.1 shows a strong positive association between the two variables. Potential grooms and brides are likely to choose from their own education (ability) probability distribution.

Figure 3.1: Scatter plot for association between the education level of husband and wife in a household (IHDS-II)

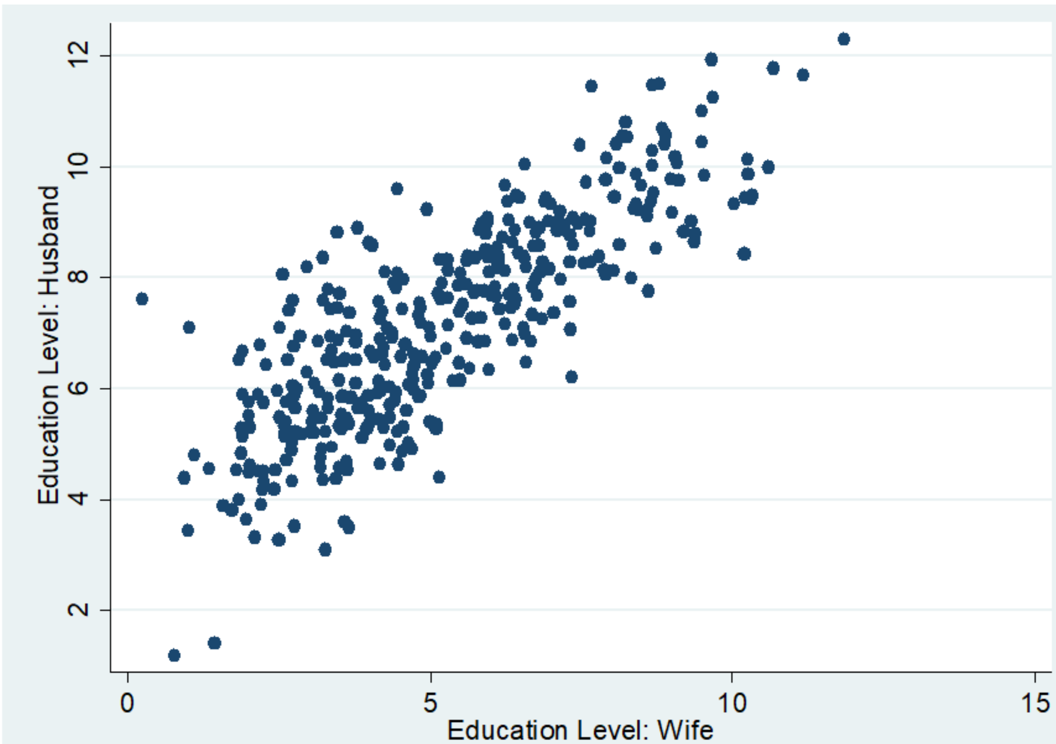
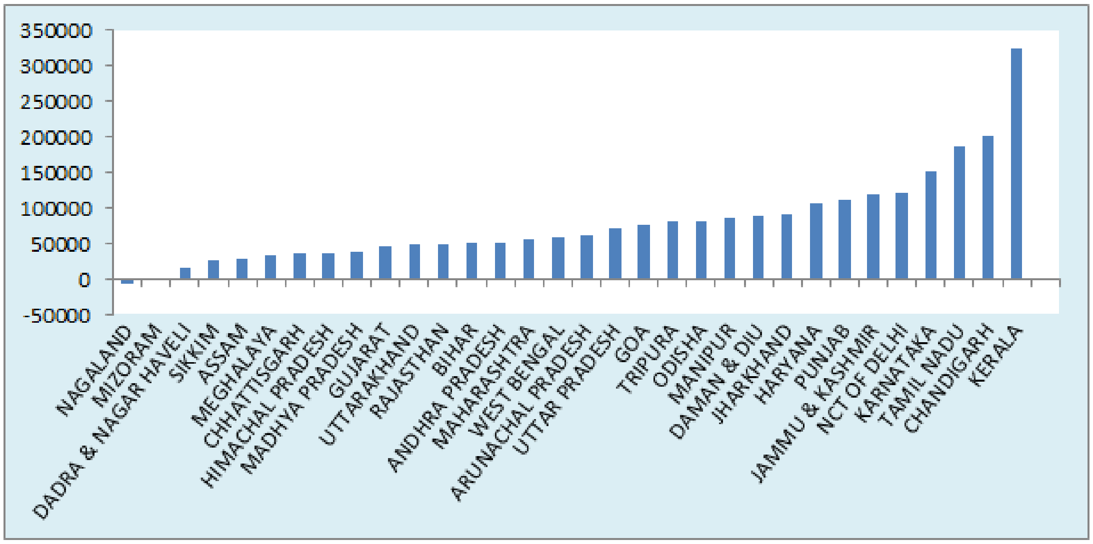


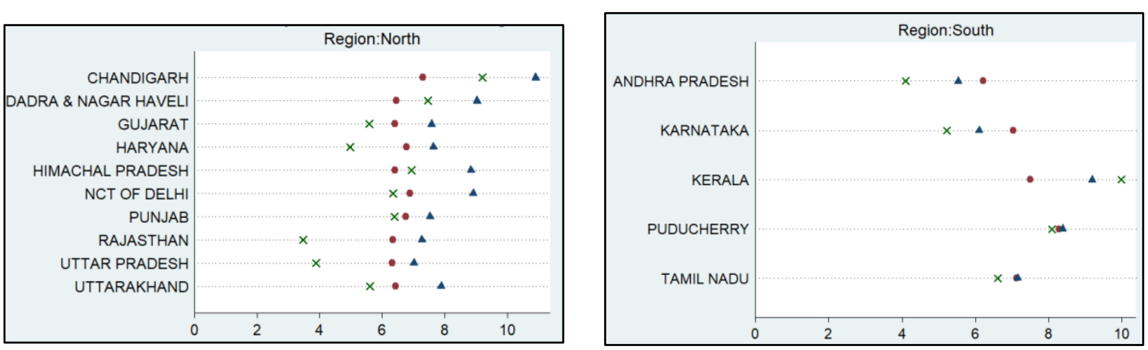
Figure 3.2 provides an overview of state-wise average net expenditure incurred by the bride's family. The figure suggests large regional variation in the net marital expenditures borne by the bride side of the family. A closer look at the numbers is indicative of least dowry transfers in the north-eastern states of India such as Nagaland, Mizoram, Sikkim, Assam, etc. These states are also known for an above average level of women representation and independence. On the contrary, states from southern India such as Kerala, Tamil Nadu, Karnataka, etc., though possess highest standards of women literacy levels and women workforce participation, rank highest in dowry payments.

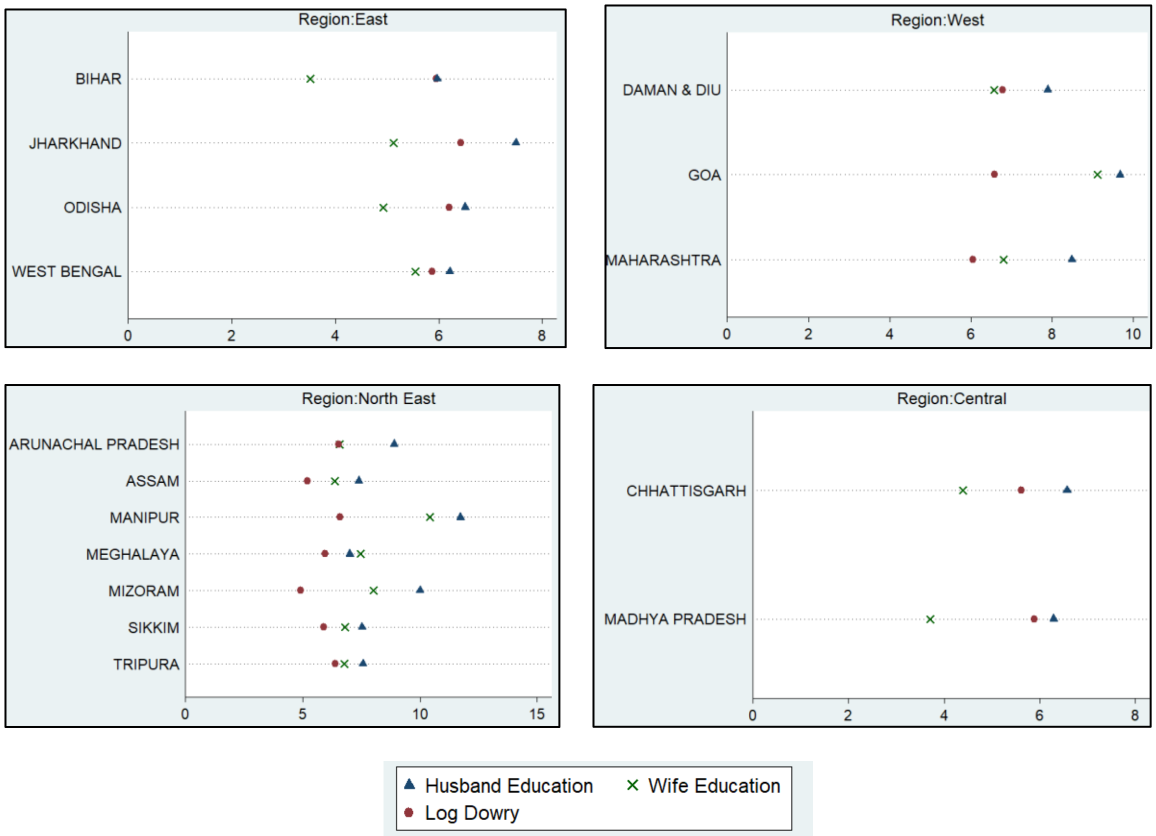
Figure 3.2: Average dowry expenditure across states of India (IHDS-II)



Region-wise and state-wise dot plot in Figure 3.3 provides an overview of the association between average dowry payments and years of schooling of the husband and wife. Dowry payments are seen to be higher in states with higher levels of husband education and lower levels of wife education. For example, Himachal Pradesh and National Capital Territory of Delhi in north both show similar husband years of schooling on an average. Dowry is however higher in Delhi with lower level of wife's education.

Figure 3.3: Region-wise dot plot of average dowry across states and average schooling years of husband and wife





3.4 Identification Strategy

To study the association between female education, marital sorting and dowry payments, the chapter estimates the following specification for individual i in household h in state s, district d belonging to religion r and caste c

$$Education\ Wife_{ihd} = \alpha + \ \beta_1 Education\ Husband_{ihd} + \beta_2 Dowry\ District_d + \beta_3 Education\ Husband^*_{ihd} Dowry\ District_d + \gamma_h X_h + \gamma_d X_d + \delta_{rh} + \delta_{ch} + \delta_s + \varepsilon_{ih}$$

(e1)

where $Education\ Husband_{ihd}$ denotes the education level of husband (of the surveyed married female i) in household h.

β_1 is a measure of assortative mating on education levels of husband and wife. A positive estimate of β_1 would indicate positive assortative mating where a household finds it ideal to marry potential grooms and brides with similar education levels. β_2 measures the difference in education level of brides in districts with greater prominence of dowry.

Estimate of β_2, if positive, would indicate greater investment in daughters' education in dowry prevalent districts in expectation of lower dowry payments at the time of marriage for a better educated bride. Estimate of β_2 may be negative, if female education expenditure is substituted with savings for future dowry payment savings.

β_3 estimates the differential outcome on marital assortative decision of male education in districts with greater dowry prominence. Districts strongly driven by norms of dowry may exhibit a positive β_3 that would suggest stronger assortative mating in marriage market in dowry prevalent districts. In this case, dowry and female education are complements, such that higher dowry is paid to seek a better educated groom for a bride with higher education. If dowry and female education are substitutes, β_3 would be negative that indicates males with higher education find it desirable to substitute education of potential bride in compensation of dowry.

X_h and X_d are the household and district level controls such as income levels in the household, age gap of husband and wife, and urbanisation rate. δ_{rh}, δ_{ch} and δ_s are the fixed effect controls for religion and caste of a household and state fixed effects, respectively.

Ordinary Least Square estimates may pose potential endogeneity bias due to omitted unobserved factors that may together determine the education levels of husband and wife. To circumvent this problem, we use instrumental variable strategy and instrument husband's years of schooling with his mother's years of schooling. Existing studies show that the education level of mothers is positively and significantly associated with the education level of children (Rihani, 2006; Coulon et. al., 2008). Husband's mother's years of schooling is derived from the "Eligible Woman" questionnaire for married females in the age group of 15-49 years. An eligible woman's response to mother-in-law's education is recorded from the question that asks, *"How many standards/class your husband's parents completed?"* (The response is recorded for mother and father separately).

The analysis further directly tests for the relationship between dowry and female education in the districts of India. The objective is to examine if dowry and female education act as substitutes or complements in marital decisions on education levels. β_3 coefficient in equation e2 directly tests for the association between female education and dowry.

$$Log(Dowry)_{hd} = \alpha + \beta_1 Education\ Husband_{ihd} + \beta_2 Education\ Wife_{ihd} + \beta_3 Education\ Husband^{*}_{ihd} Education\ Wife_{ihd} + \gamma_h X_h + \gamma_d X_d + \delta_{rh} + \delta_{ch} + \delta_s + \varepsilon_{ih} \quad \text{(e2)}$$

β_1 is expected to be positive since higher education of potential groom would reflect greater ability and hence would demand larger dowry. β_2 on the contrary is expected to be negative. A rise in the education level of potential bride would raise her bargaining power in the marriage market and hence would lead to a fall in the transfers made to the groom's family at the time of marriage. β_3 directly tests for the sign of D_{mf}, that is, how does dowry change with an additional year of education of both the groom and the bride. A positive estimate of β_3 would suggest complementarity between female education and dowry, such that the bride's parents are willing to pay a higher dowry to seek a better ability husband for their daughters with higher education. If β_3 is negative, there exists substitutability between female education and dowry. With a positive β_1, though dowry may rise with male education, but it increases at a decreasing rate with a per unit rise in female education with a negative β_3. The household is willing to substitute dowry for a bride with higher education.

Unobserved factors may cause potential endogeneity in both female and male years of schooling. The female years of schooling is instrumented with the number of high schools in the district. Number of high schools in the district are expected to be positively correlated with female education years and exogenous as they are unlikely to be correlated with dowry exchanged in the household. The estimation further exploits the education of groom's mother as an exogenous determinant of male education level[38].

3.5 Empirical Assessment

Table 3.1 shows results for equation e1. The results include controls for district and household specific characteristics that may impact the education level of the male in the family. Estimates on wife education are positive and highly significant which indicates positive assortative mating on education levels. Individuals tend to marry from their own

[38] Bride's mother's years of schooling do not provide an exogenous determinant of her own education in a model that studies the association with dowry. The literature suggests that there exist strong inter-dependencies in a mother-daughter relation that may influence dowry exchanges through other factors besides daughter's education levels and hence may not be entirely exogenous (Walker, Thompson & Morgan, 1987; Troll, 1987; Fischer, 1981).

ability distribution which suggests reinforcing effects on household cost reduction in the education of the bride and the groom. The results are in consensus with the findings of Mare (1991) and Mancuso (1997) who show that it is unlikely for individuals with higher education levels to marry someone with a lower education. Qian (1998) found that highly educated males were more likely to marry females with lesser education whereas females with higher education were less likely to marry someone with a lesser education level.

Table 3.1: Marital assortative mating on years of schooling and difference in dowry prominent districts

Wife's Years of Schooling	(1) OLS 1	(3) OLS 2	(4) OLS 3	(5) IV 1	(7) IV 2	(8) IV 3
Husband's Years of Schooling	0.606***	0.0935***	0.156***	1.301***	2.537***	2.652***
	(0.00407)	(0.00824)	(0.0128)	(0.0174)	(0.143)	(0.149)
High Dowry Deaths Districts		0.108*	0.625***		0.0298	1.029**
		(0.0550)	(0.0953)		(0.161)	(0.435)
Dowry Death District*Husband's Years of Schooling			-0.0702***			-0.144***
			(0.0108)			(0.0529)
Household Urban/Rural		0.739***	0.739***		0.566***	0.565***
		(0.0398)	(0.0398)		(0.0975)	(0.0972)
Average Education of Household		0.730***	0.731***		-1.341***	-1.329***
		(0.00952)	(0.00951)		(0.121)	(0.121)
Age Difference between Husband and Wife		-0.00824*	-0.00819*		0.0192	0.0186
		(0.00466)	(0.00466)		(0.0133)	(0.0133)
Log (Household Income)		-0.146***	-0.147***		-0.103**	-0.105**
		(0.0194)	(0.0194)		(0.0489)	(0.0487)
District FE	Yes	No	No	Yes	No	No
State FE	No	Yes	Yes	No	Yes	Yes
Observations	37,612	35,985	35,985	37,415	35,795	35,795
Adj. R-squared	0.45	0.62	0.62	0.04	0.01	0.01

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

We derive interesting results from the study of the interaction variable between the dowry district and husband's education. Though the estimates suggest a positive significant association between the education level of the husband and the wife, this association is weaker in the dowry prevalent districts as indicated by the negative significant effect of the interaction variable. The groom's family is willing to accept a bride with lower education level for higher dowry. From the perspective of the girl's family, there exist offsetting dowry effects in education since the parents of the bride, unable to secure a groom with higher education in dowry prominent districts, substitute their daughter's education for dowry. The results support King and Hill's (1993) statement, "In cultures where dowry is customary, securing a more highly educated husband for an educated woman would require a larger dowry – another hidden cost of educating females". If dowry and female education were complements, the positive assortative mating results should have strengthened in districts where dowry is highly predominant.

Husband's years of schooling may be endogenous as the wife's level of education may determine the choice on husband's level of education. This means that a female with higher education may choose to marry a male who is better educated and thus the causality may run in the reverse direction. Alternatively, husband and wife's education levels may be determined simultaneously by factors such as cultural norms, preferences, attitude and perception of individuals towards education. Wu-Hausman's F-statistic to test for the endogeneity of education level of husband is 685.43 and rejects the null of the variable being exogenous. The endogeneity is thus addressed using instrumental variable estimation as the identification strategy. Husband's mother's education is used as an IV for husband's own years of schooling. The results are directionally consistent with OLS estimates, which suggest that there exists a positive association between the education level of the husband and the wife. However, OLS estimates are found to have a downward bias. It may be argued that husband's mother's education may not be entirely exogenous as the groom's mother's education level may alter her attitude towards the education level of her son's future bride. However, statistics on a question to an eligible woman in the survey, "Please tell me who in your family decides: To whom your children should marry?" show that in 74 percent of the cases, the decision is made mostly by the "husband". The respondent herself has a larger role only in 11 percent of the cases. Since females are less likely to make a decision on the marital choices for the children, it would be valid to assume that husband's mother's education is exogenous to the years of schooling of wife.

Table 3.2: First Stage: Husband's mother's years of schooling as instrumental variable for husband's years of schooling

	Husband's Schooling			Husband's Schooling*Dowry District
	(1)	(2)	(3)	(4)
Husband's Mother's Schooling	0.563***	0.101***	0.0901***	-0.467***
	(.0087)	(.0066)	(.016)	(.0161)
Dowry District Dummy		0.0723	0.0544	6.157***
		(.0631)	(.0668)	(.0674)
Dowry District*Husband's Mother's Schooling			0.0136	0.6349***
			(.0168)	(.0170)
Household Urban/Rural		0.0005	0.0004	-0.0142
		(.0367)	(.0367)	(.0370)
Average Education of Household		0.821***	0.8214***	0.7369***
		(.0043)	(.0043)	(.0044)
Age Difference between Husband and Wife		0.0192***	-0.0256***	-0.0237***
		(.0047)	(.0047)	(.0048)
Log (Household Income)		-0.0388**	-0.0389**	-0.0486***
		(.0181)	(.0181)	(.0182)
District FE	Yes	No	No	No
State FE	No	Yes	Yes	Yes
Observations	37,415	35,795	35,795	35,795
Adj. R-squared	0.21	0.64	0.63	0.66
F-statistic	134.86	1237.42	1213.62	1388.22

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

Table 3.2 shows the first stage estimates for instrumental variable estimation in Table 3.1. First stage estimates for effect of husband's mother's years of schooling on husband's schooling are shown in columns 1 to 3. The estimates suggest that men with mothers of higher education possess higher years of schooling. Husband's mother's education is significantly and positively associated with husband's education level and the overall F-statistic of the model is 1388.22, indicating that the overall model is highly significant. Anderson-Rubin Wald test F-statistic is reported at 838.64. The test rejects the null hypothesis of weak identification and suggests that the husband's mother's education is a relevant instrument for husband's own years of schooling. The instrument is statistically valid in the given model.

Estimates in Table 3.3 directly test the association between dowry and education levels of husband and wife. OLS estimates in columns 1 and 2 show a positive significant relationship of education levels of both husband and wife with the amount of dowry exchanged. However, OLS estimates may be biased due to unobserved factors that may simultaneously affect the education level and dowry. Wu-Hausman F-statistic to test for exogeneity of wife's years of schooling is 29.6 and rejects the null hypothesis and indicates the presence of endogenous factors.

Table 3.3: Association between dowry and years of schooling

	(1) OLS 1	(3) OLS 2	(1) IV 1	(3) IV 2
Wife's Years of Schooling	0.0362***	0.0295***	-0.0532**	-0.212***
	(0.00130)	(0.00143)	(0.0235)	(0.0635)
Husband's Years of Schooling	0.0209***	0.0164***	0.0804***	1.003***
	(0.00233)	(0.00607)	(0.0171)	(0.349)
Wife's Schooling*Husband's Schooling		-0.000217		-0.0745**
		(0.000515)		(0.0302)
Age difference Husband and Wife		0.00405**		-0.0124**
		(0.00168)		(0.00580)
Log (Household Income)		0.145***		0.387***
		(0.00629)		(0.0586)
District Sex Ratio		0.00140***		0.00007
		(0.000154)		(0.000581)
Household Residence: Urban		0.0360***		0.527***
		(0.0132)		(0.122)
State Fixed Effects	Yes	Yes	Yes	Yes
Observations	31,525	29,116	15,972	14,767
Adj. R-squared	0.29	0.31	0.19	0.01

Includes controls for caste and religion
Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Instrumental variable estimates suggest that an additional year of husband's schooling is associated with a 1 percent rise in dowry. A rise in wife's schooling year on the contrary shows a fall in dowry by 0.21 percent. The estimates are consistent with the theory that postulates a rise in dowry with a rise in male education as a result of higher price for higher ability ($D_m > 0$). Dowry falls with female education as it raises the bargaining power of potential brides in the marriage market ($D_f < 0$). The coefficient for interaction between education levels of husband and wife tests for the joint marginal effect of additional years of schooling of the bride and groom on dowry. A negative estimate for the interaction term suggests that dowry is increasing at a decreasing rate. In reference to the theoretical model, this negative coefficient indicates that dowry and female education are substitutes such that $D_{mf} < 0$.

These results provide credence to the assortative mating estimates in Table 3.1 that show that positive assortative mating result is weaker in dowry prominent districts. Since $D_{mf} < 0$, households tend to substitute female education with dowry, such that in districts where dowry is a strong social norm, females with lesser education get sorted with males of higher education. Dowry compensates for the lower education levels of the females.[39] In India therefore, transfers at the time of marriage are significant determinants of marital assortative mating. Other variables included in the analysis are directionally consistent. Those residing in urban areas and households with higher income show larger dowry payments. Large differences in the age of husband and wife amount to lesser dowry payments.

First Stage estimates are presented in Table 3.4. The estimates show a strong positive association between the number of high schools in the district and wife's years of schooling. Association with other variables is also consistent in reference to the existing literature. In case of higher district sex ratio with a greater number of males, females achieve lesser years of schooling. Estimates suggest that in households with urban residence and higher income, wives have higher education levels. Husband's mother's schooling level is also seen to be positively associated with the wives' schooling years. Higher age difference between husband and wife is negatively correlated to wives' education level.

Cragg-Donald F-statistic is reported at 12.32 which rejects the hypothesis of weak identification and suggests that the number of high schools is a relevant instrument for

[39] The analysis also aimed at directly testing joint effect of male and female education on the cost of household, C_{mf}. However, directly testing this parameter requires time use variables to measure effort and time in relation to education levels. The data for the same is not available in IHDS-II.

wife's years of schooling. The overall F-statistic of first stage model is 210.92 for wife's schooling and indicates the overall model being significant.

Table 3.4: First Stage: Number of high schools in the district as instrumental variable for wife's years of schooling

	Wife's Schooling		Wife's Schooling*Husband's Mother's Schooling
	IV 1	IV 2	IV 2
Number of High Schools in District	.0018***	.0013***	-.0001*
	(.0001)	(.00019)	(.0008)
Husband's Mother's Schooling	.7115***	4.2216***	9.4592***
	(.0135)	(.16768)	(.06790)
Age difference between Husband and Wife		-.0461***	-.0084**
		(.01056)	(.00427)
Log (Household Income)		.7598***	.18435***
		(.0376)	(.0152)
District Sex Ratio		-.0069***	-.0006
		(.00108)	(.00043)
Household Residence: Urban		1.7590***	.3296***
		(.07920)	(.0320)
Number of High Schools*Husband's Mother's Schooling		-.00071**	.00054***
		(.00032)	(.00013)
State Fixed Effects	Yes	Yes	Yes
Observations	15,972	14,767	14,767
Adj R-square	0.29	0.34	0.89
F-statistic	203.08	210.92	3438.13

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

Robustness Tests

It may be argued that the results on positive assortative mating may be driven by females on the higher end of ability distribution, with higher years of schooling and in the workforce. In other words, marital assortative mating is driven by greater expectation of future wage income of wives. We derive estimates for assortative mating on education by excluding females *'who have ever worked for pay/wages'* and with years of schooling more than 10 years. The estimates in Table 3.5 provide association between years of schooling for husband and wife for a sub-sample where females either do not have sufficient education levels or have never generated any income, such that female education offers pure non-monetary benefits to the household. The estimates are consistent with the main specification, which suggests positive marital assortative mating in education, with results being weaker in districts with greater dowry prominence.

Table 3.5: Robustness validation instrumental variable estimates for marital assortative mating based on husband and wife's years of schooling

	Excludes women who have ever worked for wages		Excludes women with years of schooling>10	
Wife's Years of Schooling	(1)	(2)	(3)	(4)
Husband's Years of Schooling	1.352***	1.504***	1.102***	1.139***
	(0.0201)	(0.0557)	(0.0300)	(0.0748)
Dowry Death District*Husband's Years of Schooling		-0.211***		-0.179**
		(0.0552)		(0.0750)
High Dowry Deaths Districts		1.608***		1.089**
		(0.494)		(0.441)
District FE	Yes	No	Yes	No
State FE	No	Yes	No	Yes
Includes Controls	No	Yes	No	Yes
Observations	22,239	21,932	28,826	28,472

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

It may be argued that the instrumental variable estimates derived in Table 3.3, that directly tests for the joint association of husband and wife's years of schooling on dowry, may be driven by certain factors specific to individuals, household or the districts themselves. Robustness tests are presented in Table 3.6. Mother-in-law's schooling years are taken as an exogenous determinant of husband's education. Since dowry is measured as a perception of the head of the household, mother-in-law's education might not be completely exogenous if she herself is the head of the household. Models 1 and 2 therefore exclude households with female heads to remove simultaneity between mother-in-law's education and dowry. The estimates are found to be significant and close to the coefficients in the main model.

Models 3 and 4 exclude women from analysis who belonged to a different town or city before marriage so that the instrument, i.e., 'number of high schools in the district' for wife's education level is relevant. The IHDS-II data does not provide information on the district of residence of females before marriage. If a large number of women belonged to a different district, the IV would be irrelevant. Including only those females in the analysis that belong to the same district before marriage ensures that the IV is relevant for the eligible women's education levels.

Table 3.6: Robustness validation instrumental variable estimates for the association between dowry payments and years of schooling

	Exclude Household with Female Heads		Exclude Women from different Districts before marriage		Exclude Outlier Dowry Deaths Districts	
	(1)	(2)	(3)	(4)	(5)	(6)
Wife's Years of Schooling	-0.0632***	-0.216***	-0.0721***	-0.240***	-0.0620**	-0.244***
	(0.0240)	(0.0643)	(0.0266)	(0.0661)	(0.0266)	(0.0751)
Wife's Schooling*Husband's Schooling		-0.0775**		-0.0700***		-0.0726**
		(0.0317)		(0.0271)		(0.0354)
Husband's Years of Schooling	0.0878***	1.041***	0.0929***	0.930***	0.0826***	0.992**
	(0.0174)	(0.366)	(0.0194)	(0.298)	(0.0192)	(0.409)
State FE	Yes	Yes	Yes	Yes	Yes	Yes
Include Controls	No	Yes	No	Yes	No	Yes
Observations	14,819	14,342	13,033	12,001	12,589	11,614

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

Models 5 and 6 exclude the outlier districts in dowry deaths to ensure that the results are not driven by extreme values. Excluding the districts that either have a history of almost negligible dowry deaths or a large percentage of dowry deaths, we exclude any biasedness in the results that may be caused due to strong cultural norms or social beliefs.

The estimates from the validation tests are consistent, significant and similar to the main model. It validates that dowry payments are significantly and positively associated to male education. However, the rate of increase is lesser with additional years of female education.

3.6 Conclusion

Assortative mating in marriage market is a function of characteristics of potential brides and grooms and their respective households. The aim is to maximise household utility which is a function of both monetary and non-monetary traits. Monetary traits such as higher wages raise income and positively impact utility, whereas non-monetary traits such as appearance, intelligence, education, etc. bring down the household cost of production, thereby raising net utility. As proposed by Anderson (2007), households gain higher utility from brides and grooms with higher ability. Existing literature provides evidence of positive assortative mating on education. The studies argue that men with higher education prefer educated females in expectation of labour market wage income. However, in developing countries such as India factors such as poor female workforce participation, strong parental roles in marriage related decisions and existence of dowry as a social norm play a dominant role in marital choices relative to potential wage income of the bride. Female education is perceived as a non-monetary trait that leads to positive marginal utility in household production and fall in the cost of production. Therefore, on one hand, education of females would raise the utility of the post-marital household. On the other hand, there may exist substitutability between the education level of the bride and dowry transfers. A rise in female education may lead to a fall in dowry receipts by the groom's family. In theory, dowry acts as an equilibrating mechanism in the marriage market and can compensate for the differences in the ability gaps of the potential grooms and brides. Though dowry is strongly driven by social and cultural norms, yet the magnitude varies with the abilities of the potential groom and bride. The higher is the ability level of the groom, the larger is the net marital transfer from the bride to the groom's side. Thus, there exists a strong relationship between education levels of potential bride and marital assortative mating. The outcome may vary with the strength of substitution effect between female education and dowry payments.

An empirical assessment of assortative mating and dowry with rise in the education level of females in India using IHDS-II data suggests significant positive assortative mating on female education. Estimates suggest that brides and grooms tend to choose partners from their own ability distribution. This association however is found to be weaker in districts with relatively higher percentage of dowry deaths. This chapter proposes a basic theoretical model to support the empirical estimates. We suggest that a rise in female education would impact household utility or production through both a fall in dowry and reduction in cost of household production. On one hand, fall in dowry reduces the post-marital family income and hence utility and, on the other hand, a reduction in household cost of production would lead to an increase in household production, per unit of cost. A household should always gain from a rise in the education level of a male through both rise in dowry and fall in production cost, however, bride's education would have countering effects. Marital assortative mating decisions based on the education of potential bride and groom together would be determined by the cross marginal effects of education on household production. Magnitude and direction of cross effects of male and female education on dowry and household costs would determine the net effect on assortative mating. A rise in education of male and female, together, may either lead to offsetting or reinforcing effects on cost and dowry. Effects would be reinforcing in cost if a rise in education of both the bride and the groom generates increasing returns to scale and cost falls at a faster rate. The cost effects would be offsetting in the presence of decreasing returns to scale. Dowry may rise with male education but at a lower rate if the female is more educated. This generates offsetting effects on dowry. Parents of the bride on the other hand may be willing to pay a higher dowry for a better educated husband as the daughter attains higher education. In this case, dowry effect in education is reinforcing. The model suggests that positive assortative mating would be desirable for a household if the efficiencies achieved in cost are greater than the loss in dowry with rise in female education.

The empirical results for India using IHDS-II data provide evidence of positive assortative mating and suggest that the cost effects outweigh the fall in dowry effect. The effect is however found to be weaker in dowry prominent districts. This indicates that as social and cultural norms of dowry strengthen, substitutability between dowry and female education also increases. The marriage market allows dowry to compensate for relatively low education level of the bride. The analysis directly tests for joint association between male and female education and dowry. The estimates show that the dowry payments rise with additional years of male schooling and fall with female education. The effect of male and female education interaction variable on dowry is negative, indicating that dowry increases with male education but at a decreasing rate in response to rise in female education. Households are willing to accept lower dowry payments for a better educated bride. Probable endogeneity bias is addressed through instrumental variable estimation where the 'number of high schools' in a district is used as instrumental variable for female education. The estimates are found to be robust to validation tests which exclude factors specific to individuals, households or districts that may have driven the results.

Appendix 3A

3A.1 Derivation of Equation (3.7) and equation (3.8)

$$\frac{\partial Z}{\partial S_m} = \frac{\partial\left[D(S_m, S_f)C^{-1}\right]}{\partial S_m}$$

$$= \frac{\partial D}{\partial S_m} C^{-1} - C^{-2} \frac{\partial C}{\partial S_m} D(S_m, S_f)$$

Household production would increase with male years of schooling if:

$$D_m - C^{-1} C_m D(S_m, S_f) > 0$$

Dividing both sides by D and multiplying by S_m

$$\frac{\partial D}{\partial S_m}\frac{S_m}{D} - \frac{\partial C}{\partial S_m}\frac{S_m}{C} > 0$$

$$\tau_m - \omega_m > 0$$

Where $\tau_m = \frac{\partial D}{\partial S_m}.\frac{S_m}{D}$ and $\omega_m = \frac{\partial C}{\partial S_m}.\frac{S_m}{C}$

Equation (3.8)

$$\frac{\partial Z}{\partial S_f} = \frac{\partial\left[D(S_m, S_f)C^{-1}\right]}{\partial S_f}$$

$$= \frac{\partial D}{\partial S_f} C^{-1} - C^{-2} \frac{\partial C}{\partial S_f} D(S_m, S_f)$$

Household production would increase with female years of schooling if:

$$D_f - C^{-1} C_f D(S_m, S_f) > 0$$

Dividing both sides by D and multiplying by S_f

$$\frac{\partial D}{\partial S_f}\frac{S_f}{D} - \frac{\partial C}{\partial S_f}\frac{S_f}{C} > 0$$

$$\tau_f - \omega_f > 0$$

Where $\tau_f = \frac{\partial D}{\partial S_f}.\frac{S_f}{D}$ and $\omega_f = \frac{\partial C}{\partial S_f}.\frac{S_f}{C}$

3A.2 Derivation of Equation (3.10)

$$\frac{\partial Z}{\partial S_m} = \frac{\partial\left[D(S_m, S_f)C^{-1}\right]}{\partial S_m}$$

$$= \frac{\partial D}{\partial S_m}C^{-1} - C^{-2}\frac{\partial C}{\partial S_m}D(S_m, S_f)$$

$$= D_m C^{-1} - C^{-2}C_m D(S_m, S_f)$$

$$\frac{\partial^2 Z}{\partial S_m S_f} = D_{m.f}C^{-1} - C^{-2}D_m C_f - [\, C^{-2}C_m D_f - 2C^{-3}C_m C_f D + C^{-2}C_{m.f}D]$$

$$= C^{-1}D_{m.f} - C^{-2}D_m C_f - C^{-2}C_m D_f + 2C^{-3}C_m C_f D - C^{-2}C_{m.f}D$$

3A.3 Derivation of Equation (3.11')

$$2C^{-2}C_m C_f D - C^{-1}D_m C_f > C^{-1}C_{m.f}D + C^{-1}C_m D_f - D_{m.f} \qquad (3.11)$$

Multiplying both sides by S_m and dividing by D

$$2\frac{\partial C}{\partial S_m}\frac{S_m}{C} - \frac{\partial D}{\partial S_m}\frac{S_m}{D} > C\left[\frac{C_{m.f}DS_m}{C.D.C_f} + \frac{C_m D_f S_m}{C.D.C_f} - \frac{D_{m.f}S_m}{D.C_f}\right]$$

The left-hand side could be written as:

$$2\omega_m - \tau_m$$

We have three terms on the right sides of the equation.

The first term on the right-hand side could be written as:

$$C\left[\frac{C_{m.f}DS_m}{C.D.C_f}\right]$$

$$= \frac{\frac{\partial\left(\frac{\partial C}{\partial S_f}\right)}{\partial S_m}.S_m}{C_f}$$

$$= \frac{\partial C_f}{\partial S_m}\frac{S_m}{C_f}$$

$= \omega_{f.m}$

The second term on the right-hand side could be written as:

$$C\left[\frac{C_m D_f S_m}{C.D.C_f}\right]$$

Multiplying and dividing by S_f

$$= \frac{C\frac{\partial C}{\partial S_m}\frac{\partial D}{\partial S_f}S_m}{C.D\frac{\partial C}{\partial S_f}}.\frac{S_f}{S_f}$$

$$= \frac{\omega_m.\tau_f}{\omega_f}$$

Third term on the right-hand side could be written as:

$$C\left[\frac{D_{m.f}S_m}{D.C_f}\right]$$

$$= C\frac{\frac{\partial\left(\frac{\partial D}{\partial S_m}\right)}{\partial S_f}.S_m}{D.C_f}$$

$$= \frac{\frac{\partial D_m}{\partial S_f} . S_m}{\frac{D}{C} \cdot \frac{\partial C}{\partial S_f}}$$

In the numerator, multiplying and dividing by D_m and S_f

$$= \frac{\frac{\partial D_m}{\partial S_f} \frac{S_f}{D_m} \frac{D_m}{S_f} . S_m}{\frac{D}{C} \cdot \frac{\partial C}{\partial S_f}}$$

$$= \frac{\tau_{m.f} . \tau_m}{\omega_f}$$

Equation (3.11) therefore could be written as:

$$2\omega_m \omega_f - \tau_m \omega_f > \omega_{f.m} \omega_f + \omega_m . \tau_f - \tau_{m.f} . \tau_m \qquad (3.11')$$

Table 3A.1: Descriptive statistics for individual, household and district characteristics (IHDS-II)

Individual and Household	**Obs.**	**Mean**	**Std. Dev.**	**Minimum**	**Maximum**
Wife Education	40349	5.14	4.90	0	16
Husband Education	37675	7.08	4.82	0	16
Wife's Mother's Education	40191	1.47	3.03	0	16
Husband's Mother's Education	40105	1.10	2.64	0	16
Average Education of Household	41912	7.04	4.55	0	16
Average Wedding Expenditure by Groom	45308	161,248	184,746	-	8,500,000
Average Wedding Expenditure by Bride	45302	248,641	257,202	-	8,500,000
Net Wedding Expenditure of Bride over Groom	45295	87,393	192,686	(6,750,000)	7,500,000
Household Income	45581	131,613	214,195	(1,037,040)	11,400,000
District					
Number of Schools in District	186	352	273	30	1373
Sex Ratio (10-16 years)	365	1098	70	951	1331
Dowry Deaths (proportion of married females)	349	1.48	1.23	0	8.40

CHAPTER 4: FEMALE WORKFORCE PARTIPATION AND CRIME OUTCOMES: AN ANALYSIS FROM DISTRICTS OF INDIA

4.1 Introduction

During the past few decades, India has witnessed important socio-economic structural changes. High rates of economic growth have led to an increase in total workforce participation rate. According to the Census of India, it has increased from 36 percent in 1981 to 39.8 per cent in 2011 (Census of India). The gender gap in workforce participation rate has however remained persistent through the decades. Female workforce participation has increased marginally from 19.8 percent in 1981 to 25.5 percent in 2011. Male workforce participation on the contrary has remained significantly higher at 52.7 per cent and 53.3 per cent in 1981 and 2011 respectively, as compared to females. Amongst other social and economic outcomes of employment opportunities, these trends in workforce have strong effects on incidences of crime. Statistics from National Crime Records Bureau (NCRB) report an increase of 1.1 percent in total cognizable crimes under IPC (Indian Penal Code) and 7.39 percent rise in murder rates from 1953 to 2006. On one hand, the *'motivation theory'* of crime proposes that a rise in labour market opportunities increases the opportunity cost of apprehension and conviction and hence acts as a disincentive to engage in criminal activities (Becker, 1968). On the other hand, the theory of *'opportunity effect'* suggests that as more people join the labour market, it raises the risk of exposure to crime and offers greater opportunity to offenders to access a larger pool of probable targets (Kapuscinski, Braithwaite and Chapman,1998). The net effect of employment on crime rates is hence ambiguous. Most of the studies in literature however show that a rise in employment and labour force participation leads to a decline in crime rates.

In this chapter we estimate the effect of female workforce participation on violent and non-violent crimes for the districts of India from 1961 to 2001[40]. Female workforce

[40] Females who are either 'working' (or employed) or 'seeking or available for work' (or unemployed) during the reference period together as a percentage of total female population in the working age group constitute female labour force participation (FLPR). Female Workforce participation rate (FWPR) is defined as the percentage of total females 'working' (or employed) to the total female population in the working

participation is found to be closely associated with various socio-economic outcomes such as increasing education, labour market effects such as changes in equilibrium wage and increased competition (Lundholm and Ohlsson, 1998). It may also alter equilibrium levels of marital transfers in the marriage market, as well as alter the role of females in intra-household decision making (Anderson, 2004). A lot of these changes due to increased female workforce, affect crime rates by altering the relative utility between legal and illegal engagements and the incentive to commit crime.

Female workforce participation should affect crime due to at least four reasons. First, as more females enter the labour force it increases competition in the labour market. On one hand, this may lead to an increase in crime against women such as homicides, kidnapping and rape (Cohen and Felson, 1979). This is because as more females leave their homes to enter the labour force, they are more likely to be victims of crime. Increased female workforce participation may also pose a threat to male bargaining power and encourage them to commit more crime against women (Blanco and Villa, 2008). However, on the other hand, increased female workforce participation raises labour market competition if men and women compete for the same job. This demands higher investment in education and skills among men to gain competitiveness in the labour market. Increase in the levels of human capital investment is shown to be a strong deterrent of crime which should lead to a fall in crime incidences. The net effect due to increased participation of females in the labour market on crime due to changes in labour competitiveness, unemployment rates and wages may thus be ambiguous.

Second, if greater female workforce participation empowers women, they are more likely to report crime (Iyer, et. al., 2011). Increased reporting of crime would increase the probability of apprehension and conviction. This would raise the opportunity cost of criminal engagements. This should reduce the crime rates.

age group (Census of India, Survey). Since females who are ‘working’ would have a greater effect on crime through channels proposed than the females ‘seeking or available for work’, thus we derive the estimates using female workforce participation rate (FWPR) rather than female labour force participation (FLPR).

Third, increased female workforce participation may provide females with greater bargaining power in the marriage market. In an Indian institutional set up with prevalence of dowry[41], increased female workforce participation would lead men to invest in their human capital and labour market in order to attract high quality bride and receive larger dowry payments (Anderson, 2007; Dalmia, 2004). The greater investment in human capital should reduce crime.

Fourth, we can also expect increased female workforce participation to have long run effects on crime if it has social externality effects. There is evidence of changes in social norms with increased participation of females in the workforce. It is shown to be positively associated with investment in children's education, particularly among girls, gender parity, greater acceptability towards role of females in non-traditional tasks and rise in moral standards (Qian, 2008). This change in societal behavior and attitude with increased female workforce participation would lead to a fall in crime rates in the long run (Akerlof, 1980).

This chapter contributes to the literature on workforce participation and crime as we estimate the effect on crime rates, both contemporaneous and in the long run. The existing studies only provide evidence for effects of female workforce participation on either crime against women or crime committed by women. But to the best of our knowledge, none of the studies measure how an increase in female workforce participation may affect the opportunity cost of criminal engagement in general and not crimes specifically associated with females.

Using census data for districts of India from 1961 to 2001, we estimate the effect of female workforce participation on violent and non-violent crimes. This chapter estimates the contemporaneous effect of female workforce on incidences of crime between 1971 and 2001. The estimates may however be biased due to potential endogeneity because of both omitted variable bias and reverse causality. We estimate the effects of lagged female workforce on crime to address potential endogeneity that may arise due to reverse causality. Another advantage of using lagged female participation is that we can measure the persistent effects of females' economic participation on crime in the long run. The

[41] Dowry is the net marital transfer from the bride's family to the groom's family at the time of marriage. This could be a onetime transfer or may be incurred at different intervals.

contemporaneous effects however should be interpreted with a caveat that the estimates may be downward biased due to the reverse causal effect of higher crime rates on female workforce.

The rest of the chapter is structured as follows. Section 4.2 reviews the literature in detail. Section 4.3 outlays the variables used for the analysis and the data sources. This section also motivates the research question through trend analysis between female workforce participation and crime rates. Section 4.4 details the empirical estimation and identification strategy to test for potential endogeneity bias. Empirical results and analysis are presented in section 4.5. Section 4.6 concludes with the findings and policy implications of the study.

4.2 Literature Review

As the labour market opportunities increases, it raises the opportunity cost of apprehension and conviction and hence reduces the incentive to engage in criminal activities (Becker, 1968; Ehrlich, 1973). Another strand of literature, however, on the hand suggests that higher levels of workforce participation may lead to an increase in crime rates due to increased exposure to crime and probability of victimization (Cantor and Land, 1985; Cohen and Felson, 1979). The economic relation between crime and employment is thus ambiguous.

Studies on the effect of female workforce participation on crime emphasize on the ‘opportunity effect’ of potential offenders to access a larger pool of probable victims. As females participate more in the workforce, it increases their exposure to crime and risk of probable victimization. Kapuscinski, Braithwaite and Chapman (1998) estimate a significant and positive effect of female employment on homicide rates in Australia. They argue that the results are driven by increased exposure and victimization as a consequence of increased female employment. In a similar study, Cohen and Felson (1979) find that an increase in female work force participation is associated with a rise in violent and non-violent crimes with the increase in time spent outside the secure boundaries of home. Gartner, Baker and Pampel (1990) show that gender gap in victimization narrows as more females participate in the labour market or enrol for college. This is due to greater exposure of females to crime and victimization.

Another strand of literature argues that the changing role of females is a threat to the male bargaining power. Blanco and Villa (2008) show evidence of rise in crimes such as rape and grievous bodily harms when females experience gains in the labour market, in Veracruz, Mexico. The study suggests that the Latin American crises during 1980s and 1990s forced females to enter non-traditional roles to support household income. This rise in socio-economic status of females generates envy among men and raises the probability of female victimization.

An increase in non-traditional roles of women and greater participation in the socio-economic areas may significantly alter societal behaviour and attitude towards women. Traditional norms such as classification of gender roles, if violated, may not only cause loss of reputation but may also incentivize punishment for the offenders. Such traditional customs and social beliefs may cease to exist if the expected economic gains from offending, such as increased participation of females in male dominated roles exceeds the costs in terms of social stigma or victimization. This may lead the social codes to evolve and allow establishment of new societal and cultural norms in favour of women (Akerlof, 1980; Elster 1989).

Existing studies also provide evidence for other mechanisms through which female workforce participation may impact crime rates in a society. Witt and Witte (2000) argue that an increase in role of females in the non-traditional sector leads to changes in the social structure and family norms. According to the paper, in the U.S., increased female workforce is seen as a proxy of changing family structure such as rise in single parent families. Increased female work force participation thus may lead to lesser time spent with children. This may cause children to associate with illicit agents and lead to an increase in incidences of crime. The study finds that the association between female workforce participation and crime rates is stronger in the short run relative to the long run. In the long run, institutions such as schools, child care providers and employers find ways to provide substitution for child care, usually provided by non-working mothers.

Contrary to the arguments of child care substitution provided by Witt and Witte (2000), Afridi, Mukhopadhyay and Sahoo (2016) find strong evidence of better educational outcomes for children with increased female workforce participation. The association is driven by improvement in women empowerment with enhanced labour market opportunities. This rise in levels of education is seen to be a strong inhibitor of criminal engagements (Ehrlich, 1975; Lochner and Moretti, 2004; Buonanno and Leonida, 2009). Iyer et.al (2011) though show a rise in crime against women with increases political representation in local government. They argue that these results are driven by increase in reporting rates rather than greater incidences. Female workforce participation is therefore likely to bring down the crime rates in the long run.

While the literature is indicative of female workforce participation and its effect on reducing the crime rates in general, there is evidence that female offending rates increase when women engage in non-traditional roles. The nature of delinquencies is however limited to white collar crimes and motives mainly driven by self-defence and challenge to oppression (Grasmick, Finley and Glaser, 1984; Simon, 1975; Chesney-Lind and Pasco, 2013; Hartnagel, 1982; Chesney-Lind, 1986). Moreover, the studies suggest that moral standards of females are higher as compared to men. Halpern (2001) found that self-interest values, patterns of offending and tolerance levels differ between men and women. They argue that this explains nearly two-thirds of the variance in victimization. It is therefore unlikely that female workforce participation would lead to a net increase in overall crime rates.

Thus, the evidence suggests that greater female participation is a strong deterrent to crime. It leads to an increase in levels of education and a decline in patriarchal societal norms. As females increase participation in non-traditional roles, the traditional male dominance is seen to diminish. Greater representation of females creates higher acceptability and reduces tolerance against crime in general (Akerlof, 1980).

Existing studies supports the view that there is a reduction in crime rates as females gain better employment opportunities. It is also argued that female workforce participation improves female socio-economic status and bargaining power in the marriage market. This may affect crime through changes in equilibrium outcomes in the marriage market. Anderson (2007; 2004) in the economic model of marital transfers and dowry payments suggest that such transfers act as an equilibrating mechanism in the demand and supply marriage market. Dowry acts as a wedge between the characteristics of grooms and brides

(Dalmia, 2004, Dalmia and Lawrence, 2005). Greater female work force participation therefore, could raise the bargaining power of the potential brides and incentivize greater investment in education and labour hours by men to gain competitiveness in the marriage market. Greater investment in human capital is therefore a natural outcome of higher female work force participation. Moreover, a rise in average bride characteristics alters the property rights over marital transfers in favour of females (Anderson and Bidner, 2015). This places additional accountability on grooms to support household sustenance and require an increase in labour time and savings rate, which are shown to constrain criminal engagements (Gould, Weinberg and Mustard, 2002; Crutchfiel and Pitchford, 1997).

One could however also argue that there exists a reverse causal impact of higher crime rates on women labour force participation. Higher crime rates, especially crimes against women are shown to significantly discourage female participation in the labour force. Chakraborty et. al. (2018) find that in societies where the stigma cost of crime against women is high, females are less likely to work outside the safe boundaries of home. Lloyd (1997) observes that females are more likely to experience unemployment relative to men due to fear of victimization. Domestic violence is also shown to inhibit socio-economic status of women. Females who are victims of domestic violence are more likely to be socially and financially dependent on spouse income. This not only constrains female decision-making powers but also affects investment in human capital that restricts their competitiveness in the labour market.

The literature also finds that female investment in human capital in terms of attaining higher education and market-oriented skills may be hampered due to increased exposure and victimization of women. Potter et. al. (2018), study the long-term impact of sexual assault among undergraduate female students on life time human capital investment and career goals. The estimates show significant losses to female student human capital and mental and physical health due to incidences of assault and victimization. Higher crime rates specifically against women not only discourage female work force participation but also impede investment in education and job market skills. Such reversal effects are likely to cause an identification problem in estimation of the contemporaneous effect of female work force participation rate on crime. Certain social and cultural factors may also lead to endogeneity issue due to omitted variable bias[42].

4.3 Data

The analysis required data on district level female workforce participation and incidences of crime, from 1961 till 2001. Estimates for the contemporaneous effects of female workforce participation on crime are derived from data between 1971 and 2001[43]. Long run estimates on the other hand use data from 1961 till 2001. We gather data on district level female workforce participation and other controls such as literacy rate, urbanization rate and sex ratio from the decennial national survey, 'Census of India'. Districts are the third geographic tier for data dissemination after national and state-level tiers. Geographical structure and boundaries of districts have changed significantly due to amalgamations and partitions within the existing districts in the past decades. Where there were 356 districts in 1971, the number has increased to 640 in 2011 with only 38 percent remaining unaffected by boundary changes (Kumar and Somanathan, 2009). The changing boundaries of the Indian districts across the census years makes it difficult to control for historical, geographical and social characteristics, relevant for the study. We created a balanced panel of districts over different time periods using district population weights to map districts[44]. The weights are used to map districts for each period to the administrative divisions in 1971. This gives us a balanced panel of 333 districts in each census year.

4.3.1 Census Data

Female workforce participation is measured as the number of females in the workforce as a proportion of total workforce. This includes both the marginal and main workers. Census of India, defines workers who had worked for the major part of the reference period (i.e. 6 months or more) as the 'Main Workers'. 'Marginal Workers' are those who have worked

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[42] Proportion of Muslim population in a district is a potential IV to address the endogeneity. Srivastava and Srivastava (2010) shows that female workforce participation rate of Muslim women is nearly half as compared to the national average of all other religions. However, district level population by religion is available for only 2011 census, thus the panel nature of the data cannot be used.

[43] District level crime data is available since 1971. Therefore, we could estimate contemporaneous effects between 1971 and 2001.

[44] The weights are provided by the Office of the Registrar General and Census Commissioner, India.

less than 6 months in the reference period. Female workforce participation includes both married and unmarried females, 15-59 years.

Control variables such as literacy rate, proportion of schedule caste and schedule tribe population[45], sex ratio (number of females per 1000 males) and urbanization rate (population proportion residing in urban areas) are obtained from the Census.

Descriptive statistics for the census variables are shown in the Table 4A.1 in appendix. The proportion of female workforce in total workforce is only 21 percent during 1961-2001, with a slight increase to 33 percent in 2011. Sex ratio is severely skewed at 933 girls per 1000 boys during the entire period. It has worsened overtime from 941 in 1961 to 933 in 2001. Though there is an increase in overall sex ratio from 933 in 2001 to 943 in 2011, child sex ratio shows a fall from 927 to 919 girl child per 1000 male child

We study two crime outcomes, violent crimes and non-violent crimes, per 100,000 population in the district. Violent crime is measured as a sum of murders, attempt to murder, rape, kidnapping, dacoity[46] and riots. Non-violent crime comprises of robbery, burglary, theft, criminal breach of trust, cheating and counterfeiting. The data is obtained from the National Crime Records Bureau (NCRB) and is available since 1971. Crime against women is subject to reporting bias especially in India due to social and economic cost associated with stigma attached to such crimes. Thus, we do not study gender specific crimes separately. Violent crimes though, capture the components of crime against women such as rape and kidnapping which are more likely to be reported

Table 4A.2 in appendix presents the descriptive statistics for crime. We present the statistics both for aggregate crime and its different components. The data suggests that the incidences of non-violent crime are higher than the incidences of violent crime. On an

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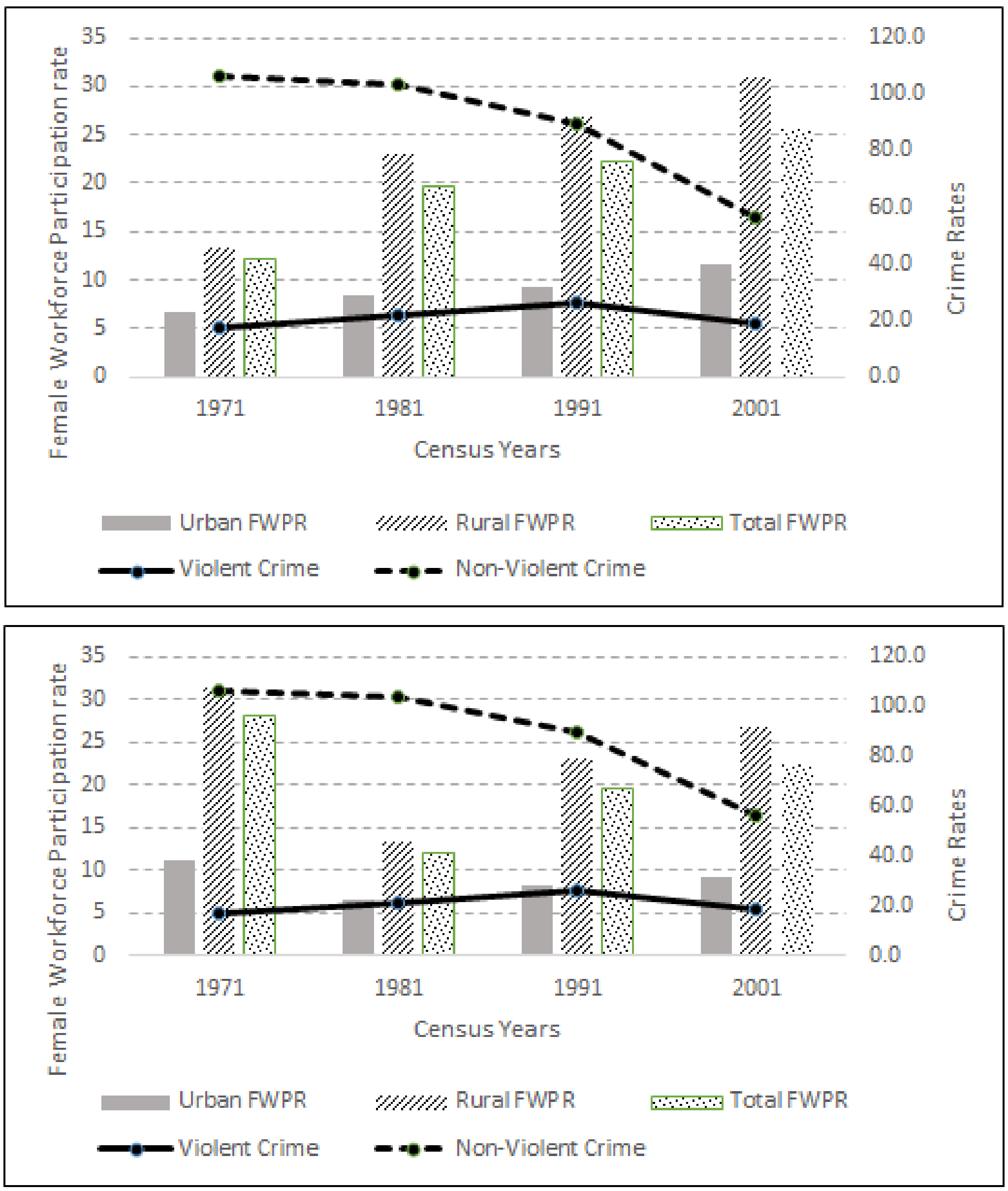
[45] Scheduled Caste and Schedule Tribes are the officially designated groups of historically disadvantaged individuals in India. The terms are recognized in the Constitution of India and the groups are designated in one or the other of the categories. These groups are more vulnerable to victimization and oppression.

[46] "When five or more persons conjointly commit or attempt to commit a robbery, or where the whole number of persons conjointly committing or attempting to commit a robbery, and persons present and aiding such commission or attempt, amount to five or more, every person so committing, attempting or aiding, is said to commit "dacoity" (Section 391, Indian Penal Code)

average, there were approximately 70 non-violent crimes reported per 100,000 individuals as compared to around 22 cases reported for violent crimes. Cases of rape and kidnapping specifically document an increase. This may however be due to an increase in reporting over time with increase in literacy levels and increase in policing. Among non-violent crimes, burglary and theft are the largest components whereas riots are highest under violent crime.

Figure 4. 1: Trend analysis for proportion of (a) female work force (b) lagged female workforce against Violent and Non-Violent Crime (per 100,000 population)



Data source: Census of India for FWPR and NCRB for crime rates

A graphical analysis of the association between female workforce rate and crime percentages in Figure 4.1(a) above indicates a fall in non-violent crimes with increasing female workforce participation. Non-violent crimes reduced from 82 incidences per 100,000 persons in 1971 to 38 in 2001. Since 1971, Indian economy has also witnessed a continuous rise in female workforce till 2001. Total female workforce participation was 12.06, 19.67, 22.27 and 25.68 respectively in 1971, 1981, 1991 and 2001. This increase has been more pronounced in the rural areas. This is due to male urban migration and diversification of agricultural activities which led to an increase in demand for female labour. Despite greater representation of females in the workforce since 1971, violent crime rate shows a rise till 1991. It however falls between 1991 and 2001 from 26.3 to 18.7 incidences per 100,000 persons. Graphical trends do not suggest a consistent association between female workforce participation trends and crime.

In Figure 4.1(b), the x-axis shows crime rates plotted against female workforce from the previous period or census year. For example, crime at 1971 is plotted against female workforce participation in 1961. The trends indicate a steep decline in rate of female workers from 1961 to 1971. Existing studies suggest a decline in female workforce in agricultural sector between 1961 and 1971 due to technological advances such as, use of High Yielding Variety (HYV) seeds. These advances further reduced females' marginal roles in agriculture. However, between 1971 and 2001, statistics show a continuous rise in female workforce. The graphs indicate that periods with a rise in female workforce are accompanied with a fall in non-violent crime rates in the long run. Violent crimes show an initial rise with an increase in female workforce participation, but a decline as female workforce rises further. As female workforce increases initially, 'opportunity effect' and victimization rate may be stronger due to increased exposure to risk and greater competition in the labour market (Kapuscinski, Braithwaite and Chapman,1998). In the long run however, changes in social and economic structure, such as rise in education, greater gender parity, availability of substitutes for mother's time and attention may bring down violent crimes (Afridi, Mukhopadhyay and Sahoo, 2016; Akerlof 1980; Ehrlich, 1975).

The scatter plot in Figure 4.2 indicates a negative association between female workforce rate and violent and non-violent crimes. This negative association is however not causal, as it may be driven by district level or time variant characteristics such as literacy rate, income and sex ratio which have not been controlled for here. Figure 4.3 plots the decade lagged female workforce participation in crime rate. The association of lagged female workforce participation is also shown to be negative for both violent and non-violent crimes.

Figure 4. 2: Scatter plot of contemporaneous Proportion of female work force against Violent and Non-Violent Crime (per 100,000 population)

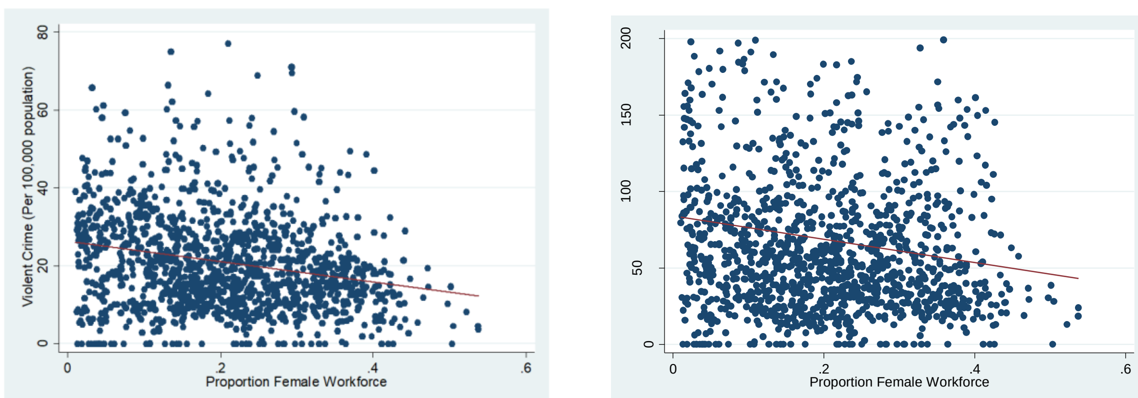
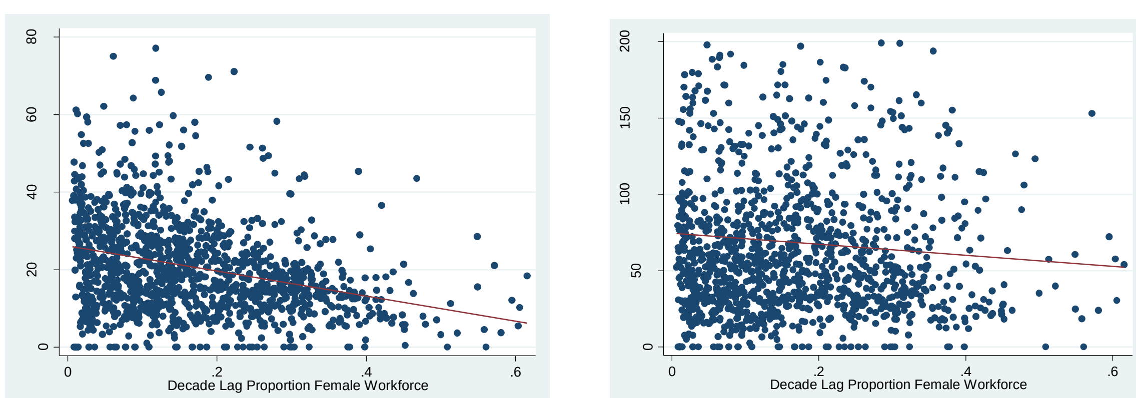


Figure 4.3: Scatter plot of Decade lagged Proportion of female work force against Violent and Non-Violent Crime (per 100,000 population)



4.4 Empirical Strategy

4.4.1 Contemporaneous Effects

Equation (4.1) below shows OLS regression with district and time fixed effects.

$$Crime_{dt} = \beta_0 + \beta_1 FWPR_{dt} + \beta_2 X_{dt} + \Upsilon_d + \delta_t + \varepsilon_{dt} \quad (4.1)$$

$Crime_{dt}$ refers to crime in district d in time t where t ranges from 1971 till 2001. Υ_d captures the district specific characteristics invariant over time. δ_t controls for year fixed effects. β_2 is the estimates vector for the district specific controls such as urbanization rate, schedule caste and schedule tribe population (the marginalized class), sex ratio etc.

Table 4. 1: The contemporaneous effects of female workforce participation on Violent and Non-Violent Crime

	Violent Crime			Non-Violent Crime		
	(1)	(2)	(3)	(4)	(5)	(6)
Female workforce participation	-11.88*	-6.609	-6.994	80.65**	107.2***	106.7***
	(7.082)	(7.061)	(7.043)	(38.47)	(36.86)	(37.00)
Literacy rate		19.84	22.25*		147.0**	149.8***
		(12.10)	(12.18)		(58.04)	(57.81)
Schedule Caste Proportion		-2.636	-1.989		9.806	10.55
		(14.92)	(14.76)		(72.23)	(72.09)
Schedule Tribe proportion		-4.058	-4.230		-9.199	-9.396
		(14.15)	(14.10)		(36.70)	(36.72)
Urbanization rate		20.17	18.87		56.75	55.27
		(16.97)	(16.67)		(48.15)	(47.76)
Sex Ratio (Females per 1000 males)			0.0214***			0.0245
			(0.00656)			(0.0573)
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
District Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,304	1,276	1,276	1,304	1,276	1,276
R-squared	0.117	0.126	0.129	0.219	0.222	0.222
Number of district_id	333	333	333	333	333	333

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

Table 4.1 presents the results for the contemporaneous effect of female workforce participation on crime outcomes. Models with time and district fixed effects in column 1, suggest a fall in violent crime rates by approximately 0.6 percent with a one percent increase in female workforce participation (Relative to a mean of approximately 12 registered violent crimes per 100,000 population). The estimates however are insignificant with inclusion of other controls in columns 2 and 3. Estimates for non-violent crimes on the other hand are not only significant but indicate a positive association between the two. Column 6 provides estimates for the contemporaneous effect of female workforce on non-violent crime rates and includes relevant controls. The estimates suggest a 1.5 percent rise in non-violent crimes with a one percent rise in female workforce participation rate (relative to a mean of approximately 70 registered non-violent crimes per 100,000 population). The *'opportunity effect'* theory may explain the positive estimates for non-violent crimes. Higher exposure of females to victimization outside the safe boundaries of home and greater accessibility for illicit agents to a larger pool of potential targets may drive the results. A positive association may also arise with inability of the labour market to absorb the rise in available labour causing unemployment. A rise in unemployment rate provides incentive to commit crime, not only to raise financial resources but also because it reduces the cost of apprehension and conviction.

The contemporaneous effects may suffer from omitted variable bias due to certain cultural and social factors that may affect female workforce participation and crime rates simultaneously. Instrumental variable estimation could be a probable identification strategy to circumvent the bias. However, both female workforce participation and crime are closely associated with most of the social, economic and historical factors, which is why it is hard to find an instrument that is exogenous to the model. We attempted using proportion of Muslim population as the potential IV for female workforce participation. Srivastava and Srivastava (2010) shows that female workforce participation rate of Muslim women is nearly half as compared to the national average of all other religions. Muslim women face relatively more stringent social norms and traditional expectations that restrict female mobility and work opportunities. Doumato (1999) quotes the Islamic ideological beliefs that restricts males' and females' common areas of work and thus constrains expansion of work opportunities for females in Saudi Arabia. A strong hold of traditional values governed by religious norms does not permit males and females to work together. This has limited labour force participation of Muslim women to 'women only jobs' that minimize interaction with the gender counterpart. Muslim women find larger challenges to education attainment; which is a strong determinant of work opportunities (Tyrer and

Ahmad, 2006; Srimulyani, 2007; Hamdan, 2005). Literature provides sufficient support that suggests association between female workforce participation and religious affiliation.

However, population by religion at the district level is available only for 2011. The IV estimates suggest a fall in violent and non-violent crimes with a rise in female workforce participation. These results are opposite to the estimates for contemporaneous effects for panel 1961 to 2001 in Table 4.1, which show a rise in crime with increase in female workforce. The IV estimates are derived from cross sectional data and does not control for the time invariant characteristics of the districts and variation over years. This makes it hard to compare estimates from two strategies, pooled OLS and IV in the absence of an overlapping analysis period and may explain the opposite results[47].

The estimates in Table 4.1 may also be potentially biased due to reverse causality and simultaneity. Not only does female workforce participation affects crime rates, but incidences of crime may also affect female workforce. Districts with higher crime rates may constrain female workforce participation as females find it unsafe and insecure to move out of the safe boundaries of home to work.

To deal with the simultaneity bias, we study the effect of lagged female work force participation rate on crime. Crime in period 't' is unlikely to impact female work participation in the previous time periods. A decade lag marks a structural shift in the economy with females assuming greater socio-economic roles and earning greater acceptability with improved status and increased bargaining in the marriage market. The lagged coefficients would also provide an estimate for the effect of female workforce participation on crime in the longer run.

Equation (4.2) below shows the OLS regression for lagged effects[48] of female workforce participation on crime with district and time fixed effects.

$$Crime_{dt} = \alpha_0 + \alpha_1 FWPR_{dt-1} + \alpha_2 X_{dt} + \eta_d + \theta_t + \mu_{dt} \qquad (4.2)$$

[47] We tried other variables as an IV for female workforce participation such as number of women hostels and number of textile industries that largely employ women. However, the data was insufficient to derive robust estimates.

[48] Since the data is decadal, hence a lag of 1 period would indicate a lag of a decade.

$\alpha_1$is the coefficient for a decade lagged effect of female workforce participation on crime incidences per 100,000 people. α_2 is the vector for district specific controls as included in equation 4.1 for contemporaneous effects. η_d controls for district fixed effects and θ_t controls for year fixed effects.

Table 4.2: Lagged effects of female workforce participation on Violent and Non-Violent Crime

	Violent Crime			Non-Violent Crime		
	(1)	(2)	(3)	(4)	(5)	(6)
Lagged female workforce participation	-24.19*	-23.96*	-23.48*	-148.9***	-157.7***	-179.5***
	(14.6)	(13.51)	(13.76)	(46.41)	(45.89)	(47.29)
Female workforce participation			-3.025			137.4***
			(7.175)			(34.87)
Literacy rate		21.32*	20.98*		128.0**	143.1**
		(11.45)	(11.58)		(55.61)	(56.38)
Schedule Caste Proportion		-2.123	-2.435		2.135	16.31
		(13.16)	(13.10)		(76.57)	(73.64)
Schedule Tribe proportion		-8.153	-7.813		22.81	7.358
		(13.44)	(13.64)		(34.94)	(35.43)
Urbanization rate		17.44	17.28		39.84	47.05
		(17.77)	(17.87)		(49.91)	(51.24)
Sex Ratio (Females per 1000 males)		0.0203***	0.0204***		0.0277	0.0257
		(0.00690)	(0.00684)		(0.0502)	(0.0563)
Observations	1,288	1,262	1,262	1,288	1,262	1,262
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
District Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.115	0.127	0.127	0.224	0.225	0.234

Heteroskedasticity robust standard errors in parentheses

***** p<0.01, ** p<0.05, * p<0.1**

Estimates for a decade lagged effects of female workforce participation are presented in Table 4.2. The estimates suggest that an increase in female workforce participation leads to a significant decline in both violent and non-violent crimes with a lag of one decade. Columns 2 and 5 shows the estimates for lagged effect of female workforce on violent and non-violent crimes respectively. The analysis includes district specific controls along with year and district fixed effects. The results indicate that a one percentage increase in female workforce is estimated to reduce violent crime by approximately 1.1 percent (relative to mean of approximately 21 registered incidences) and non-violent crime by 2.24 percent (relative to mean). This is equivalent to 24 lesser incidences of violent crime and 158 lesser incidences of non-violent crimes per 100,000 persons with a one percentage increase in female work force rate.

A brief comparison with the contemporaneous effects suggests that though in the short run a rise in female workforce participation may lead to a rise in non-violent crimes and no significant effects on violent crimes, in the long run however, the results show a negative association between the two. As the literature indicates, a rise in female workforce participation has a significant impact on socio-economic outcomes such as rise in children's education levels, particularly girls, increased human capital investment by men to gain competitiveness in the labour and marriage market and greater gender parity. All such changes in the long run either raise the apprehension and conviction cost of crime and discourage engagement in illicit activities, or, alter societal attitudes and norms towards greater acceptability of increased socio-economic roles of females, reduced tolerance towards crime or higher standards of mutual respect and equality. All these factors should lead to a fall in crime rates, both violent and non-violent, in the long run.

The estimates may still be subject to potential bias due to omitted variables. However, availability of data constrains the addressal of this issue using an IV strategy.

Estimates on lagged effects of female workforce participation may also be biased since contemporaneous female workforce participation may also affect crime rate, simultaneously. Moreover, effects of female workforce participation are persistent, not only for incidences of crime, but the rate at which females participates in the labour market. Districts with a history of higher female workforce are more likely to have a larger share of females in the labour market, in present and future. Columns 3 and 6 include contemporaneous female workforce participation rate along with the lagged female workforce variable. The estimates for violent crime, both for the contemporaneous and lagged effects of female workforce are consistent with the previous analysis, which shows an insignificant effect contemporaneously and a decline of 1.1 percent relative to the mean. The estimates for non-violent crime show that the effects are not only directionally consistent but are stronger. Results suggests that a one percentage increase in female workforce leads to a rise of non-violent crimes by 2 percent (relative to the mean) contemporaneously. However, with a lagged decade, a one percentage increase in female workforce leads to decline by 2.6 percent (relative to the mean).

It is worth estimating the effects of female workforce participation on disaggregated crimes. Table 4.3 below shows the estimates for both contemporaneous and lagged effects of female workforce participation rate on different types of crime.

Table 4. 3: Effect of female workforce participation on disaggregated crime rates: Contemporaneous and Lagged

	Contemporaneous		**Lagged Effects**	
	Estimates	**Standard Error**	**Estimates**	**Standard Error**
	(1)	(2)	(3)	(4)
Murder	-4.040***	(1.038)	-2.134**	(0.937)
Attempt to Murder	-4.481***	(0.830)	-2.548***	(0.606)
Rape	-0.713*	(0.422)	0.168	(0.371)
Kidnapping	-2.307***	(0.851)	-2.199***	(0.697)
Dacoity	-2.987***	(0.611)	-2.316***	(0.640)
Robbery	-1.218	(1.427)	-2.048	(1.344)
Riots	-15.30***	(3.699)	-18.97***	(4.335)
Burglary	11.26*	(6.537)	4.055	(6.209)
Theft	19.36	(14.85)	-3.260	(12.72)
Cheating	0.109	(1.050)	-2.062**	(0.899)
Counterfeiting	0.130	(0.232)	0.00574	(0.168)
Controls	Yes		Yes	
District FE	Yes		Yes	
Year FE	Yes		Yes	
N	1248		1234	

Heteroskedasticity robust standard errors in parentheses

***** p<0.01, ** p<0.05, * p<0.1**

Columns 1 and 2 show the estimates and standard errors for contemporaneous effects respectively. Lagged effect estimates and standard errors are in columns 3 and 4. Results suggests that a rise in female workforce participation contemporaneously leads to a significant decline in crimes violent in nature, such as murder, rape, kidnapping, dacoity and riots. Contemporaneous effect of female workforce on non-violent crimes such as theft, cheating, counterfeiting is directionally increasing, though insignificant. Burglary however is significant and shows a rise of approximately 11 more incidences with a percentage rise in female workforce contemporaneously. In the long run, with a decade lag, a rise in female workforce participation is seen to reduce violent crimes significantly. Cheating under non-violent crime is negative and significant.

Robustness checks

Levels of income, provision of infrastructure and work opportunities may vary widely between the urban and rural areas and might affect female labour market opportunities differently. For instance, districts with better infrastructure and larger number of schools facilitate females' attainment of higher education and gain competitiveness in the labour market. On the other hand, the poorer districts may distribute education in favour of male child affecting female future labour market opportunities. In Table 4.4, we show results by dropping 10 percent most urban districts and 10 percent most rural districts.

Table 4.4: Effect of female workforce participation on violent and non-violent crimes (excluding most 10% rural and most 10% urban districts)

	Contemporaneous Effects				Lagged Effects			
	Violent Crime		**Non-violent Crime**		**Violent Crime**		**Non-violent Crime**	
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Contemporaneous Female Workforce	-12.79	-12.79	173.88***	188.03***	-11.77	25.21***	177.19***	114.67***
	(10.60)	(10.60)	(51.72)	(45.96)	(10.49)	(9.66)	(51.63)	-42.98
Lagged Female Workforce					-27.37*	-54.98***	-151.21**	-103.55***
					(16.30)	(11.07)	(67.17)	(40.28)
Controls	No	Yes	No	Yes	No	Yes	No	Yes
District FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	944	943	944	943	940	939	940	939
R-squared	0.16	0.17	0.18	0.21	0.16	0.080	0.20	0.17

Robust standard errors in parentheses

***** p<0.01, ** p<0.05, * p<0.1**

Columns 1 to 4 show estimates for the contemporaneous effects of female workforce violent and non-violent crimes. Columns 5 to 8 provide long run estimates, that includes both a decade lagged effects and contemporaneous effects of female workforce participation on crime rates. The estimates are found to be directionally consistent and close to the estimates from the main specifications. Contemporaneous effect of female workforce on violent crime remains insignificant, whereas for the non-violent crimes, the estimates are larger in magnitude and continue to remain significant and positive. On the other hand, coefficients for the lagged effects for both violent and non-violent crimes are smaller in magnitude but remain significant as in the main results. This suggests that the previously shown results are directionally robust. The magnitude of the coefficients varies marginally and shows that the effect of female workforce on crime outcomes may be driven by differences in growth characteristics of the most urban and most areas.

4.5 Conclusion

There exists a close association between employment opportunities and incidences of crime. On one hand, a rise in labour market opportunities may lead to a rise in apprehension and conviction cost of criminal engagements and hence leads to a fall in crime. On the other hand, as more people join the labour market, it increases their exposure to crime outside the safe boundaries of home and cause higher victimization rate. The effects of employment on crime rates is thus argued to be ambiguous. Though male workforce participation in India has increased from 52.7 percent in 1981 to 53.3 percent in 2011, the gender gap in the workforce has been persistent. Female workforce participation increased marginally from 19.8 percent in 1981 to 25.5 percent in 2011. This chapter studies the impact of female work force participation on violent and non-violent crimes, both contemporaneous and with a lag for the districts of India, between 1961 and 2001.

Female workforce should affect crime due to at least four main reasons. Firstly, as more females enter the labour force, it increases competition in the labour market. This may lead men to invest more in skill and education which is suggested in literature to be a strong deterrent of crime. Secondly, if greater female workforce participation empowers women, they are more likely to report crime. Increased reporting of crime would increase the probability of apprehension and conviction. Higher opportunity cost of criminal engagements should reduce crime rates. Thirdly, increased female workforce participation may provide females with greater bargaining power in the marriage market. This may lead men to invest in human capital to attract a bride with higher ability and receive higher dowry. Fourth, increased female workforce participation is shown to have social externality effects such as increased investment in children education and gender parity. This change in societal behaviour should lead a fall in incidences of crime.

Pooled OLS estimates are derived for the contemporaneous effects of female workforce participation on violent and non-violent crimes, with district and year fixed effects. We include controls for literacy rate, proportion of schedule caste and schedule tribe population, sex ratio and urbanization rate. The estimates suggest a 1.5 percent rise in non-violent crimes with a one percent rise in female workforce participation rate (relative to a mean of approximately 70 registered non-violent crimes per 100,000 population). This may be explained by increased exposure to crime with a rise in employment opportunities. The effect on violent crimes is found to be insignificant though.

The contemporaneous effects may suffer from potential endogeneity due to reverse causality. To circumvent the potential simultaneity bias, we estimate a decade lagged effects of female workforce participation rate on crime. The results indicate that a one percentage increase in female workforce is estimated to reduce violent crime by approximately 1.1 percent (relative to mean of approximately 21 registered incidences) and non-violent crime by 2.24 percent (relative to mean). This may also reflect the persistent effect of female workforce in constraining crime in the long run. Increase in human capital investment by men, rise in education levels of children and positive social externalities would support the fall in crime rates with a rise in female labour market opportunities. The results on contemporaneous and lagged effects are found to be robust to exclusion of 10 percent most urban and 10 percent most rural districts in India.

A rise in female workforce participation is leads to a significant decline in crime, both violent and non-violent in the long run. We argue that as females increase their participation in non-traditional roles of females, this encourage human capital investment, gender parity and greater investment in children. Though the contemporaneous effects estimates may not suggest a desirable outcome, however, the long run effects are persistent and show a robust significant decline in both violent and non-violent crimes. However, the contemporaneous results shown in this chapter needs to be interpreted with caution, since they may suffer from potential endogeneity bias due to reverse causality and omitted variables.

Appendix 4A

Table 4A.1: Descriptive statistics: Census Variables

	1961-2001				
	N	**Mean**	**Std. Dev**	**Min**	**Max**
Proportion of Female Workforce in Total Workforce	1312	0.21	0.11	0.01	0.54
Proportion Literate	1309	0.4	0.16	0.08	0.84
Proportion Schedule Caste	1283	0.15	0.08	0	0.52
Proportion Schedule Tribe	1283	0.1	0.18	0	0.95
Urbanization Rate	1283	0.21	0.16	0	1
Sex Ratio	1311	933	70	636	1189

Table 4A.2: Descriptive statistics: Violent and Non-Violent crimes and corresponding categories

	1971-2001				
	N	**Mean**	**Std. Dev**	**Min**	**Max**
Violent Crime	**1277**	**21.5**	**15.1**	**0**	**200.0**
Murder	1277	3.6	2.6	0	21.9
Attempt to Murder	1290	2.1	3.0	0	33.8
Rape	1277	1.3	1.4	0	10.3
Kidnapping	1277	2.1	2.2	0	15.3
Dacoity	1283	1.3	2.1	0	28.5
Riots	1277	11.1	12.1	0	169.6
Non-Violent Crime	**1277**	**69.7**	**60.1**	**0**	**587.6**
Robbery	1277	2.9	3.9	0	80.7
Burglary	1277	20.3	17.3	0	174.6
Theft	1277	41.0	41.9	0	460.4
Criminal Breach of Trust	1277	2.4	2.5	0	29.2
Cheating	1277	2.9	3.3	0	36.4
Counterfeiting	1277	0.2	1.1	0	31.7

CHAPTER 5: CONCLUSION

In developing countries such as India, females are not only the under-represented gender in terms of population numbers, but are also highly under-represented on statistics of literacy levels, work force participation, political representation and decision making. As per the 2011 census of India, there are only 943 females per 1000 males, with child sex ratio (0-6 years) at a greater disproportion of 919 girls per 1000 boys. Amartya Sen (1992) estimated around 37 million missing women in India. Biologically, higher primal survival rates of girl child and lower female mortality in comparison to males should lead to more females than males. The distorted sex ratio in India however, suggests intervention that has caused severe bias against females. Strong patriarchal norms and relative preference for sons have caused severe biases in female-male ratio aided by the advancement of technology and accessibility to sex-selective abortions. Poor representation of females in numbers has led to low representation at social and economic fronts. Literature provides evidence that minority groups are invariably subject to oppression and exploitation, and this is reflected in the statistical figures for females in India. Female literacy rates according to 2011 India census is significantly low at 65.45 percent as compared to 82.14 percent for males. Similarly, the women work force participation was reported at around 25.5 percent as compared to male work force participation rate of around 53.26 percent. Females have mostly been confined to non-productive household chores. In 2014-15, approximately 5 percent of the girls dropped out of primary school and nearly 17 percent out of secondary education. Around 30 percent of the girls quoted '*engagement in household activities'* as the reason for school drop-out[49].

Low participation rates in active work force and lack of accessibility to adequate education has led to high dependency of females on male counterparts. This has further deteriorated social and economic value of females as reflected in the large amounts of dowry exchanges, monetary or non-monetary, in the marriage market. NCRB has reported approximately 8,200 cases of dowry deaths on an average every year in India.

[49] Source: MHRD, Department of School Education and Literacy, Statistics Division, 2018

The existing social and economic biases against females may not only affect the growth and development outcomes among females, but also affect other socio-economic parameters such as health and education. One of the adverse impacts of poor representation of females is on incidences of crime. Literature suggests that as men outnumber women, there is an increase in the rates of criminal engagements. There are several reasons for this rise in crime. First, men are statistically shown to be more violent than women. Second, shortage of females in the marriage market raises stress and competition amongst men that trigger violent behaviour. Third, the labour market ceases to offer an environment of competition and skill development with low levels of female workforce participation. Lack of competition leads to poor investment in education and human capital by men. Lower standards of education and reduced labour supply hours are known to increase incidences of crime.

Not only does low female representation cause a rise in crime, but there also exist reverse causal effects. In an environment characterized by high crime such as kidnapping, rapes, theft and murders, sons are perceived as assets and daughters as liabilities. Social crime such as dowry, require parents of girl child to reduce present consumption, increase labour hours and raise savings to meet future dowry expenditures. These effects lead to strong preference for sons and female biases. A society characterized by female oppression and with greater access to medical advancement and technology is likely to practice sex-selective abortions and female infanticides. This generates a vicious circle where poor socio-economic status of females causes undesirable outcomes in the marriage and labour market leading to more crime. This further worsens female representation in all aspects, physical, social and economic.

This thesis studies the effect of female representation, in population, literacy levels and in the labour force participation on two main social outcomes, violent and non-violent crime and marriage market outcomes. Chapter 2 estimates the contemporaneous, short run (post one decade) and long run (post two decades) effects of son preference on violent and non-violent crime. Son preference aided by sex-selective abortions cause child sex ratio to be biased towards males and distortions in population sex ratio in the future decades. Sex ratios may have both a negative and positive effect on crime. On one hand, marriage is seen as a stabilizing factor for males. Thus, a skewed sex ratio, where more men are competing in the marriage market over fewer women, could be a source of conflict and violence (Dreze and Khera, 2000). On the other hand, Guttentag (1983) in their seminal book argue that when females are in shorter supply, men invest more in marriage and family, which in turn leads to a stable society with lower levels of violent crime. Similarly, high sex ratio increases female bargaining power in the marriage market, shifting resources to favour women.

While the effect of sex ratio on crime can go in either direction, recent empirical evidence has supported the former view i.e. imbalances in sex ratio lead to more violence. However existing studies have not been able to obtain credible estimates controlling for the endogeneity of the sex ratio itself. Moreover, these studies have mostly emphasized only on the effect of sex ratio on crime directly through the marriage market. Finally, there are no credible estimates for the effect of son biasedness, measured by the Child Sex Ratio, on crime in India. This chapter makes a contribution to this literature by measuring the long run effect of son preference on crime.

We address the identification challenge by exploiting district level variation in historical area under wheat-rice cultivation and cross time variation in relative producer prices of wheat-rice. We find that an increase in CSR leads to significant increase in both non-violent and violent crimes in the short run. The results are not robust to alternate specifications for the effect of sex ratio on crime reported 20 years later. These estimates suggest that the imbalance in the pre-marital sex ratio in India between 1961 and 2001 led to a 28.8 percent increase in violent crime and 17 percent increase in non-violent crime.

Further, while much of the literature has focused on competition and violence due to shortage of brides, to the best of our knowledge, none of the existing studies shows the role of social customs and institutions in explaining the sex ratio and crime nexus. Improvements in education, labour market conditions and economic development have led to better opportunities for Indian women over the last two decades. Yet, there has been a downward trend in sex ratios at birth leading to an alarming demographic masculinization. According to World Bank projections, imbalances in sex ratio are likely to exacerbate by 2031 with only 898 girls in the 0-6 age group per 1000 boys. This decline in the sex ratio suggests that the availability and misuse of sex determination technology, particularly among the urban educated Indians, has overshadowed any improvements in status of Indian women through better labour market and education opportunities. Thus, any attempt to change patriarchal social norms must be accompanied with stronger implementation of existing law, for gender imbalances have implications on several socio-economic outcomes.

Chapter 3 studies the association between the education levels of male and female in the marriage market. The existing literature suggests that positive assortative mating based on education may be explained by the groom’s expectation of higher future wage income, associated with higher education levels of bride. We argue that in developing countries such as India, given the poor returns to female human capital investment, female education in India is a non-monetary rather than a monetary trait. On one hand, female education adds positively to the groom’s household utility by bringing down the household cost of production, and on the other hand, dowry received by the post-marital household falls with higher levels of female education. Thus, a household would find it optimal to marry a female with higher education if the fall in costs outweighs the fall in dowry. The chapter proposes a basic theoretical model that derives the conditions under which positive or negative marital assortative mating would be optimal for a household. Empirical results using IHDS-II data suggests that there exists positive assortative mating in the education levels of husband and wife, however the results are weaker in dowry prominent districts. In districts where dowry exists as a strong social norm, the positive association in the education levels of husband and wife is smaller. This suggests substitutability between female education and dowry, where groom’s households are willing to substitute bride education with dowry. Estimates show that dowry increases with male education, but at a decreasing rate with an increase in female education. Dowry is also seen to fall with a unit increase in female education.

Chapter 4 estimates the contemporaneous and a decade lagged effect of female workforce participation on violent and non-violent crime. Greater participation of females in the workforce raises competition in labour market that induces higher human capital investment by men. Higher investment in education and increased labour hours are shown to be strong deterrents of crime in literature. Increased female workforce participation also has effects for marriage market outcomes, where a rise in female workforce leads to a rightward shift in women ability distribution. Increased competition amongst men in the marriage market to secure a higher ability bride and receive higher dowry encourage investment in education and labour hours that reduces crime rates. Existing studies suggest that greater representation of females has positive social externalities that lead to greater gender parity, raise moral standards and reduce tolerance towards crime. Greater representation of females in the society is shown to increase reporting of crime. Increased probability of being caught and apprehended discourages engagement in criminal activities. Pooled OLS estimates for contemporaneous effects of female workforce participation suggest a 1.5 percent rise in non-violent crimes with a one percent rise in female workforce participation rate (relative to a mean of approximately 70 registered non-violent crimes per 100,000 population). This may be explained by increased exposure to crime with rise in employment opportunities. The effect on violent crimes is found to be insignificant though. To circumvent potential simultaneity bias in contemporaneous estimates, we estimate decade lagged effects of female workforce participation on crime. The results indicate that a one percentage increase in female workforce is estimated to reduce violent crime by approximately 1.1 percent (relative to mean of approximately 21 registered incidences) and non-violent crime by 2.24 percent (relative to mean). This may also reflect the persistent effect of female workforce in constraining crime in the long run. Increase in human capital investment by men, rise in education levels of children and positive social externalities would explain the fall in crime rates with a rise in female labour market opportunities.

The thesis therefore concludes that better female representation in socio-economic arenas have positive effects in terms of reducing crime rates, both specifically against females, in form of female infanticide, sex-selective abortions and dowry and constraining crime in general. Increase in female education levels raise the bargaining power of women, not only in the marriage market but also in intra-household decision making, and is likely to reduce social crimes such as dowry. Numerous policies to curb crime rates have not been very effective as reflected in the increasing trends in incidences of crime. Increase in female workforce participation, education and economic roles that alter societal attitude and tolerance towards crime are alternative policy options to address the increasing crime rates in India.

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