Essays on Constraints and Solutions to Women's Human Capital Development in India



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I dedicate this thesis to my beloved grandmother or Dadi, Asha Dhar (1926-2022). She was the third woman in Kashmir to graduate from college. As a writer and lecturer, she always championed the pursuit of knowledge.

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Abstract

Despite three decades of rapid economic development in India, there continue to be significant gender gaps and challenges for women's human capital development. This thesis, written in a three-paper format, seeks to identify multiple constraints and test interventions to improve women's educational and labor market outcomes in India. Using a combination of experimental and quasi-experimental methods, I present research which sheds light on, as well as addresses, interlinked constraints related to women's advancement in their education and careers. My first paper examines whether working women in India face a penalty in the marriage market, using an online correspondence study on a marriage website. I find that women who signal wanting to work after marriage face a sizeable penalty in the marriage market, and receive significantly less interest from male suitors relative to women who have never worked or are willing to give up work after marriage. The second paper evaluates a post-primary technology-aided remedial education program to improve learning and educational outcomes, in a context with acute learning deficits. The program leads to large gains in basic reading and math skills for male and female students, but fails to translate into better scores on the national exam which measures grade level competencies. The third paper assesses the implementation and impact of gender quota introduced for boards of all listed companies in India. While the law succeeded in increasing women's representation on corporate boards, it unexpectedly increased gender pay gaps for board membership. Using an established instrumental variables strategy where I instrument on pre-reform variation, I also find evidence that the law improved firm performance and personnel-related outcomes, but that there was no ripple effect on women's employment. Taken together, these research papers contribute to a deeper understanding of barriers and potential solutions to enhance women's human capital development in India.

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1

Introduction

Despite three decades of rapid economic and social development, outcomes for women in India remain considerably poorer than those of men. Gender imbalances are far-reaching and manifest themselves throughout the life cycle from ante-natal care (Bharadwaj and Lakdawala 2013), survival at birth and early childhood (Jha et al. 2006), to educational opportunities (Maitra et al. 2016), control over marriage and fertility (Jain 2014), labor force participation (Pande et al. 2017; Deshpande and Singh 2021; Afridi et al. 2018), asset ownership (Agarwal 1994; Deininger et al. 2013), and late life care (Anderson and Ray 2012)

Moreover, many of these gender gaps are widening or stagnant despite economic progress, suggesting that poor women and girls do not necessarily benefit from a country's economic development alone (Duflo 2012; Kabeer 2016).

The productive use of human capital is an essential input enabling economic growth, while education and employment play a crucial role in increasing incomes and eliminating poverty. The startlingly low learning outcomes and work force participation rates for women in India is therefore a significant cause for concern. According to the Annual Status of Education Report (ASER) from 2020, less than half of adolescent girls (44 per cent), aged 14-18 years in rural India, could do

basic arithmetic operations such as division (Pratham 2020) In addition, only 23 per cent of women participated in the workforce in 2018, declining from 43 per cent in 1993-94, even though the country has grown more developed and educated (Government of India 2019). Finally, women continue to be underrepresented in leadership roles as well. Women hold less than one-fifth of board membership seats in listed companies in India (Tumbe 2022).

This thesis answers the overarching question of how to address barriers and constraints to women's human capital development in India. It contributes to the literature in this area through experimentation and empirical analyses in collaboration with the private sector, non-profit organizations and government agencies in India. Specifically, I address gaps in the academic literature on women's work, education and leadership. These research papers contribute to a clearer understanding of barriers and potential solutions to women's human capital development in India. I outline the context and issues below, and describe how I tackle these gaps in the literature through my papers.

Existing social norms related to gender roles, household work, unpaid care and marriage may affect marriage outcomes for working women and influence women's choices on work and marriage. I aim to study how working women fare in the Indian marriage market in Chapter 2, to see if there are marriage market penalties for "career women" given the prevalence of conservative gender norms. In the second and third papers, I aim to examine solutions to mitigate constraints for women's human capital development. Chapter 3 examines whether a post-primary remedial education program can improve learning outcomes and exam scores for students – both girls and boys. Chapter 4 focuses on the implementation and impact of a gender quota for board leadership introduced in India, and examine whether a quota can change individual women's outcomes as well as firm level outcomes. I elaborate on each of the proposed research questions, methods and implementation below.

One of the most pronounced, and increasing, gender gaps in India is in labor force participation rates. India has one of the lowest labor force participation rates for women globally, ranking 120 among 131 countries where for which data are available (U. Chatterjee et al. 2015; ILO 2019). India lags behind similar economies in terms of its female labor force participation (FLFP) rate, even in comparison to other BRICS and South Asian countries. Moreover, FLFP has declined in the last decade from 43% in 1993-94 to 31% in 2011-12, based on estimates from the National Sample Survey (NSS), while it is near universal for men, although estimates vary with studies ((Pande et al. 2017). The recent Periodic Labor Force Survey report released by the government, while not comparable to the NSS, also shows FLFP at 23% ((Government of India 2019)). India's female labor force participation continues to be low despite the increasing number of women pursuing secondary and post-secondary education, decreasing fertility rates and improved infrastructure access (piped water, electricity) (E. Chatterjee et al. 2018)

There is a growing literature to understand and explore constraints to women's work in India – rise in family income (Bhalla and Kaur 2011); increasing education (Mehrotra and Sinha 2017); lack of suitable job opportunities with growing urbanization and shrinking opportunities in agriculture (Desai et al. 2018; U. Chatterjee et al. 2015); social norms and attitudes towards employment (Pande et al. 2017); marital norms (Coffey et al. 2018); access to safe transportation (Borker 2021) and measurement and misclassification of women's work (Deshpande and Kabeer 2019).

In Chapter 2, I explore the potential role of marital norms and preferences in driving choices around women's work in India – a country where marriage rates are still near universal. I conduct the first ever experimental correspondence study with male suitors on an Indian matrimonial platform to gauge marital interest and marriage market outcomes based on women's employment and their income.

More specifically, the study asks the following questions to better understand the relationship between women's work and marriage in India

1. How does a woman's having ever worked affect male suitors' interest and potential outcomes in the marriage market?

2. How does a woman's intention to continue working and earning after marriage, affect male suitors' interest and her options in the marriage market?

3. As a working woman, does earning more than a male suitor affect their interest and her potential outcomes in the marriage market?

I create 5 fictitious marital profiles for women on India's most popular matrimonial website Shaadi.com, which are identical in every way except in their statements around work and income. The only difference lies in the reporting of whether a) they currently work or not and b) whether they intend to continue working after marriage. For the profiles of the women who work, I also vary their income – relatively higher or relatively lower than the eligible male suitors.

I create these profiles for 4 different caste categories and randomly assign eligible male suitors from in and around the national capital region from these castes to receive expressions of interest from one of the same-caste female profiles. I thus randomize 2749 active male suitors on the platform to receive invites from one of the fabricated profiles in their caste. As in other online correspondence studies, I monitor the male suitors' responses and acceptance of these invites and use it as a proxy for marital interest and potential marriage outcomes.

The results indicate there are sizeable differences in male marital interest expressed towards women who want to pursue a career after marriage. All else equal, women who have never been employed receive the most interest from male suitors on average, followed by women who are working but propose to give up work after marriage. Women who state an interest in continuing to work after marriage receive 15-22 per cent less interest from men on the platform. These results clearly signal a clear marriage market penalty and lower support for women's work after marriage from grooms and their families.

Interestingly, contrary to my hypothesis in the registered Pre-Analysis Plan, higher earning women seem to fare better in the marriage market. While one might have expected higher earning women to face a greater penalty for threatening male social status, the additional income from a higher-earning wife actually seems to act as a sweetener and weaken the penalty. They face a slightly lower penalty than the profiles of women with relatively lower income who want to keep working after marriage.

In this paper, I also examine three competing channels which mediate the relationship between for women's work and marriage market outcomes. I look specifically at channels related to gender norms, human capital development and income. I find strong evidence pointing to the Gender Norms channel. I find that the Income channel has a weak effect, and I am able to rule out the Human Capital Development channel as a factor.

This stand-alone paper contributes to the emerging literature on gender norms, labor and marriage by pointing to the existence of a penalty in the marriage market linked to women's labor supply decisions. To my knowledge, this is the first experimental study to cleanly identify the relationship between women's labor supply, earnings and their marriage market outcomes. The research has clear implications on the need to address and shape restrictive gender and marital norms, in order to promote women's labor force participation in India. Based on these findings, I am currently exploring future research with a marriage market platform and an Indian women's rights organization. With co-authors in India, I am discussing the possibility of testing and designing an online campaign with videos, messages and subtle nudges aimed to inform and liberalize male suitors' preferences towards working women.

While the prospect of marriage restricts investments in women's labor supply and human capital development, there are significant constraints which stem human capital development at earlier stages. Factors such as learning outcomes and abilities are central for human capital development and inclusive growth. In India, learning outcomes lag behind grade level competencies by many grades, severely influencing

the accumulation of human capital for women and girls. In Chapter 3, I evaluate a technology based post-primary remedial education program which aims to improve learning outcomes for girls and boys. I lay out the context and details below.

Many reports in India have highlighted the gravity of the learning crisis in India for the past decade. The Annual Status of Education Reports (ASER) surveys and reports have consistently shown that many children in schools, despite high enrolment rates, continue to lack basic skills in reading and arithmetic, which are foundational for learning and acquiring knowledge in the school system. In 2017, the report showed that more than half the students in the age group of 14-18 years were unable to perform simple mathematic operations like division and a fourth were unable to read basic texts fluently in their own language (Pratham 2017). In Chennai Municipal Corporation (CMC) schools, Grade 9 students on average could not read paragraphs or do basic mathematics like multiplication or division. Their learning competencies were equivalent to those that would normally be associated with Grades 2 or 3.

In this context, my coauthors and I conduct a randomized evaluation of an innovative remedial education program targeted at post-primary school (Grade 9) students in Chennai, India. In partnership with the Chennai Municipal Corporation, our implementation partner Avanti Fellows launched an intensive, blended-learning after-school program for teaching Science and Math to Grade 9 students. Avanti's remedial education program for Grade 9 in schools included trained facilitators, technology aids, along with an emphasis on peer learning and team counseling. Conducted after school for an hour for five days a week, Avanti classes ran for 40 weeks in an academic year, led by trained facilitators rather than teachers. Facilitators, who were fresh graduates themselves, were primarily trained in facilitating classroom sessions which involved peer learning, team work and student collaboration. The facilitators relied on technology aids, such as pre-recorded videos, lectures and worksheets by making use of the basic technology available in government secondary schools in Chennai, such as computers (without internet).

In partnership with the CMC, 24 eligible public schools across Chennai were selected for the study, and 12 schools were randomly allocated to receive Avanti's program for a year. These 12 schools were selected randomly by a paper lottery conducted publicly at the CMC. To analyze the impact of the program, we collected data from approximately a thousand students in our sample on their basic learning competencies, surveys on their time use and participation in the program. Most importantly, we also collected novel administrative data on their scores and performance on the national exam in Grade 10 one year later. We find that Avanti's program was successful when it came to improving basic learning outcomes of the students – for both boys and girls. Given the severe learning deficiencies in advanced grades, we find the program led to sizable gains of 0.9 standard deviation in basic reading and 0.8 standard deviation in Mathematics. The effect sizes were large, and comparable to other remedial education programs that had been evaluated in the Indian context. While I find no differential effects by gender, the study highlights a promising potential for delivering remedial education for girls by using basic technology, combined with in-person facilitation, collaboration and teamwork.

However, a more sobering finding was that these impressive gains in basic learning failed to translate into any improvement on a standardized, public national grade-level exam that is a critical determinant for students' future academic and employment opportunities. We conclude that remedial programs implemented with students at the post-primary level with severe learning deficiencies can be effective in acquiring basic learning, but are not sufficient to overcome the accumulated academic deficiencies at the grade-level.

Furthermore, using our detailed data, we are able to show that in fact Avanti's program had no effect on the time students spent studying outside the school, the take-up of private tuition, or even the support they got from their parents. Instead, we conclude that the gap between where Grade 9 students are in terms of their academic learning (Grade 2 or 3 level) is far from what the exams at grade-level

(Grades 9 and 10) actually require. So even though Avanti's program is not 'too little' in improving basic learning, it is definitely 'too late' at this stage to move the needle sufficiently on impacting grade-level learning outcomes. This indicates that such programs targeted at the post-primary level may not be sufficient to overcome the accumulated learning deficiencies at grade-level for boys and girls.

This research contributes to a growing body of evidence on pedagogical interventions to improve learning outcomes and test scores, though these studies have primarily focused on primary level education. These include Teaching at the Right Level (Banerjee et al. 2007; Banerjee et al. 2016), computer assisted learning (Linden et al. 2003; Lai et al. 2015) including adaptive technology-aided instruction (Muralidharan et al. 2019), curriculum-based expert-led instructional videos (Beg et al. 2020), low-technology interventions such as SMSes and direct phone calls (Angrist et al. 2020), model schools (Kumar 2020), activity based learning (Barros et al. 2020) and performance-based incentives for teachers (Muralidharan and Sundararaman 2011).

Our findings indicate the need to rethink post-primary educational initiatives in the context of high learning gaps and the urgency to address learning levels earlier at the primary level itself, in order to build girls' human capital development. These results also reinforce the importance of models of 'Teaching at the Right Level' (Banerjee et al. 2016), and ensuring that learning is driven based on the child's needs rather than the dictates of the curriculum. We hope results like these can hold important lessons to inform the implementation of India's recent National Education Policy 2020, which highlights the importance of foundational numeracy and literacy, and the role of education technology for achieving educational goals for boys and girls.

In Chapter 4, I examine a different aspect of women's human capital development. I focus on women's leadership, specifically in the Indian corporate sector. I study the evolution of women's leadership, following the introduction of board quotas for women in 2013, and its impact not only on women leaders and female employees,

but also other staff welfare and firm level outcomes. I investigate the effects of the gender quotas on the quantity and quality of men's and women's participation on boards, as well as impacts on firm performance and other personnel related outcomes. To my knowledge, this is the first paper in a developing country setting to rigorously assess the impact of gender quotas on boards.

Despite the growing number of women entering the corporate sector, women's representation in leadership roles in business and management has lagged significantly. Until the 1990s, women constituted only 1 per cent of all board directors in the top 200 firms of India. This proportion rose very slowly to 2 per cent by 2000 and to only 5 per cent by 2010 (Tumbe 2022). To counter the lack of boardroom diversity and to improve gender parity in leadership, new policies and programs such as legal gender quotas are becoming increasingly popular, in business as well as in politics. Over 15 countries have introduced gender quotas for boardroom diversity, including Norway, Italy and Belgium, and developing countries such as Kenya and South Africa. In 2022, the European Union passed a legislation for gender balance on corporate boards.

In India, a new law mandating the inclusion of a female board member on the board of all listed companies was announced in 2013, and would take effect in 2014. I apply an established instrumental variables strategy laid out in Bertrand et al. (2019) and Ahern and Dittmar (2012) where I instrument on pre-reform variation in female board membership to measure the exogenous change in board membership required by the quota.

To better understand the implementation and impact of the quotas, I ask the following questions in this study:

1. Did the gender quotas succeed in improving female representation on corporate boards?

2. How did the gender quotas change the nature and structure of female representation on boards?

3. How did the gender quotas change gender pay gaps for board members?
4. What was the impact of the quotas for female board representation on firm performance (such as income, profit, sales, return on assets)?
5. What was the impact of the quotas on personnel (such as allocation to staff training and welfare, overall hiring and recruitment of female employees)?

My results show that the reform was successful in improving gender parity in representation and participation on corporate boards. There was near universal compliance with the law, within a few years of its introduction. The gender quota led to an influx of new and more educated and independent women directors on boards, who were not insiders. However, their participation largely continues to follow gendered patterns with higher participation in committees such as ethics or nomination and remuneration committees and lower participation in more prominent committees such as business development committees.

However, despite the increased gender diversity, the quota appears to have surprisingly exacerbated gender pay gaps for board members. Even after controlling for observable differences in age, education, experience, tenure, independence, committee participation and other firm and sector characteristics, I find that gender pay gaps persist or widen. This is an interesting area for deeper investigation, and I hope to conduct more mixed methods research here in the future.

Above all, I examine the downstream impact of the quota on firms and personnel outcomes, I find that increased participation from women on corporate boards, following the reform, translates into improved sales, total income, net profits and return on assets. In addition, I find increased investment and allocation towards staff training and welfare, as well as growth in the number of employees. There is no significant impact, however, on female employment. These results are robust and consistent across multiple specifications.

Overall, these results demonstrate that gender quotas can be successful instruments to improve women's participation in leadership positions, with gains in firm

performance and staff welfare. However, the gender quota does not improve women's relative pay for board membership and also does not significantly increase women's employment and recruitment in the corporate sector. Despite positive gains in firm performance and staff welfare allocation, the quota does not translate to strong effects on women's empowerment or gender diversification of the work force.

The paper adds to the literature and to policy debates on gender quotas by examining impacts on women leaders, as well as firm and personnel outcomes. These results make an important contribution to the literature on women's leadership, by providing a fresh example of the impact of gender quotas from a developing country context with a rapidly growing corporate sector. Future research efforts on corporate gender quotas should also examine the mechanisms and channels driving these impacts.

In the following chapters of the thesis, I present each of these papers and discuss their results and contributions in more detail.

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2

Indian Matchmaking: Are Working Women Penalized in the Marriage Market?

Diva Dhar*

Abstract

This paper shares results from an online experiment to assess whether working women face a penalty in the marriage market in India. Using a randomized controlled trial on a popular Indian matchmaking website, I find that profiles of women who signal wanting to work after marriage receive upto 22 per cent less interest from men than those of women who have never worked. Women willing to give up work after marriage face a lower penalty. In a country characterized by low female labor force participation and near-universal marriage rates, these findings on marital preferences may help explain the role of gender norms in shaping women's labor supply decisions in India.

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2.1 Introduction

The productive use of human capital is an essential input enabling economic growth, while employment outside the home plays a crucial role in increasing incomes and eliminating poverty. The startlingly low labor force participation rate of women in India is therefore a significant cause for concern. In 2018, only 23 per cent of women participated in the workforce, *declining* from 43 per cent in 1993-94, even as the country has grown more developed and educated (Government of India 2019).

The literature has considered several explanations for low female labor force participation. One of these is the possible role of gender norms (Jayachandran 2020), including marital norms. Marital patterns are important for understanding key decisions such as labor supply (Becker 1973). Men's preferences in the marriage market may play a significant role in constraining women from joining, staying or excelling in the work force (Bursztyn et al. 2017). Studies in the United States have shown that men prefer to date women who seem less ambitious (Fisman et al. 2006) and that marital incentives may explain why women try to appear less assertive and ambitious in the presence of male peers (Bursztyn et al. 2017). This factor may be particularly consequential in India because the country is characterized by both remarkably high marriage rates[1] as well as regressive attitudes towards working wives and mothers. Almost half of adult men and women report that married women whose husbands earn well should not work outside the home (Coffey et al. 2018).

More marriages take places annually in India than in any other country on the globe (Beauchamp et al. 2022). Given the high disutility of being single and the continuing hold of marriage in Indian society (Beauchamp et al. 2022), women's choices or decisions to work may be closely linked to potential outcomes and penalties in the marriage market. To better understand this channel, I conduct

1. Indeed, while marriage rates have been declining in most industrialized countries, including East Asia, marriage is near universal in India and there is no significant gap between skilled and unskilled women (Kashyap et al. 2015). By the age of 45-49, only 1 per cent of women and 2 per cent of men have never been married (Population Sciences 2017).

the first experiment online to determine whether working women are discriminated against in the marriage market - for having entered the labor force or wanting to continue to work after marriage. I create 5 fictitious marital profiles for women on India's most popular matrimonial website Shaadi.com, which are identical in every way except in their statements around work and income. The only difference lies in the reporting of whether a) they currently work or not and b) whether they intend to continue working after marriage. I also vary the income of those who work (relatively high or low). In this manner, I create profiles for 4 different caste categories and randomly assign men from these castes to receive expressions of interest from one of the same caste profiles. 2749 male suitors, registered and active on the website, and living in and around the Indian capital, receive invites from one of these fabricated profiles. In turn, their responses are captured as an indicator of marital interest and potential marriage outcomes.

I find large differences in responses and interest expressed towards women who want to pursue a career after marriage. All else equal, women who have never worked seem to elicit the most interest on average, followed by women who propose to give up work after marriage. Women who state an interest in continuing to work after marriage receive 15-22 per cent lower interest in terms of initial acceptances. This clearly indicates lower preference and support for women's work after marriage. Interestingly, while there is a clear penalty for work after marriage, the additional income from a higher-earning wife seems to weaken the penalty. While one might have expected higher-earning women to face greater discrimination for outperforming men and threatening male social status, the study results show that this is not the case. In fact, higher earning women who want to continue working after marriage face a slightly lower penalty than their lower earning peers. I test three competing channels to explain these overall preferences for women's work and relative earnings - the *Gender Norms* channel, *Human Capital Development* and *Income* channels. I find strong evidence pointing to the *Gender Norms* channel. I find the evidence of some effect of the *Income* channel, and rule out the *Human Capital Development* channel.

This study contributes to the literature on gender norms, marriage and women's labor force participation in India. While previous work looks at various features of the marriage market in India and South Asia (Anukriti and Dasgupta 2017) including dowry (Chiplunkar and Weaver 2021; Calvi and Keskar 2021; Anukriti et al. 2022; Corno et al. 2020), migration (Beauchamp et al. 2022), sex ratios (Bhalotra et al. 2020; Anukriti et al. 2022; Alfano 2017), age of marriage (Field and Ambrus 2008; Buchmann et al. 2021), and investments in daughters (Andrew and Adams 2022), this study focuses on women's labor supply and related norms.

This experiment helps cleanly identify the relationship between women's labor force participation (both before and after marriage) and income with their outcomes in the marriage market. To my knowledge, this is the first experimental study that assesses the impact of women's labor supply decisions on marital patterns using the revealed preference of potential male partners.

The remainder of this paper proceeds as follows. In Section 2.2, I explore the relevant literature and contribution of this study. In Section 2.3, I lay out the study objectives and research questions. In Section 2.4, I explain the experimental design and data collection in more detail. Section 2.5 lays out the empirical analysis and results. Finally, I discuss limitations of the study in Section 2.6. Section 2.7 concludes.

2.2 Literature

There is a growing body of descriptive evidence from India documenting the prevalence of regressive gender norms related to work for women, especially married women and mothers. For instance, the recent Social Attitudes Research, India survey conducted in various regions (Delhi, Mumbai, Rajasthan and Uttar Pradesh) shows that around half the adults, both men and women, report that married women whose husbands earn well should not work outside the home (Coffey et al. 2018). With the exception of the national capital region of Delhi, the approval rate for women's work is lower than what it was in the United States 45 years ago (Coffey

et al. 2018). Similarly, Dhar et al. (2019) find that only 21 per cent of adolescent boys, and 27 per cent of their fathers surveyed in Haryana disagreed with the statement that a woman's most important role is to be a good home maker. In addition, around 40 per cent of men surveyed in India believe that working women don't have good relations with their children compared to stay at home mothers (Pande et al. 2017). Pande et al. (2017) note that social norms around women's role as domestic caregivers often mean that women are curtailed from seeking work, and that these views may in turn be internalized, suppressing their participation in the labor force.

Beyond these attitudes on gender roles, there may also be additional marital norms around a woman's income relative to her spouse. Fisman et al. (2006) find that American men exhibit a preference for dating women who are less ambitious than them. In fact, Bertrand et al. (2015) find that rising female wages play a substantial role in explaining decreasing marriage rates in the United States. Further, they show that a higher potential income for the woman relative to her husband can lower her probability of participation in the labor force. If the woman does work, she is likely to work fewer hours, so that she earns less than her potential income. This analysis reveals that the wife's share of household income in the United States shows a sharp drop just at the half-point mark, such that they would not outperform their husbands. For couples where the wife does earn more, the authors find lower reported satisfaction, greater discord and a higher likelihood of divorce. The projections from their model show a substantial decline in potential matches if the woman's income exceeds the husband. Similarly, Bobonis (2011) find that cash transfers in Mexico to women increased divorce rates.

Low (2023) documents men's preferences related to women's age, fertility and income in the United States. She finds that men have a negative preference for age, which is a proxy for fertility. For every year a woman ages, her income must increase by USD 700 to compensate for loss in fertility, to remain equally attractive to male suitors. In India, Kashyap et al. (2015) find evidence of gender-regressive marital

norms around spousal education. They find that despite increased education for women, less than 13 per cent of marriages between 1999 and 2004 are hypogamous. Based on a dynamic, general equilibrium matching model of the Indian marriage market, Beauchamp et al. (2022) also show that men do not exhibit a preference for wives' education and actively switch away from highly educated women.

In the presence of such norms and preferences, marital incentives may shape women's decisions around work. For example, the prospect of marriage can lead women to downplay stated career goals (Bursztyn et al. 2017). In a field experiment with married and single female MBA students, they find that single women downplay their career ambitions by reporting lower desired salaries, lower willingness to work longer hours or travel frequently, when their stated preferences were visible to their peers, including male peers. A model developed by Bertrand and Duflo (2016) for developed country contexts predicts that improved labor market opportunities for skilled women in countries with more conservative gender norms is less likely to improve their marriage prospects, compared to countries with more progressive gender norms. To put this mechanism to the test in India, my paper aims to use an online experiment to determine whether women who pursue careers and earn higher incomes than male suitors face a penalty in the marriage market in India. It is the first experiment, to my knowledge, to capture the prevalence, and extent of, discrimination against women's work in the marriage market. The experimental nature helps cleanly establish the link between women's work and marital prospects, strengthening the body of evidence on gender norms and marital incentives around women's work.

These findings on strong male preferences for non-working and non-earning partners also mark a significant departure from the current literature on preferences on online dating platforms, which are largely from developed countries. Neyt et al. (2022) find that men's initial interest on Tinder does not seem to vary by job status or prestige, and in fact they are less likely to start a conversation with women who are unemployed in Belgium. Ong and Wang (2015) also find that male users on

a popular Chinese dating website express equal interest in women across income segments, whereas Low (2023) find that online American male daters value higher partner income, though this preference may disguise other factors such as age and fecundity. A systematic review of the literature on online dating preferences by Abramova et al. (2016) shows that men place a priority on physical appearance, rather than socio-economic status. While in general, they prefer high-income partners over low-income partners, they are also more open and ready to acquaint themselves with lower income women (Abramova et al. 2016).

Related to this study, there is also an emerging, but mixed, body of evidence showing whether attitudes and norms related to women's work can be shifted. Bursztyn et al. (2017) find that men in Saudi Arabia underestimate support for women's work by other men, but a quick intervention to correct and update beliefs about social norms can help increase interest in job search service and uptake for their spouses. Dhar et al. (2022) find that a school based intervention can change gender attitudes, including those towards gender roles for work, for adolescent boys and girls. On the other hand, Dean and Jayachandran (2019) find that videos and discussions on women's employment led by employers have no effects on family attitudes.

2.3 Study Objectives

This experimental study conducted with male suitors on Shaadi.com is designed to gauge the impact of a woman's choice to work and her relative income on her marriage market outcomes, in terms of the responsiveness and interest from male candidates on an Indian matrimonial website.

More specifically, the study asks the following questions to better understand the relationship between women's work and marriage in India:

1. How does a woman's having ever worked affect male suitors' interest and potential outcomes in the marriage market?

2. How does a woman's intention to continue working and pursuing a career after marriage, affect male suitors' interest and potential outcomes in the marriage market?

3. For a working woman, does earning more than a male suitor affect male suitors' interest and her potential outcomes in the marriage market?

Marriage websites and platforms have grown rapidly and have been adopted widely among young people and their families (Kaur and Palriwala 2018), and this experiment was administered on India's most popular matrimonial website, Shaadi.com. Shaadi.com has reached more than 35 million users since 1996 and connected hundreds of thousands of life partners (Shaadi.com, 2019), making it an ideal and convenient setting for the experiment. The experiment was implemented with a sample of 2749 male suitors across castes/sub-castes (Brahmin, Agarwal, Rajput and Kayastha) in and around the National Capital Region of India, registered on the platform. Research ethics approval for the study was given by the Blavatnik School of Government, Departmental Research Ethics Committee, in line with the University of Oxford procedures for human subjects research.

The main outcome this study looks at are response rates from the male suitors in the sample to the expressions of interest from fabricated female profiles, which differ only in their details on work and income. This response from male suitors can be taken as a proxy for potential marriage outcomes. Previous studies have shown that preferences captured through these experiments can be a good proxy for actual outcomes, as shown by Banerjee et al. (2013) based on their analysis of preferences of those who place marriage ads in a newspaper. Based on the variation in the response rate from male suitors, the study can thus help identify if there is a penalty to being a career woman or a high-income earner in the Indian marriage market. I will use the response rates to see if there is significantly higher responsiveness and interest from male suitors for the marriage profiles of women who do not work or those who profess to leave work after marriage. Among the profiles for working women, I will look at whether responsiveness is higher for those who earn less.

2.4 Experimental Design and Setting

This study employs methods similar to those used in other experimental and correspondence studies on discrimination, such as Edelman et al. (2017) and Bertrand and Mullainathan (2004) who test for racial discrimination in rental markets and job hiring respectively. It applies these methods to test for discrimination in the marriage market against women's work and income. I do so by creating sets of typical marital profiles for women from different castes/sub-castes that are nearly identical in nature. The only difference lies in the reporting of whether they currently work or not, and signaling whether they intend to continue working after marriage. For those who work, I vary profiles by income (see below). All else equal, the differences in response to these different marriage profiles helps ascertain discrimination against women's work and career choices.

2.4.1 Creating marriage profiles for women

First, the experimental study on Shaadi.com required a number of (fabricated) women's profiles to be created on the website for the purpose of the study. In order to look realistic, the profiles developed for the study were modelled on other profiles on the website, using language and structure which would make them seem representative and typical of other women on the site. The language was further refined based on inputs from and consultations with other young users of the website.

Given that marriage preferences in India for Hindus (who form the majority of the population) are strongly linked to caste endogamy (Banerjee et al. 2013; Kaur and Palriwala 2018), separate profiles were created for the 4 caste categories in the study - Kayastha, Agarwal, Brahmin and Rajput. Within each caste category, the profiles created were identical on all other counts/criteria, apart from those linked to work and income – the two focal determinants of this study. The surnames, which are caste indicators, were kept the same, but the first names were varied slightly. There were no photographs shared for any of the profiles to avoid any

confounding factors. To the male user on the website, the photo category would show as 'protected', signaling that they would not be able to see the photo at the first stage of the interaction on the website .

More specifically, the following criteria were identical across the profiles for each caste category – age (24), height (5'4"), skin complexion (fair), religion (Hindu), mother tongue (Hindi), location (Noida – close to Delhi), education (Bachelor of Arts in Advertising/Marketing), lifestyle (no smoking, no drinking and vegetarian); horoscope (none) and hobbies. Some of these choices (such as language, lifestyle) were made to impose fewer restrictions on sampling and to help ensure a broader sample of eligible men. There was no mention or reference to dowry in line with the profiles and rules of the website, given the illegality of the practice. It is important to note that the skin complexion category was dropped by Shaadi.com in the middle of one of the experimental rounds, following a campaign on discrimination against skin color. This change occurred simultaneously across all profiles in end-June 2020, and was therefore not a confounder.

While the profiles for each caste were identical in each of the categories such as skin color, age, height, education, there were differences in their statements around work and income, modelled on typical profiles on the website. The profiles were varied to specify whether they currently worked or not, how much they earned (higher income or lower income than male suitors) and whether they intended to pursue a career after marriage or preferred to spend time with family and at home. The profiles were also linked to different phone numbers and IP addresses, but these were not visible to other users of the website. Given the variations on work and income, the profiles for each of the 4 caste categories would fall in the following treatment arms:

1. **Control** - Never worked (NW): Not working woman who does not intend to work after marriage

2. **Treatment 1 - (HIW+)** - High income, working woman pre-marriage and post-marriage - Woman working at Rs 7-10 lakhs income category, with a stated preference for continuing work after marriage

3. **Treatment 2 -(LIW+)** – Low income, working woman pre and post-marriage – Woman working at Rs 2-4 lakhs income category, with a stated preference for continuing work after marriage

4. **Treatment 3 -(HIW)** - High income, working woman pre-marriage only - Woman working at Rs 7-10 lakhs income category, with a stated preference for giving up work after marriage

5. **Treatment 4 -(LIW)** - Low income, working woman pre-marriage only (LIW) – Woman working at Rs 2-4 lakhs income category, with a stated preference for giving up work after marriage. (Note: Detailed profiles can be found in Appendix B)

Other than their description related to work and income, the profiles of women developed for each caste category were identical in all other respects. Finally, it is also important to note that the profiles on the Shaadi.com were made based on subscriptions in the basic category – that is, they would not be differentially promoted by the website or by the website's algorithms to potential suitors.

2.4.2 Expressions of interest to male suitors

The experiment was conducted with 2749 male suitors in order to be sufficiently powered to measure the changes in response rates from male suitors based on women's work choices and income. The experiment was rolled out between April 2020 and September 2020 with the male suitors registered to marry on the website. It was carried out in 4 consecutive rounds – one for each caste/caste-category in the following order – Agarwal, Brahmin, Rajput and Kayastha.

For each caste round, a sample of approximately 700 eligible bachelors of that same caste were selected based on certain eligibility filters using information publicly

available on their profiles which was culled and entered. The sampling criteria for men included that their profile should have been active in the last month, that their location should be in and around the National Capital region of India, their annual income should be between Rupees 4-7 lakhs (i.e. ranging from approx. USD 6,000-10,000) and their age should be 21 years and above (legal age of marriage for men). No other criterion related to height, education, lifestyle, mother tongue or diet was applied. However, the sampling criteria also included dropping any candidate who was explicitly not interested in the characteristics of the female profiles above – i.e. a candidate for example, who has a specific preference for a woman in another state or a woman who is taller or is non-vegetarian. Around 50 profiles or less than 2 per cent of initially screened profiles were dropped based on these criteria[2].

For each caste, the first approximately 700 eligible filtered suitors (650 for Rajputs due to sample size constraints) were then randomly allocated to receive an expression of interest from one of the five arms of female profiles, as specified above, for the purpose of the study. That is, the suitors received a standard 'invite' messaging expressing their interest (see detail in Appendix C) from one of the profiles belong to the control group (NW) or one of the four treatment groups (HIW+, LIW+, HIW, LIW). Overall, 2749 bachelors from the website received an expression of interest. The characteristics of the men on the website can be seen in Table 2.1, and are discussed later in Section 2.5.

2.4.3 Measuring Responses and Interest from Male Suitors

The response from each male suitor who received an invite or expression of interest from one of the fabricated female profiles was monitored over a period of 30 days. Their online response or the status of their response is categorized in the following ways by Shaadi.com –*declined invite* (where they actively decline the expression of interest to explore the connection); *accepted invite* (where they actively accept

2. The following number of profiles were dropped for each caste group: Agarwal- 16, Brahmin-12, Rajput-9, Kayastha-13.

the expression of interest to connect further);*responded later* (where they have not seen the invite, have not responded or have chosen to not give a specific response) and *requested photo* (where they signal they would like to first see the profile photo before giving a response one way or the other).

For this study, I use a binary variable on whether the suitors accepted the invite or not, as the primary outcome to measure marital interest. Any additional text messages on the profile (which could only be sent by those who accepted the invite) were not used in the experiment. Moreover, there could be no further attempt following the initial response to contact the women via email or phone, since that information was hidden and not made visible or available to male suitors.

In addition to response data from male suitors, details of their socioeconomic characteristics such as their educational qualifications, domain of work, who created and managed the account and other details were also culled from their public profiles. These data are used to check for balance across treatment arms and also better understand any observable characteristics which predict responsiveness and interest in working women.

Ultimately, the study measures how the male response rate and interest differs across treatment arms to test for discrimination based on women's work status, career orientation and income.

2.5 Empirical Analysis

The main analysis is an intent-to-treat analysis. I use the following empirical specifications in this study to understand the variation in response across women's work and income status:

$$Y_{ij} = \beta_0 + \beta_j Treat_j + \gamma X_i + \varepsilon_i \tag{2.1}$$

Y_{ij} is the outcome variable measured for male suitor i in treatment arm j. The primary outcome here is a binary variable which captures the response or expression

of interest from the male Shaadi.com user. $Treat_j$ is a dummy variable for the treatment arms. Thus, β_j represents the coefficient for the responsiveness from male users to the women across treatment groups on the outcome. X_i contains individual level controls and characteristics such as caste, education, age, location, food preferences, field of specialization, type of work and the Shaadi.com account ownership.

2.5.1 Sample description

The sample for the study across arms was created between April to July 2020 from the following castes - Agarwal, Brahmins, Rajput and Kayastha. Table 2.1 describes the characteristics of the 2749 male suitors on Shaadi.com who met the eligibility criteria for inclusion in the sample and were randomly assigned to one of the treatment groups.

Over half of the men in the sample only had an undergraduate degree, whereas less than 1 per cent had a doctorate. The most common field of study was Engineering – approximately 40 per cent of the sample had studied Engineering. Other common degrees included Arts & Sciences, Management, Finance and Commerce. A small proportion had pursued medicine, education and other fields.

Subsequently, the most common jobs and professions reported by the male candidates were engineering, IT/software, accounts and finance. The majority of men in the sample were from Delhi and the National Capital Region. As Delhi borders many states, approximately 20 per cent of the men in the sample were from neighboring states such as Haryana and Rajasthan.

Finally, approximately 60 per cent of these accounts were created and run by the individual themselves. However, over a quarter of the accounts were created by parents, and the remaining run by others in their families. Finally, the sample is spread almost evenly across all 4 castes in the sample – Brahmin, Rajput, Agarwal and Kayastha.

While the characteristics were mostly balanced across treatment groups, there were certain significant differences for a few characteristics in one or two arms. For example, the LIW arm has a higher number of male suitors with an undergraduate degree alone (56.3%) compared to the NW arm(50.7%) and this difference was modest, but statistically significant. However, these differences were small, spread out across groups and were not concentrated in any one treatment arm. I also control for these baseline differences in the regression analysis on final outcomes, following Bruhn and McKenzie (2009), to ensure the robustness of my findings.

2.5.2 Does women's work affect marital interest from men?

Average responses

Table 2.2 and Figure 2.1 show the mean acceptance rates across all treatment arms, capturing the differences in male suitors' response to women's intention to work and their relative income from their marital profiles. The first row in Table 2.2 shows that mean acceptance rates are highest for the women who have never worked, i.e. the NW arm, at 69.8 per cent. Next, the acceptance rates seem to hover over 66 per cent for those who worked before marriage but state their interest in discontinuing work after marriage - the HIW and LIW arms. The differences between the means of these groups and the NW arms are not statistically significant. However, there is a sharp drop in response for women who want to continue working after marriage. Their acceptances rates are at 59.6 and 54.7 per cent for the high income (HIW+) and low income (LIW+) groups respectively. This represents a difference in overall response rates of 10 to 15 percentage points from the NW group, which can be attributed simply to women's intentions to work after marriage. There is, however, significant variation in mean response rates across castes, as captured in Figure A1.

How strong is the penalty in the marriage market for a woman if she intends to pursue her career after marrying? These average response rates imply that women who have never worked receive 15-22 per cent more interest in the marriage market compared to women who want to keep working. For every 100 men who respond to a woman who has never worked, only 78-85 men will respond to a woman who

wants to keep working. Similarly, if a woman is working but plans to give up work, she will actually have 11-20 per cent more interest in initial response rates than if she expressed a desire to keep on working after marriage. A woman who has never worked is thus more likely to have more options in the marriage market – and a woman who wants to work, but earns less than the man, is likely to receive less interest.

Regression analysis

I conduct regression analyses using linear and logit models, both with and without controls, to estimate the treatment effects. Table 2.3, Columns 1-4 report on the regressions where the primary outcome is men's responsiveness and interest for the marital profiles, using both linear and logit models. The regressions in columns 1 and 2 include additional control variables to account for other characteristics of the male suitors in different groups and caste differences

I find that, all else equal, *men are demonstrably less interested in women who want to work after marriage.* These results in Rows 1 and 2 are robust across specifications, with and without controls. There is also suggestive evidence of a minor penalty for those who worked before marriage but do not plan to continue working. The coefficients are small and negative as seen in Rows 3 and 4.

The linear specification in Column 1 shows that men were 10 percentage points less likely to respond to women who earn more than them and want to work after marriage (HIW+ group). They were 15 percentage points less likely to respond to women who want to continue work but earn less than them (LIW+ group). This difference is robust across specifications – this translates into 15-22 per cent less interest from men. The logit model in Column 2 also show odds ratios of 0.55 and 0.43 respectively for the HIW+ and LIW+ groups, signaling that women in these groups have lower odds of receiving responses from men. Across specifications, the results consistently show that there is sizeable, significant negative interest from men in both arms where women want to *work after marriage.* These results are robust and significant to more expansive definitions of interest and responsiveness

from male suitors. As Table A3 shows, these results hold even when I broaden the defined variable of interest from 'accepting invite' to those who also 'requested a photo'.

In comparison, the effect sizes of having worked before marriage on interest from male suitors are smaller. Column 1 does show that men were 3 and 4 percentage points less likely to send a response for the HIW and LIW groups respectively, than to women who had never worked (NW). However, the results for the HIW group are not significant and those for the LIW group are not consistently significant. These results are also not significant when the definition of interest is expanded to include photo requests, as seen in Table A3. We thus see a slight, but not consistently significant, reduction in interest in women who have been employed before marriage, compared to those who did not work at all.

2.5.3 Does women's relative income affect marital interest?

The next set of analyses look at whether the primary outcome of men's expression of interest in marriage changes based on the relative income of the women.

Testing specifically for differences to response to women who earn more or less than the men, I find that income makes a significant difference *only* for the women who want to continue working after marriage. Column 5 of Table 2.3 indicates that the t-test statistic is significant for the difference between HIW+ and LIW+ groups, whereas the t-test is not significant for differences between the HIW and LIW groups. This means that the amount of income matters for men's choices only when women want to continue working after marriage. Contrary to initial expectations given regressive attitudes around higher incomes for women, it seems that men are slightly more (not less) interested in women who earn more than them. This indicates that the norm against women earning relatively more than their spouse does not seem to hold sway.

This result seems to suggest that while there is a clear preference for women not working after marriage, there does not seem to be an additive preference or norm

around women earning more than their husbands. In fact, men seem to be willing to give up some of their unease around women's work should they earn more after marriage. I discuss further explanations for why this might be the case in Section 2.5.6.

2.5.4 Heterogeneity analysis

Caste heterogeneity

Table 2.5 examines the differences in responses to women's work across the four castes in the study. By running separate linear and logit models with controls for each caste group, it is clear that there are important differences across castes. The penalty towards women who want to work after marriage for both high and low income earners is strongest among Agarwal and Brahmin castes – both of which are higher on the caste hierarchy.

In contrast, these results do not seem to hold consistently for the castes of Rajputs and Kayasthas, who are deemed to be comparatively lower on the caste hierarchy. For Rajputs, the coefficients are negligible and not statistically significant. For Kayasthas, the coefficients are negative but are not consistently significant.

Is the penalty for women's work after marriage more pressing for higher castes? While this study encompasses a limited number of castes, these results suggest that this may be the case. These estimates echo findings from previous research which indicate that norms restricting women's work are more rigid for upper caste women in India (Field et al. 2010; Agte and Bernhardt 2023), whereas lower caste women are subject to fewer restrictions on their work. These rigid norms derive from Hindu concepts around 'purity' and 'pollution', where higher caste women's status and honor are shielded by keeping them away from encountering men outside their family alone (Jayachandran 2020; Chen 1995).

Heterogeneity by men's education

Table 2.4 reports the differences in responses to women's work based on the male candidate's education. The 'higher education' dummy identifies those men who

have a postgraduate Masters or doctoral degree, and is interacted with treatment status in the regression. There does not seem to be any concrete evidence of differential discrimination from those men with higher education, given that all of the interaction terms are small and not significant. Higher education does not seem to change preferences related to women's work after marriage.

2.5.5 What type of men are interested in women who work?

The probit regression shown in Table A1 analyzes if there are any observable differences associated with those men who are more likely to accept employed women after marriage.The only observable differences are that men who are more likely to accept working spouses tend to be slightly younger, and are more likely to have an account created by themselves, rather than by their families. Their education, work sector or specialization are not predictive of the progressiveness of their attitudes related to women's work.

2.5.6 What explains these preferences?

There may be a few potential mechanisms at play driving the differences in responses and reactions from grooms and their families to women's employment and income. I lay out and discuss three main channels in this section - *Gender Norms, Human Capital Development* and *Income* channels. I use the differences in male interest across arms shown in Table 2.3 to disentangle the prevalence of these channels, as noted in the published pre-analysis plan for this paper.

The first channel is the *Income* channel. In keeping with standard economic theory, there may be a preference for women who work and earn, and those who earn more, as they increase the overall income of the household. However, on the other hand, men may not prefer women who work or earn more than them because they would face sanctions or social costs within their families and communities, due to regressive gender norms. Restrictive gender norms around women's work may lower their preferences on women who have worked or earned more, specifically those who are planning to work after marriage, since they would not be in line with prevalent social

norms. This mechanism would thus constitute the *Gender Norms* channel. Lastly, a woman's work and higher income may be a signal of *human capital development*, which may be valued for the improved ability to contribute to her children's future human capital development (Afridi et al. 2017), like schooling (Behrman et al. 1999). This is the third channel - the *Human Capital Development* channel. All three channels could have been driving preferences, but the randomization and differences across treatment arms allow us to disentangle the effects of these channels.

To start with, I look at the *Gender Norms* channel. First, since men are visibly a lot less interested in the profiles of women who want to pursue careers after marriage, it's clear that gender norms and social expectations around wives not working and staying at home is a powerful driver of marriage preferences. Since human capital accumulation signalling, at the time of the match, is the same for women who have worked and are willing to give it up (HIW and LIW) compared to those who seek to pursue a career (HIW+ and LIW+), the differences in interest across those groups illustrate the sway of social and gender norms on working after marriage. The *Gender Norms* channel alone explains this sizeable difference in interest between the two groups, underlining the importance of social and gender norms in driving decisions around marriage and women's work. However, the *Gender Norms* channel does not extend to penalizing women who have at least worked before marriage to the same extent, as long as they signal the desire to leave work and conform to more traditional gender roles after marriage.

However, there is some evidence that the *Income* channel also contributes to marriage preferences. Within the group of women who want to work after marriage, there is a marginally higher preference for women who earn more, suggesting that the *Income* channel has some effect. While still quite weak, the *Income* channel can chip away at and counter some of the negative response arising from the *Gender Norms* channel. Weighed against the prospect of greater income and benefits, men seem to more be willing to give up their qualms around women's work. However, the benefits from additional income do not seem to be strong enough to completely overcome

the social costs of going against prevalent gender norms. It's also important to note that the *Income* channel cannot account for the responses towards higher and lower income women (HIW and LIW) who do not want to continue working after marriage, since their income generation would end with marriage.

Finally, the *Human Capital Development* channel hypothesis does not seem to pan out. I arrive at this conclusion in two different ways. First, men do not show a concretely higher demand for women who have work experience (HIW and LIW) over those who do not (NW), even if both sets of women meet prevalent gender norms by staying at home after marriage. Second, men do not seem to be significantly more interested in women who earned relatively more *before* marriage (HIW), compared to those who earn less (LIW). The ability to earn relatively more is a proxy for greater human capital accumulation, but men seem indifferent between these two groups. This is not the case, however, for those who earn more after marriage, but that difference can be attributed to the *Income* channel. Thus, I conclude that male suitors do not seem to place a value on work experience and income generation as a contributor for human capital development for future offspring.

To summarize, men's lower rate of responsiveness to women who want to work after marriage can be explained by the dominance of the *Gender Norms* channel. This channel, can be somewhat mitigated or countered, by the *Income* channel, which explains why women who earn more (HIW+) elicit more interest than their lower income counterparts (LIW+). Lastly, the *Human Capital* channel does not explain marital demand. There may potentially be other alternate channels at play, such as fertility or dowry, assuming these differ by women's work status, but these are beyond the scope of the paper.

2.6 Limitations

This study has a number of limitations. The first weakness of this study is that the outcome of interest relies on a crude measure, since it only involves examining online responses to expressions of interest. This measure of interest does not ultimately

capture whether male suitors proceed to marry a working woman or not. While expressions of interest can be a good proxy for marital interest (Banerjee et al. 2013), the study is ultimately not able to capture the final outcomes of marriage rates.

Another limitation of this study is that it relies on only one channel where people seek for marriage matches – online sites – whereas there are many other avenues to find marital matches such as social networks, newspapers, or even love at first sight! This is a common limitation for online and correspondence experiments. Moreover, given the use of this website, these results may also only be representative of more urban, wealthier, educated Indians who have access to the internet and use matrimonial sites. Finally, given the sample of suitors were chosen from in and around the national capital region, and belong to a certain wealth bracket and castes, it is not certain that these results would extend to other groups.

One more note of caution is that the experiment was conducted during the COVID pandemic. Given the nature of the randomized trial, the assumption is that unobserved effects from the pandemic would affect all groups equally in their marriage preferences. However, while it does not affect the internal validity of the experiment, it is possible to argue that these preferences, in a time of crisis, may not be representative of a post-pandemic world, even in the quest for a long-term partner. It was not possible to delay the experiment, but the results do largely coincide with results from a pilot/test case held with around 100 suitors from the website before the onset of the pandemic.

2.7 Conclusion

This paper examines whether women's choices around work and career lead to discrimination in the marriage market in India. This is the first study to assess the prevalence, and extent, of discrimination against working and career women in the marriage market in India, using an innovative online experiment. The findings of this study could, in turn, help explain whether marital and gender norms pose a deterrent to why women do not join, stay or excel in the labor market.

I find that there is indeed a sizeable penalty in the marriage market for women who express an interest in pursuing a career after work. Women who want to continue pursuing work get considerably lower marital interest from male suitors. This effect is specifically predominant in the relatively higher castes among the castes selected in the study sample, given more conservative gender beliefs held and enforced by higher castes.

I find that these differences in expressions of marital interest are driven largely by preferences related to conservative norms around marriage and women's work. While the prospect of greater or additional income may help weaken these marital preferences somewhat, it does not seem to be able to overturn this reaction. Men and their families are willing to leave money on the table, in order to conform to societal expectations on gender roles and male social status.

As the literature review indicates, marital norms and incentives related to women's work in the marriage market may also potentially influence women's decision and choices around workforce participation. Given the strength of the institution of marriage in India, this sizeable penalty in the marriage market could pose an important deterrent for women from continuing work and building careers. This is an area which requires further investigation in the future. Future research efforts on behavior and norm change should also focus on changing specific norms around marriage and gender roles.

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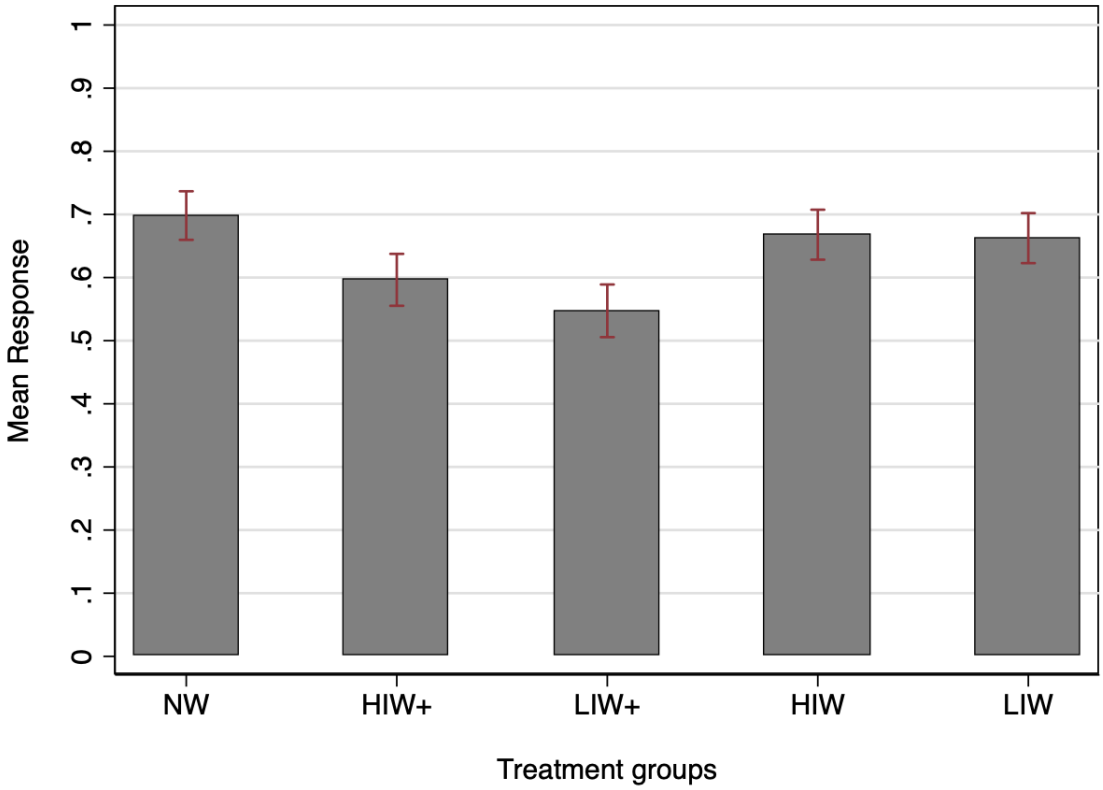
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Figures

Figure 2.1: Mean response across treatments



Tables

Table 2.1: Balance table for randomisation across all treatments

Variable	**NW** Mean(SE)	**HIW+** Mean(SE)	**LIW+** Mean(SE)	**HIW** Mean(SE)	**LIW** Mean(SE)
Sample size	550	550	550	548	551
Age	28.468	28.375	28.546	28.630	28.588
	(0.095)	(0.099)	(0.097)	(0.096)	(0.099)
Panel A- Edu Qualifications (%)					
Undergraduate	50.7	55.3	50.7	52.4	56.3*
	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)
Postgraduate	44.4	39.5	43.0	41.4	37.3**
	(0.022)	(0.021)	(0.021)	(0.022)	(0.021)
Doctorate	0.9	0.8	0.6	0.8	0.2
	(0.004)	(0.004)	(0.003)	(0.004)	(0.002)
Diploma & Other	4.0	4.4	5.8	5.4	6.2
	(0.008)	(0.009)	(0.010)	(0.010)	(0.011)
Panel B- Subject Field (%)					
Engineering, CS & IT	36.4	43.1**	39	40.4	41.2
	(0.021)	(0.022)	(0.021)	(0.022)	(0.022)
Commerce	11.0	7.3**	11.3	9.4	9.1
	(0.014)	(0.011)	(0.014)	(0.013)	(0.013)
Management	13.8	14.9	10.7	14.4	9.6**
	(0.015)	(0.016)	(0.013)	(0.015)	(0.013)
Finance	14.0	12.0	11.6	11.9	11.4
	(0.015)	(0.014)	(0.014)	(0.014)	(0.014)
Arts & Sciences	15.9	14.9	18.0	14.4	20.0*
	(0.016)	(0.016)	(0.017)	(0.015)	(0.018)
Medicine, Education & Other	8.9	7.9	9.4	9.4	8.7
	(0.012)	(0.012)	(0.013)	(0.013)	(0.012)
Panel C- Job (%)					
Accounts & Finance	12.2	14.8	15.6	16.4*	10.4
	(0.014)	(0.015)	(0.016)	(0.016)	(0.013)
Business & Entrepreneurship	7.3	5.1	5.4	5.8	7.8
	(0.011)	(0.010)	(0.010)	(0.010)	(0.012)
Teaching & Training	4.5	2.3**	4.9	2.6*	3.0
	(0.009)	(0.006)	(0.009)	(0.007)	(0.007)
Engineering	11.7	17.4***	12.0	12.6	13.2
	(0.014)	(0.016)	(0.014)	(0.014)	(0.015)
IT/Software	12.4	12.4	14.4	15.7	10.6
	(0.014)	(0.014)	(0.015)	(0.016)	(0.013)
Marketing	5.6	5.1	4.7	4.0	6.7
	(0.010)	(0.010)	(0.009)	(0.008)	(0.011)
Sales	2.8	3.6	3.4	1.7	3.4
	(0.007)	(0.008)	(0.008)	(0.006)	(0.008)
Manager/Director	6.0	6.0	6.8	7.7	7.3
	(0.010)	(0.010)	(0.011)	(0.012)	(0.011)

Continued on next page

Table 2.1: – continued from previous page

Variable	**NW** Mean(SE)	**HIW+** Mean(SE)	**LIW+** Mean(SE)	**HIW** Mean(SE)	**LIW** Mean(SE)
Other	0.373	33.4	32.8	33.4	37.5
	(0.021)	(0.020)	(0.020)	(0.021)	(0.021)
Panel D- Location (%)					
Delhi	45.6	49.3	47.5	43.9	50.6*
	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)
NCR	35.0	32.2	32.5	38.1	31.1
	(0.020)	(0.020)	(0.020)	(0.021)	(0.020)
Neighbouring States	19.3	18.5	20.0	18.0	18.2
	(0.017)	(0.017)	(0.017)	(0.016)	(0.016)
Panel E- Account created by (%)					
Parent	25.3	30.2*	29.0	25.4	24.3
	(0.019)	(0.020)	(0.019)	(0.019)	(0.018)
Self	61.4	57.3	57.9	59.9	58.6
	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)
Other	13.3	12.5	13.1	14.8	17.1*
	(0.015)	(0.014)	(0.014)	(0.015)	(0.016)
Panel F- Caste (%)					
Agarwal	25.5	25.5	25.5	25.5	25.4
	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)
Brahmin	25.5	25.5	25.5	25.3	25.6
	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)
Rajput	23.6	23.6	23.6	23.7	23.6
	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)
Kayastha	25.5	25.5	25.5	25.5	25.4
	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)
Vegetarians (%)	56.7	52.0	54.9	55.4	54.4
	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)

Notes: ***, **, and * indicate significant difference from the NW control group mean at the 1, 5, and 10 per cent critical level.

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Table 2.2: Frequency table for accepted invites across treatments

Final Response	**NW**	**HIW+**	**LIW+**	**HIW**	**LIW**
Accepted invite	69.81	59.63	54.72	66.78	66.24
(SE)	(0.019)	(0.020)	(0.021)	(0.020)	(0.020)
Did not accept invite	30.19	40.37	45.28	33.16	33.76
Mean	0.698	0.596	0.574	0.667	0.662
Ratio to NW	-	0.85	0.78	0.95	0.94
Difference with NW	-	0.102***	0.151***	0.030	0.036

Notes: All figures are in percentages and sorted column-wise. Ratios are reported for each group's acceptance rate to control group's acceptance rate.

Table 2.3: Regression Analysis

Variable	**Linear Model 1**	**Logit Model 2**	**Linear Model 3**	**Logit Model 4**	**T-test 5**
	Co-efficients	Odds Ratio	Co-efficients	Odds Ratio	Difference
	(SE)	(SE)	(SE)	(SE)	(SE)
HIW+	-0.102***	0.55***	-0.101***	0.63***	
	(0.026)	(0.08)	(0.028)	(0.08)	
LIW+	-0.150***	0.43***	-0.150***	0.52***	0.049**
	(0.027)	(0.06)	(0.028)	(0.06)	(0.029)
HIW	-0.035	0.81	-0.030	0.86	
	(0.025)	(0.11)	(0.028)	(0.11)	
LIW	-0.042*	0.77*	-0.035	0.84	0.005
	(0.024)	(0.11)	(0.028)	(0.10)	(0.028)
Covariates	Yes	Yes	No	No	
Control Mean	69.81		69.81		

Notes: Final responses against all treatment groups. Robust standard errors are reported in parentheses. ***, **, and * indicate significance at the 1, 5, and 10 percent critical level. Regressions which control for covariates include the following characteristics- education qualifications (undergraduate/masters/PhD/other), city of residence (Delhi/NCR/neighbouring states), account created by(parent/self/other), subject field of educational qualifications (engineering, CS & IT/commerce/management/finance/arts &sciences/other), job (accounts & finance/business & entrepreneurship/teaching & training/engineer/IT & software/sales/marketing/manager & director/other), and caste (Agarwal/Rajput/Kayastha/Brahmin). T-test for significance of means between TG 1 & TG 2, and TG 3 & TG 4.

Table 2.4: Heterogeneity in response by education

Variables	**Co-efficients (SE)**
HIW+	-0.111 (0.034)**
LIW+	-0.156 (0.037)***
HIW	-0.052 (0.033)
LIW	-0.052 (0.031)
NW*Higher education	-0.009 (0.036)
HIW+ *Higher education	0.010 (0.041)
LIW+ *Higher education	0.004 (0.043)
HIW*Higher education	0.029 (0.038)
LIW*Higher education	0.011 (0.037)
Covariates	Yes

Notes: Robust standard errors are reported in parentheses. ***, **, and * indicate significance at the 1, 5, and 10 percent critical level. Regressions which control for covariates include the following characteristics-education qualifications (undergraduate/masters/PhD/other), city of residence (Delhi/NCR/neighbouring states), account created by(parent/self/other), subject field of educational qualifications (engineering, CS & IT/commerce/management/finance/arts &sciences/other), and job (accounts & finance/business & entrepreneurship/teaching & training/engineer/IT & software/sales/marketing/manager & director/other), and caste.

Table 2.5: Caste wise analysis of final responses against treatments.

Variable	Agarwal		Brahmin		Rajput		Kayastha	
	Linear Model 1	**Odds Ratio 2**	**Linear Model 3**	**Odds Ratio 4**	**Linear Model 5**	**Odds Ratio 6**	**Linear Model 7**	**Odds Ratio 8**
HIW+	-0.189***	0.185***	-0.123**	0.287**	0.011	1.048	-0.102	0.643*
	(0.046)	(0.083)	(0.041)	(0.126)	(0.066)	(0.294)	(0.062)	(0.171)
LIW+	-0.430***	0.061***	-0.096*	0.347*	-0.027	0.882	-0.053	0.799
	(0.084)	(0.025)	(0.039)	(0.156)	(0.065)	(0.243)	(0.062)	(0.206)
HIW	-0.029	0.686	-0.028	0.641	-0.011	0.948	-0.074	0.730
	(0.035)	(0.343)	(0.033)	(0.305)	(0.065)	(0.266)	(0.064)	(0.195)
LIW	0.002	1.219	-0.031	0.620	-0.099	0.639	-0.052	0.805
	(0.030)	(0.696)	(0.034)	(0.294)	(0.064)	(0.183)	(0.063)	(0.210)
Covariates	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: Robust SE are reported in parentheses. Odds Ratios for logit regressions are shown. ***, **, and * indicate significance at the 1, 5, and 10 percent critical level.

2.A Appendix A

Additional Figures and Tables

Figure A1: Mean response by caste (for all treatments)

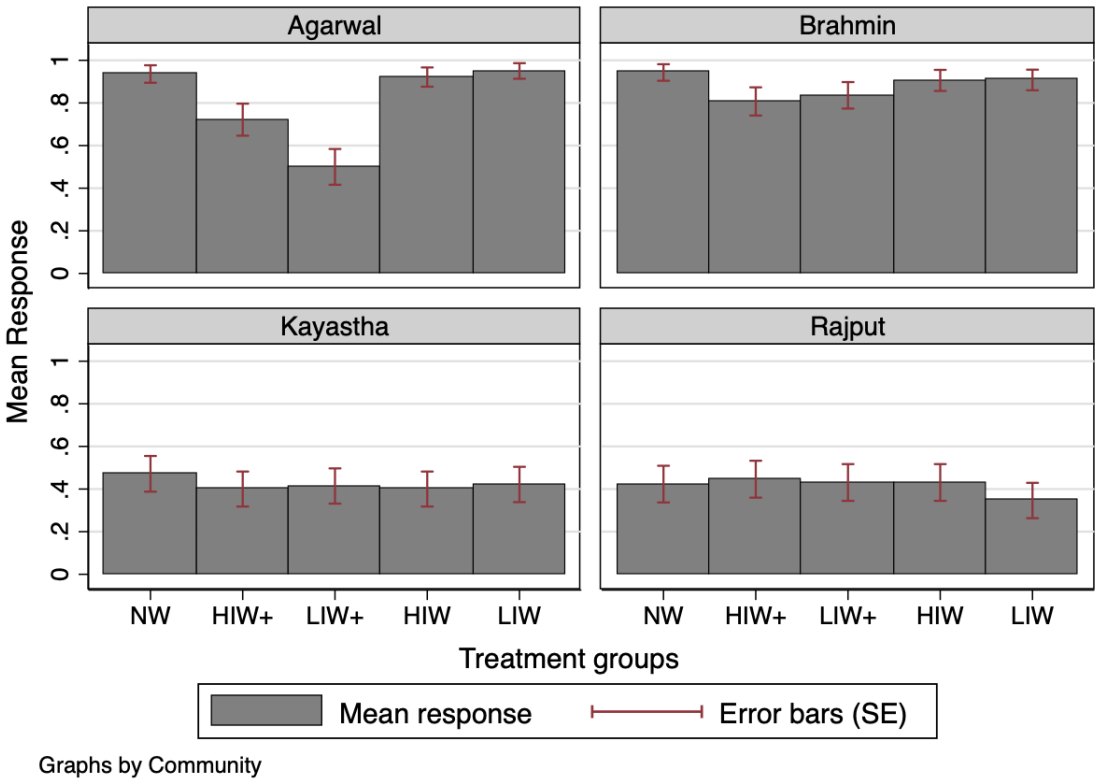


Table A1: Probit analysis

Variable	**Coefficient (SE)**
Higher income	0.128 (0.084)
Age	-0.042 (0.019)**
Vegetarian	0.109 (0.093)
Account created by self	0.178 (0.096)*
Account created by other	-0.087 (0.137)
Postgraduate (Masters & PhD)	0.027 (0.096)
Other	0.318 (0.208)
Commerce	-0.306 (0.186)
Management	-0.118 (0.162)
Finance	0.191 (0.171)
Arts/sciences	0.103 (0.144)
Other	-0.048 (0.181)
NCR	0.066 (0.099)
Neighbouring states	0.014 (0.148)
Business & Entrepreneurship	0.040 (0.228)
Teaching & Training	-0.362 (0.256)
Engineer& IT	-0.011 (0.195)
Software	0.147 (0.197)
Sales	-0.039 (0.222)
Marketing	0.511 (0.261)
Manager/Director	-0.052 (0.212)
Other	-0.028 (0.145)
Constant	1.272 (0.572)*

Notes: Probit Analysis on responses record from male suitors who respond to/accept the invites from the *post-marriage working* treatment arms (both *high* and *low* income). ***, **, and * indicate significance at the 1, 5, and 10 percent critical level. Robust standard errors are reported in parentheses. All regressions control for characteristics of male suitors.

Table A2: Overall responses from within and outside the sample

	NW	**HIW+**	**LIW+**	**HIW**	**LIW**
In Sample					
Declined invite	25	55	57	26	26
Accepted invite	384	328	301	366	365
Requested photo	12	3	12	15	16
Respond later	136	166	181	148	151
Out of Sample					
Requested photo	3	0	1	2	3
Invites	11	6	4	9	11
N	571	558	556	567	572

Note: Frequency table for final responses across treatments, including male profiles outside the sample. All figures are sorted column-wise.

Table A3: Regression Analysis (Response=1 if Invite accepted or Photo requested)

Variable	**Linear Model 1**	**Logit Model 2**	**Linear Model 3**	**Logit Model 4**	**T-test 5**
	Co-efficients (SE)	Odds Ratio (SE)	Co-efficients (SE)	Odds Ratio (SE)	Difference (SE)
HIW+	-0.106*** (0.026)	0.54*** (0.08)	-0.109*** (0.028)	0.61*** (0.07)	
LIW+	-0.137*** (0.027)	0.46*** (0.07)	-0.140*** (0.028)	0.54*** (0.06)	0.030 (0.029)
HIW	-0.025 (0.025)	0.85 (0.12)	-0.024 (0.027)	0.88 (0.11)	
LIW	-0.033 (0.024)	0.81 (0.11)	-0.028 (0.027)	0.87 (0.11)	0.003 (0.028)
Covariates	Yes	Yes	No	No	

Notes: Final responses against all treatment groups. Robust standard errors are reported in parentheses. ***, **, and * indicate significance at the 1, 5, and 10 percent critical level. Regressions which control for covariates include the following characteristics- education qualifications (undergraduate/masters/PhD/other), city of residence (Delhi/NCR/neighbouring states), account created by(parent/self/other), subject field of educational qualifications (engineering, CS & IT/commerce/management/finance/arts &sciences/other), job (accounts & finance/business & entrepreneurship/teaching & training/engineer/IT & software/sales/marketing/manager & director/other), and caste (Agarwal/Rajput/Kayastha/Brahmin). T-test for significance of means between TG 1 & TG 2, and TG 3 & TG 4.

2.B Appendix B

Figure B1: Treatment Profiles

Qualities	Control Group	Treatment Group 1	Treatment Group 2	Treatment Group 3	Treatment Group 4
Name	Leena Agarwal	Meena Agarwal	Neena Agarwal	Reena Agarwal	Seema Agarwal
	Leena Pandey	Meena Pandey	Neena Pandey	Reena Pandey	Seema Pandey
	Leena Thakur	Meena Thakur	Neena Thakur	Reena Thakur	Seema Thakur
	Leena Srivastava	Meena Srivastava	Neena Srivastava	Reena Srivastava	Seema Srivastava
City	Delhi	Noida	Noida	Noida	Noida
City of Family	Delhi	Delhi	Delhi	Delhi	Delhi
Marital Status	Never married	Never married	Never married	Never married	Never married
Diet	vegetarian	vegetarian	vegetarian	vegetarian	vegetarian
Height	5'4"	5'4"	5'4"	5'4"	5'4"
Community	Agarwal, Brahmin, Rajput, Kayastha	Agarwal, Brahmin, Rajput, Kayastha	Agarwal, Brahmin, Rajput, Kayastha	Agarwal, Brahmin, Rajput, Kayastha	Agarwal, Brahmin, Rajput, Kayastha
Education level	Bachelor in advertising/marketing	Bachelor in advertising/marketing	Bachelor in advertising/marketing	Bachelor in advertising/marketing	Bachelor in advertising/marketing
Income	N/A	Rs 7-10 lakhs	Rs 2-4 lakhs	Rs 7-10 lakhs	Rs 2-4 lakhs
College name	IP University	IP University	IP University	IP University	IP University
You work with	N/A	N/A	N/A	N/A	N/A
As	Does not work	Media professional	Media professional	Media professional	Media Professional
Company name	N/A	N/A	N/A	N/A	N/A
About yourself	I am a girl with homely values and tastes from a respectable family. I would describe myself as well-mannered, smart and cheerful. I hold a Bachelors in Marketing from IP University, but I do not work. I enjoy spending time at home and watching movies. After marriage, I would like to focus on family and home-building only. I am looking for a supportive and understanding partner. I think that should suffice for a bio, we can discuss more if you choose to contact me. Please contact if you think we'll be a match.	I am a career-oriented, ambitious girl from a respectable family. I would describe myself as well-mannered, smart and cheerful. I hold a Bachelors in Marketing from IP University, and I work as a consultant at an advertising firm. I enjoy spending time at home and watching movies. After marriage, I would like to focus on career building and family. I am looking for a supportive and understanding partner. I think that should suffice for a bio, we can discuss more if you choose to contact me. Please contact if you think we'll be a match.	I am a career-oriented, ambitious girl from a respectable family. I would describe myself as well-mannered, smart and cheerful. I hold a Bachelors in Marketing from IP University, and I work as a consultant at an advertising firm. I enjoy spending time at home and watching movies. After marriage, I would like to focus on career building and family. I am looking for a supportive and understanding partner. I think that should suffice for a bio, we can discuss more if you choose to contact me. Please contact if you think we'll be a match.	I am a girl with homely values and tastes from a respectable family. I would describe myself as well-mannered, smart and cheerful. I hold a Bachelors in Marketing from IP University, and I work as a consultant at an advertising firm. I enjoy spending time at home and watching movies. After marriage, I would like to focus on family and home-building only. I am looking for a supportive and understanding partner. I think that should suffice for a bio, we can discuss more if you choose to contact me. Please contact if you think we'll be a match.	I am a girl with homely values and tastes from a respectable family. I would describe myself as well-mannered, smart and cheerful. I hold a Bachelors in Marketing from IP University, and I work as a consultant at an advertising firm. I enjoy spending time at home and watching movies. After marriage, I would like to focus on family and home-building only. I am looking for a supportive and understanding partner. I think that should suffice for a bio, we can discuss more if you choose to contact me. Please contact if you think we'll be a match.
Mother Tongue	Hindi	Hindi	Hindi	Hindi	Hindi
Profile created	Self	Self	Self	Self	Self
Age	24	24	24	24	24
Religion	Hindu	Hindu	Hindu	Hindu	Hindu
Family details	Father- employed; Mother-Homemaker; 1 brother (unmarried)	Father- employed; Mother-Homemaker; 1 brother (unmarried)	Father- employed; Mother-Homemaker; 1 brother (unmarried)	Father- employed; Mother-Homemaker; 1 brother (unmarried)	Father- employed; Mother-Homemaker; 1 brother (unmarried)
Skin colour	Fair	Fair	Fair	Fair	Fair
Horoscope	Non Manglik/does not matter	Non Manglik/does not matter	Non Manglik/does not matter	Non Manglik/does not matter	Non Manglik/does not matter
Body Type	Average/Athletic	Average/Athletic	Average/Athletic	Average/Athletic	Average/Athletic
Smoke	Does not smoke	Does not smoke	Does not smoke	Does not smoke	Does not smoke
Drink	Does not drink	Does not drink	Does not drink	Does not drink	Does not drink

2.C Appendix C

Invites received by the male suitors would appear as follows:

- Invite message on Shaadi.com

"_____ wants to connect with you on Shaadi.com. Respond now to chat with him."

"Hi, I came across your profile on Shaadi.com. If you would like to connect please accept my request."

3

Not Too Little, But Too Late: Improving Post-Primary Learning Outcomes in India

Diva Dhar and Gaurav Chiplunkar and Radhika Nagesh*

Abstract

We evaluate an innovative remedial education program targeted at post-primary school students with severe learning deficiencies in India and find that: (i) while it substantially improved students' foundational learning; (ii) these gains did not translate into any improvement on a (grade-level) standardized national exam. We rule out alternate mechanisms to rationalize these results and conclude that the impact of such programs implemented at the post-primary level is not 'too little' to overcome students' learning deficiencies at the grade-level, but may be 'too late' to meaningfully impact performance on important grade-level exams that are crucial for students' future academic and job placements.

JEL codes: I21, I26, I28, J24

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3.1 Introduction

Investment in education to improve human capital development and boost "inclusive growth" has been at the cornerstone of development policy across the world. However, despite an increase in student enrollments worldwide, learning outcomes have stagnated, especially in low- and middle-income countries.[1] For example, 61 percent of adolescents across the globe are unable to achieve minimum proficiency levels in Math and Reading upon completing lower secondary school (UNESCO 2017; World Bank 2018). The Indian context, which is the focus of this study, is no exception either. Despite making impressive strides in primary and secondary school enrollment rates, learning at the post-primary level continues to remain poor. For example, in a nationally representative sample of Grade 8 students, 55 percent could not read a simple English sentence and 57 percent could not do a simple mathematical operation (Pratham 2016). In our sample of Grade 9 students as well (see Figure 3.1), around half the students could not read a story or complete basic multiplication and division.

These learning deficiencies–both in India and globally–continue to accumulate over time as students fall behind academically through the school system, absorbing and learning very little from their grade level classroom instruction that remains above their learning levels (Banerjee and Duflo 2011).[2] This has further implications on their subsequent education choices, early employment outcomes, and long-run socio-economic status and mobility more broadly (Das et al. 2022). While a large body of literature provides various explanations for the continued deficiencies in learning levels at the primary level,[3] there remains little evidence on how policies and interventions can impact these outcomes at the post-primary or secondary school level, and whether they can improve student performance in grade-level

1. See Angrist et al. (2021), Glewwe and Muralidharan (2016), and Murnane and Ganimian (2016).

2. A 'no detention' policy in India, for example, implies that students are promoted regardless of learning levels and are not held back or tested by schools at least until Grade 8.

3. See Kremer et al. (2013), Glewwe and Muralidharan (2016) and Evans and Popova (2016) for extensive reviews.

exams. Understanding the effectiveness of such programs is also of relevance to public policy, given that most countries across the world spend over a third of their education budget on secondary education (World Bank 2020).

In this paper, we evaluate the impact of an innovative after-school instruction program developed by Avanti and implemented with post-primary school students with substantial learning deficiencies in the public schools of Chennai, India. The program incorporated the use of technology into a remedial instruction program, where trained facilitators made effective use of technology aids (video recordings, presentations, worksheets etc.), with peer learning and counseling, to enhance students' cognitive and non-cognitive development (see Section 3.2 for details). The incorporation of technology aids, in an otherwise standard remedial program, was aimed to improve the quality of education for marginalized students at minimal costs to the schools.

While an evaluation of this program is an interesting exercise in its own right, we are particularly interested in the timing of when it was implemented. More specifically, since the program was implemented at the post-primary level (Grade 9 students), we examine whether it: (a) improved basic learning outcomes of these students; and (b) further impacted test scores on an important, standardized, public national exam one year later.[4]

On the first question of interest, we find that Avanti's program led to large, significant gains in basic Reading and Math ASER scores (0.9σ and 0.8σ respectively). These effects are remarkable, given that these students are already in higher secondary school, and comparable to similar remedial education programs in India such as the MindSpark program (Muralidharan et al. 2019) which catered to students in Grades 6-9, and Teaching at the Right Level (Banerjee et al. 2016) for younger grades. However, by using a novel administrative dataset of national exam scores which are traditionally not used in the literature, we find that these large gains

4. As we will elaborate later, all students have to take a mandatory national exam in Grade 10, which significantly impacts students' future educational choices and subsequent labor market outcomes.

in foundational learning outcomes did not translate into any improvements in test scores in the national exam one year later. We show that this was not because the program crowded out time or effort that students could put in for grade-level material (such as absenteeism in school, attending private tuition classes, self-study, etc.), or the parental support that they received, but because the accumulated learning deficiencies at grade-level were too large to overcome. On average, these Grade 9 students had reading and math skills required for Grades 3 (see Figure 3.1).

Put together, we conclude that in contexts where there are substantial learning deficiencies at grade level, carefully designed remedial education interventions can bring large gains in basic learning levels, even at the post-primary level. However, we show that it might be too late at this stage to translate these large gains in foundational skills into meaningful grade-appropriate progress on school completion and further accumulation of human capital (through tertiatry education for example). This highlights the importance of policy debates in developing countries to address the mismatch between student learning and grade-level requirements (Muralidharan et al. 2019). Furthermore, it reiterates the importance of the timing of when these programs are implemented to mitigate learning deficiencies at the primary school level itself instead of letting them accumulate across grades.

Our paper contributes to a growing body of research that has evaluated the impact of pedagogical interventions to improve learning outcomes and test scores. These include Teaching at the Right Level (Banerjee et al. 2007; Banerjee et al. 2016), computer assisted learning (Linden et al. 2003; Lai et al. 2015) including adaptive technology-aided instruction (Muralidharan et al. 2019), curriculum-based expert-led instructional videos (Beg et al. 2020), low-technology interventions such as SMSes and direct phone calls (Angrist et al. 2020), model schools (Kumar 2020), activity based learning (Barros et al. 2020) and performance-based incentives for teachers (Muralidharan and Sundararaman 2011). While this literature has primarily focused on improving outcomes in primary schooling, the focus of our study is to evaluate

the impact of a similar remedial education program that is implemented at the post-primary level, where there is less evidence. Moreover, we also study how this impacts students' performance on important national exams at the post-primary level, which are a common feature across many countries and impact students' subsequent education and employment outcomes. From a policy perspective, the latter is an important exercise to ascertain whether remedial education programs implemented with students at a later stage in their schooling education can help them overcome learning deficiencies at the grade-level and improve their performance thereafter.

Our paper also complements evidence on "what works" in improving learning outcomes in developing countries more generally, such as provision of information on school quality (Andrabi et al. 2015); student level scholarships and incentives (Blimpo 2014; Kremer et al. 2009); improved access through free bicycles for girls (Muralidharan and Prakash 2017); curricular simplification and pacing (Mbiti and Rodrigue-Segura 2020; Pritchett and Beatty 2012); public rankings of schools (Cilliers et al. 2019); and bundled interventions such as combining school grants with teacher incentives (Mbiti et al. 2019).

The rest of the paper is organized as follows: Section 3.2 describes the empirical context and the experimental design. Section 3.3 describes the data collection and the sample. Section 3.4 discusses the empirical strategy and results. Section 3.5 offers a short conclusion.

3.2 Empirical Context

3.2.1 Avanti's Program

Avanti's blended learning approach for low resource settings combines trained facilitators and technology aids, and places an emphasis on peer learning and team work. There is also a small component involving parent and student counseling. Conducted after-school for an hour for five days a week, Avanti's remedial classes run for 40 weeks in an academic year, led by trained facilitators rather than teachers.

Facilitators are usually fresh graduates who are required to have a Bachelor's degree, preferably (but not necessarily) in STEM, and do not have teaching certification or qualifications. Instead, they are trained on facilitating classroom sessions, peer learning and team work. They also rely on and provide pre-recorded video lectures, presentations, worksheets and other academic materials developed by Avanti for reading, math and science, which are adapted to the context.[5] In the study schools, the program materials and discussions are mostly in Tamil (the local language), even though the school's official medium of instruction may be English or Tamil.

A typical facilitated class in the Avanti program would include 1-2 pre-recorded, short 5 minute videos explaining key basic concepts in the Grade 2-5 syllabus (such as carry over addition, number line, solids and liquids, etc.). Following each video, students would be encouraged to divide up in small groups to collaboratively solve worksheets and exercises with activities or multiple choice questions related to the content of the video or lecture (e.g., sums, drawing on the number line, identifying solids, etc.). Students would work together and help each other to problem solve, with minimal intervention from facilitators, who would only resolve or address questions when necessary. Finally, facilitators would wrap up the session with lectures summarizing key concepts learnt from the videos and in-class discussion. The program also helped provide occasional career counseling and guidance for students and parents. Table B1 provides a summary of the principal components of the Avanti program. The program costed approximately USD 45 per student every (school) year, or USD 5/month for every student, which is cheaper than comparable secondary school programs in India such as MindSpark (USD 15/month) and those run by the Government of Delhi (USD 22/month) (Muralidharan et al. 2019).

5. Avanti's pedagogy incorporates features from Eric Mazur's peer instruction and collaborative learning pedagogy (Fagen et al. 2009; Schell et al. 2013; Zhang et al. 2017) and other blended learning programs. Avanti has adapted this methodology for low-resource settings (common to educational settings in developing countries and in particular, India) for teaching reading, maths and science in government secondary schools in India, using basic technology and infrastructure available or installed in schools, such as computers (without internet).

3.2.2 Experimental Design

The study was conducted in a sample of 24 government schools under the management of the Chennai Municipal Corporation (CMC) in the city of Chennai, India. Of the total 281 schools under the CMC, data on Grade 9 students for 24 schools was provided by the Education Department of the Corporation of Chennai. Schools were selected based on the following eligibility criteria: (a) minimum of 45 students in Grade 9;[6] (b) maximum of 110 students;[7] (c) no previous experience or engagement with Avanti (to avoid contamination). The experimental design involved introducing the Avanti program in 12 randomly selected schools (henceforth, treatment schools) for the academic year 2016-17, leaving students from the remaining 12 schools to serve as a comparison group (control schools). The selection was done in an open paper lottery at the Chennai Municipal Corporation, under the observation of the research team to ensure that the selection was fair. Schools complied with the treatment selection and the program was introduced for all Grade 9 students attending the treatment schools. There was no further screening or targeting within treatment schools, and all students were required to attend the program. The control schools maintained a status quo, and no other program was introduced in those schools, to our knowledge.

From each sample school, 45 students were randomly sampled based on student registers at each school for a survey at the beginning of the academic year (henceforth, Baseline). However, out of 1080 students listed from student registers, baseline surveys were completed with 991 students. This was because some students could not be surveyed either due to school absence on the days the survey was taking place in their schools, or because they had changed or dropped out of that school between enrollment and the baseline survey. Our final study sample therefore comprises of these 991 students at baseline (92 percent of the listed students). During the year, some students dropped out or transferred to other schools resulting in a final

6. Based on power calculations at 80 percent power and statistical significance at 5 percent level, assuming a 10 percent sample attrition rate between the baseline and endline.

7. For logistical reasons, Avanti could not handle schools with more than 110 students.

(henceforth, Endline) sample of 887 students one year later (89.5 percent of the baseline sample).

3.3 Data

We use multiple data sets for our analysis. Some were collected by us during the baseline and endline surveys, while administrative data on student performance in a standardized national exam were provided to us by the school. We discuss these data below.

Student Socio-Demographic Surveys: As mentioned previously, we implemented two rounds of surveys with all students in our sample. Data from the baseline survey was collected from 991 students, and subsequently from 887 students one year later during the endline survey. We collected data on students' demographic and household information, aspirations and a battery of tests to measure gender attitudes and non-cognitive skills such as critical thinking, communication, goal-setting, problem solving, grit, self-esteem and team work (West et al. 2014; Duckworth and Quinn 2009). The survey tools were administered in the local language (Tamil).[8]

Student Learning Outcomes (ASER Tests): We measured learning outcomes of students at the start and end of the program using the standard ASER testing tool for Reading and Mathematics. The ASER instrument has been widely adopted in India (and other countries) to assess students' mastery over foundational skills at different stages of education. It is also frequently used in evaluations, such as those of Pratham's Read India program (Banerjee et al. 2010). The ASER test uses a five-point grading system and covers up to Grade 2 level reading skills and up to Grade 4 level mathematics ability (see Table B2). The test was administered orally for each student, by trained enumerators, and lasted up to ten minutes,

8. While we do not discuss the impact of our intervention on non-cognitive skills (such as communication, problem solving, gender attitudes, etc.), we do measure them and find no impact. Results are available upon request.

following standard administration protocols laid out by ASER.[9] Figure 3.1 provides the distribution of the ASER reading and math skills for the students in our sample at baseline, as well as the appropriate grade-level requirement.

Guardian Surveys: For all students in the baseline survey, we also surveyed one of their guardians (either the mother or father) as well. They were asked questions on the support provided for the child's school activities in the household (see Table B3), whether their child attended tuition classes after-school, and the amount of time the child spent at home on self-study (such as doing homework, etc.). While we were able to survey a guardian for all students at baseline, due to various factors outside our control, we were able to survey guardians for 856 out of 887 students at the endline (96.5 percent).

Scores on a Standardized National Exam: Finally, we also requested schools to provide the exam scores (across all subjects) for all students who appeared in a national standardized Grade 10 examination in 2018. We use these data for two purposes: first, we match them to the students in our baseline data. This allows us to not only record their scores, but also generate an indicator variable on whether a student appeared for the Grade 10 exams or not. Second, since we have the scores across all students in these schools (irrespective of whether they were in our baseline sample or not), we also use them to examine the impact of our treatment more broadly.

3.3.1 Sample Description

We now describe our sample of students in Panel A of Table 3.1. 41 percent of students in our sample are female, and students are on average 14-15 years of age (which is appropriate for Grade 9 students). Around 88 percent of students come from socially disadvantaged backgrounds (Scheduled Castes, Scheduled Tribes and Other Backward Castes) and 76 percent are Hindu. From Panel B, 20 percent of

9. Information on the modalities of conducting the ASER test and tools is retrieved from asercentre.org/Survey/Basic/Pack/Sampling/History/p/54.html

students have parents who are illiterate, and 65 percent who have at most completed a high-school degree. Only 10 percent of households earn a monthly income more than Rs. 10,000 (PPP-adjusted USD 550). Panel C describes the cognitive and non-cognitive ability of students as well as the parental support they receive. As described before, we use the ASER tool to measure basic cognitive ability in reading and math (see Table B2). The reading scores, for example, indicate that students are able to read words and paragraphs on average, but not stories. Similarly, on basic math, they could do simple operations of addition/subtraction, but not more complicated ones such as multiplication/division. These scores indicate that an average Grade 9 student has only mastered skills usually taught in Grades 2 and 3, and are lagging far behind in the grade-level skills needed. This finding resonates with other studies in the Indian context that document the wide learning gap at the post-primary level (Pratham 2016).

Columns (2) and (3) of Table 3.1 then report the averages separately for students in the control and treatment schools, while Column (4) reports the difference between them. The p-value from a t-test that examines whether this difference is different from zero is reported in parentheses below. We do not see significant differences between students in treatment and control schools. The differences are small and statistically insignificant at conventional levels.

3.4 Results

We now turn to examining the effect of the intervention for an individual i in school s. We estimate the following regression specification:

$$Y_{isE} = \alpha + \beta T_s + \gamma_1 Y_{isB} + \delta_1 X_i + \delta_2 X_s + \varepsilon_{is}$$

where Y_{isE} and Y_{isB} are the outcome variables of interest for an individual i measured at endline and baseline respectively. T_s is a binary indicator that takes the value 1 (0) for a treatment (control) school, X_i and X_s are time-invariant characteristics of the individual and school respectively. We use gender, age, religion, and a dummy

for caste (SC/ST, OBC and others) for X_i, and number of boys and girls, and the language of instruction in the school for X_s. We estimate the above specification both without and with individual and school controls and report them in Panels A and B in each table respectively. Lastly, since the randomization was done with 24 schools, we wild-bootstrap cluster our standard errors at the school level, as suggested by Cameron et al. (2008) for statistical inference with small clusters. This is reported in all tables as the p-val (OLS) value. Furthermore, we also report the p-value from a two-sided randomization inference test, denoted as p-val (RI) in all tables. This test, originally proposed by Fisher (1935) and developed by Heß (2017) and Young (2019), allows for statistical inference by comparing the realized treatment effect with 1500 placebo assignments. This procedure therefore has the advantage of providing inference with correct size, regardless of the sample and cluster size.

3.4.1 Impact on Basic Learning Outcomes

We begin by examining the effect of the treatment on basic learning outcomes, as measured by the ASER reading and math scores. We examine the impact of our intervention in three ways: first, we standardize the ASER scores to have mean zero and standard deviation 1 in the control group, so that the treatment effect can be interpreted in standard deviations. We report the results in Columns (1) and (2) of Table 3.2. As mentioned previously, Panel A reports the results without any individual and school characteristics, while Panel B controls for them.

We make two observations before discussing the results. First, baseline and endline scores are strongly positively correlated and second, controlling for individual and school characteristics does not substantially alter the magnitude or statistical inference of the impact of the intervention. Turning to the impact of our intervention, from Panel B (our preferred specification), after controlling for baseline ASER scores, individual and school characteristics, students in treatment schools have a 0.92σ and 0.80σ higher ASER reading and math scores respectively as compared those in control schools at endline. As a benchmark, this impact is comparable to similar

programs evaluated in the Indian context using ASER, such as Teaching at the Right Level (Banerjee et al. 2016) and Mindspark programs (Muralidharan et al. 2019). Since the ASER scores are discrete and ordinal, we also use an alternate specification and report results from a rank-ordered logistic regression in Columns (3) and (4) of Table 3.2. The results and their statistical inference are qualitatively similar for both outcome variables.

Second, we examine the distributional impact of the intervention across different levels of cognitive ability. Specifically, in Appendix Table A1, we report the difference in the endline cognitive level by comparing treatment and control students with the *same* cognitive level at baseline. For example, in Column (1), we restrict the sample of students (in both treatment and control schools) to only those who could read at least a word at baseline. We find that students in treatment schools have a 0.43 higher ASER reading score at endline as compared with their control school counterparts. Similarly in Column (2), treatment school students who could read a paragraph at baseline have a 0.78 higher ASER score at endline as compared to their control school counterparts who could also read a paragraph at baseline. Lastly in Column (3), we see that among students who could read a story at baseline, those in treatment schools (compared to control) have around 0.76 higher reading score at endline. Similarly, turning to Math scores in Columns (4)-(6), we find that students in the treatment schools have a higher math score at endline as compared to their control school counterparts who start at the same baseline math level. Put together, the above analysis suggests that the Avanti program robustly improved students' basic reading and math skills across all levels of cognition at baseline.

3.4.2 Impact on Standardized National Exam Score

It is mandatory for all students in India completing Grade 10 to write a standardized national exam– the All India Secondary School Examination (AISSE). Students are tested in five subjects, namely: Math, English, Science, Social Sciences and the local language (Tamil, in our case). The AISSE exam is an important milestone in a student's education because these scores are used for future admissions in higher

education as well for early career job applications. One of the reasons that Avanti's program was delivered in Grade 9 was also with the aim to potentially help students perform better in this Grade 10 national exam. Given the large improvement in basic cognitive ability discussed in the previous section, we examine whether this gain translated into an improvement in the AISSE scores. As discussed previously, we obtain the list of AISSE scores for all the five subjects for all students in our 24 schools.

As a first exercise, we match them to the students in our study sample and report the results in Table 3.3. As with the other tables, we report the results without any controls in Panel A, and with students and school controls, along with baseline reading and math ASER scores in Panel B. In Column (1) we construct a variable that takes the value 1 if a student in our sample appeared for the AISSE and 0 otherwise. 82 percent of students in our sample appeared for the AISSE and the intervention had no impact on increasing this probability. In Columns (2)-(7) we then examine the impact of our intervention on AISSE exam scores. Reassuringly, we see that baseline ASER scores are strongly positively correlated with AISSE exam scores. However, the treatment does not have any significant impact on these exam scores. The estimated magnitudes are very small (±1-2 p.p.) across all subjects, and nowhere statistically significant at conventional levels.

In Table A3, we take advantage of the fact that we have the AISSE scores across all students in our sample schools. This allows us to examine the impact of our intervention across the school more broadly. As before, Panel A reports the results without any controls, while Panel B controls for school and student characteristics. Gender and caste are the only two student demographic variables available in these data. As reported in Table A3, we find no impact of our intervention on AISSE scores. The estimated coefficients are very small (±1-2 p.p.), statistically insignificant at conventional levels, and comparable to our study sample (Table 3.3).

This indicates that while the intervention significantly improved basic cognitive skills, it failed to translate into gains in standardized national exam scores for those students one year later. The natural explanation to rationalize this observation (which we explore in the next section) is that the learning deficiencies at the post-primary level are so severe (Figure 3.1) that despite significant improvements in basic reading and math skills, it is unrealistic to be able to expect students to catch up to the grade-level requirements.

3.4.3 Mechanisms

We now turn to understanding mechanisms that may have driven these results. First, we look at whether the program, which required students to stay back in school for an hour for five days a week, crowded out school time and efforts from students which could otherwise have been allocated towards studying grade-level material. Using data from the guardian survey (described in Section 3.3), we examine the impact of our intervention on various measures of students' time and effort outside the school. Specifically, we study absenteeism in school, parental support in studying, participation in private tuition classes, and time spent on self-study after school. As reported in Table 3.4, we find no effect of our intervention on any of these activities. The estimated coefficients are small in magnitude and statistically insignificant at conventional levels. If anything, the estimated coefficients in some cases go in the opposite direction of what would be needed to explain away our results through these channels.

For example, we find no effect of our intervention on absenteeism in school, as measured by the number of days in the previous week that a student was absent (Column 1). We also find no impact of the intervention on an index of parental support (Column 2).[10] If anything, the estimated coefficients indicate a small reduction in absenteeism (by around 6 percent) and an increase in parental support

10. The questions used to construct the index of parental support is described in Appendix 3.B. It aggregates responses on a Likert scale from 1-5 across four indicators of how often parents help their child with school work, homework, attending events and talking about school activities. As reported in Table A2 in the Appendix, the intervention has no impact on any of these individual indicators either.

(by around 1 percent). Similarly, in Columns (3)-(6), we find no effect of the intervention on either the probability of attending private tuition classes or studying at home (Columns 3 and 5 respectively), or the amount of time spent on either activity (Columns 4 and 6 respectively).

Put together, we find no evidence that our intervention crowded out effort and time that students could allocate to studying grade-level material. Therefore, while the intervention improved students' basic learning, neither the direct or indirect effects were large enough to mitigate the substantial learning deficiencies acquired by the post-primary level, thus resulting in no improvments in the AISSE scores.

3.4.4 Attrition

As mentioned previously, we were able to survey 887 students from our baseline sample of 991 students (an attrition of 10.5 percent). This attrition was caused both due to students dropping out of school as well as transfers to other schools, for example, due to family migration. In Section 3.C in the Appendix, we test for differential attrition between control and treatment groups and check whether this affects our estimates. Specifically, we do so in two ways: first, we examine whether student and parent characteristics, cognitive and non-cognitive ability, and parental support are differentially correlated with either dropouts (Table C1). We find no evidence of differential attrition. Second, to account for potential endogenous attrition from the sample, we estimate Lee bounds on the treatment effects (Lee 2009). We report the the 90th, 95th and 99th percentiles of the lower and upper bounds for our Reading and Math scores respectively. These estimates are consistent with our main analysis. For example, from Panel A of Table C2, the attrition-adjusted lower bound on the impact of our intervention lies between 0.59σ-1.5σ for reading and 0.3σ-0.9σ for Maths. This increases our confidence in the robustness of our results after taking into account attrition of students from our sample.

3.5 Conclusion

This paper reports on the results of an evaluation of a technology-based remedial education program in India, which was specifically targeted towards post-primary school students in Grade 9, and achieved significant improvements in basic learning outcomes. We find that students had significant learning deficiencies at baseline, with demonstrated reading and math levels at Grade 2 or 3 on average. We find that the daily-run program, led by facilitators (rather than teachers) with technological inputs and academic materials, was successful in improving basic learning outcomes of these older students. The effect sizes are large, demonstrating that it is possible to improve learning and cognitive outcomes at higher grades, which are associated with increased earnings in later life (Blau and Kahn 2005). Moreover, the program cost is reasonable at USD 5/month per student, given the program intensity and the powerful combination of education technology with in-person facilitation and teamwork. The program is cheaper than other secondary school technology based programs in the literature such as Mindspark's technology aided instruction (USD 15/month), or the regular government expenditure in Delhi (USD 22/month) per student (Muralidharan et al. 2019). The program is also more or comparably cost effective at USD 87/SD, relative to many programs dealing with education technology or secondary schooling. This includes education technology programs such as Mindspark's technology aided instruction (USD 203/SD) (Muralidharan et al. 2019) or individual computer assisted learning programs (USD 64/SD) (Banerjee et al. 2007) or secondary school programs such as girls' scholarships in Kenya (USD 72/SD) (Kremer et al. 2009) and conditional cash transfers for adolescent girls' education in Malawi (USD 1667/SD) (Baird et al. 2011).

However, while our study shows that it is possible to overcome basic learning deficiencies at an older age through post-primary remedial educational initiatives, an important take-away from our study is that these gains fail to translate into any improvement on grade-level exam scores. Remedial programs targeted at the post-primary level may not be sufficient to overcome the accumulated learning

deficiencies at grade-level. As Pritchett and Beatty (2012) note, the regular grade-level curriculum may be excessively difficult for learners in these settings, who have continued to accumulate deficiencies over many years and still to need to build on basic skills. Teaching post-primary students grade-level material could be ineffective for student learning (Barros et al. 2020). We hope these findings can help inform the debate around the targeting and implementation of India's recent National Education Policy (2020), which highlights the importance of foundational numeracy and literacy, and the role of education technology for achieving educational goals.

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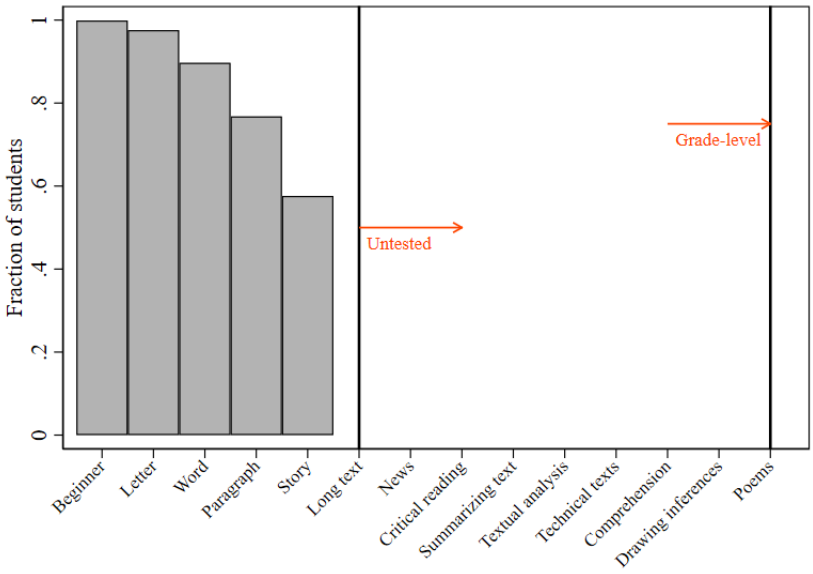
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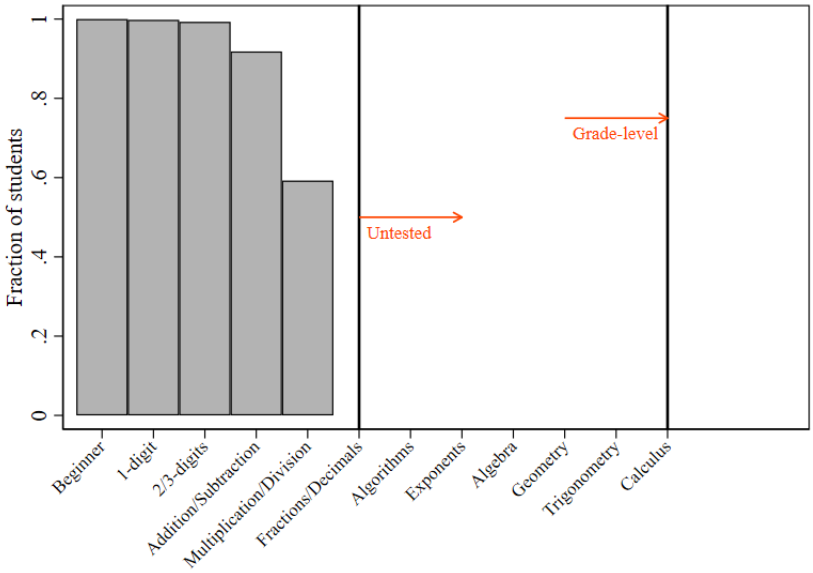
Figures and Tables

Figure 3.1: Reading and Math Levels at Baseline

(a) Reading scores



(b) Maths scores



Notes: The above figure shows the cumulative fraction of students across various levels of reading and math as measured by the ASER test.

Table 3.1: Sample Characteristics

	N	Whole Sample	Control	Treatment	(3)-(2)
		(1)	(2)	(3)	(4)
Panel A: Student Characteristics					
Female	991	0.41	0.41	0.41	0.00
		[0.49]	[0.49]	[0.49]	[0.84]
Age	991	14.88	14.85	14.92	0.07
		[0.86]	[0.88]	[0.84]	[0.22]
Hindu	991	0.76	0.74	0.77	0.03
		[0.43]	[0.44]	[0.42]	[0.26]
SC/ST	991	0.42	0.40	0.43	0.03
		[0.49]	[0.49]	[0.50]	[0.27]
OBC	991	0.46	0.46	0.46	0.00
		[0.50]	[0.50]	[0.50]	[0.99]
Panel B: Guardian Characteristics					
Literacy: None	991	0.20	0.21	0.19	-0.02
		[0.40]	[0.40]	[0.39]	[0.59]
Literacy: High-school	991	0.65	0.65	0.64	-0.01
		[0.48]	[0.48]	[0.48]	[0.82]
Income > Rs. 10k	991	0.10	0.10	0.10	0.00
		[0.31]	[0.31]	[0.30]	[0.94]
Panel C: Student Cognitive, Non-Cognitive Skills and Parental Support					
ASER Reading	991	4.22	4.16	4.27	0.11
		[1.10]	[1.14]	[1.05]	[0.11]
ASER Maths	991	4.50	4.49	4.52	0.03
		[0.67]	[0.70]	[0.65]	[0.52]
Parent Support	991	14.82	15.04	14.59	-0.45
		[3.97]	[4.14]	[3.77]	[0.07]
Life Skills	991	23.00	22.99	23.01	0.02
		[2.39]	[2.31]	[2.48]	[0.87]
Student Attitudes	991	15.56	15.62	15.49	-0.13
		[3.00]	[2.87]	[3.14]	[0.48]

Notes: Female takes the value 1 if the student is a female and 0 otherwise. SC/ST and OBC is an indicator variable that takes the value 1 if the student is from a Scheduled Caste/Tribe or Other Backward Caste respectively. Illiterate and High-school take the value 1 if the student's guardian is illiterate or has completed at most high-school education respectively and 0 otherwise. Income>10k takes the value 1 if the guardian's income is more than 10k and 0 otherwise. See Appendix 3.B for measurement of ASER and Parent Support variables. Column (4) reports the difference between treatment and control i.e., Columns 2 and 3. A p-value of the t-test of this difference is reported in brackets below.

Table 3.2: Impact on Cognitive Ability

	Standardized ASER Score		ASER Score	
	Reading	Maths	Reading	Maths
	(1)	(2)	(3)	(4)
	OLS	OLS	O. Logit	O. Logit
PANEL A: Without Individual and School Controls				
Treatment	0.925***	0.801***	2.025***	1.956***
	(0.131)	(0.138)	(0.295)	(0.323)
Baseline	0.455***	0.540***	0.893***	1.445***
	(0.0457)	(0.0515)	(0.0957)	(0.129)
p-val (OLS)	0.00	0.00	0.00	0.00
p-val (RI)	0.00	0.00	0.00	0.00
R^2	0.357	0.30		
PANEL B: With Individual and School Controls				
Treatment	0.916***	0.806***	2.038***	2.054***
	(0.159)	(0.159)	(0.355)	(0.394)
Baseline	0.440***	0.515***	0.884***	1.387***
	(0.0464)	(0.0557)	(0.108)	(0.145)
p-val (OLS)	0.00	0.00	0.00	0.00
p-val (RI)	0.00	0.00	0.00	0.00
R^2	0.372	0.315		
N	887	887	887	887

Notes: The outcome variable in Columns (1) and (2) are the ASER scores for Reading and Maths that have been standardized to have mean 0 and standard deviation 1 for the control group. Individual controls include gender, age, religion, and caste. School controls include language of instruction and the number of boys and girls in the school. 'Baseline' captures the students' responses to the survey question at baseline. Wild-bootstrapped standard errors are clustered at the school-level and reported in parentheses. p-val (OLS) reports the p-value for the treatment coefficient estimated by the wild-bootstrapped clustered standard errors, while p-val (RI) reports the p-value using randomized inference method. * denotes p<0.1, ** denotes p<0.05 and *** denotes p<0.01 respectively.

Table 3.3: Impact on Standardized National Exam Scores

	Any Exam?	Tamil	English	Maths	Science	Social Science	Total
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
PANEL A: Without Individual and School Controls							
Treatment	-0.000653	0.541	1.365	1.916	-0.646	-0.967	0.406
	(0.0529)	(2.994)	(2.403)	(2.330)	(2.502)	(3.068)	(2.025)
p-val (OLS)	0.990	0.857	0.570	0.411	0.796	0.753	0.841
p-val (RI)	0.993	0.859	0.587	0.423	0.801	0.753	0.857
R^2	0.000	0.000	0.002	0.006	0.001	0.001	0.000
PANEL B: With Individual and School Controls							
Treatment	0.000437	-0.815	0.654	1.851	-1.316	-2.004	-0.353
	(0.0400)	(2.125)	(2.305)	(2.101)	(2.372)	(2.451)	(1.569)
ASER Reading	0.0656***	5.727***	3.059***	0.532	3.073***	4.425***	3.370***
	(0.0157)	(1.024)	(0.698)	(0.545)	(0.535)	(0.836)	(0.647)
ASER Maths	0.0947***	5.823***	5.014***	3.372***	2.708***	5.825***	4.640***
	(0.0247)	(1.025)	(0.853)	(0.714)	(0.795)	(0.985)	(0.730)
p-val (OLS)	0.991	0.701	0.777	0.378	0.579	0.414	0.822
p-val (RI)	0.997	0.710	0.793	0.407	0.587	0.398	0.841
R^2	0.142	0.282	0.202	0.127	0.168	0.212	0.254
Control Mean	0.82	64.56	51.22	45.68	62.35	59.79	56.77
N	991	814	814	814	814	814	814

Notes: All outcome variables are the percentage marks scored by a student in their Class X exams. Panel A does not include any controls, while Panel B includes individual and school controls. Individual controls include gender, age, religion, and caste. School controls include language of instruction, number of boys and girls and the baseline ASER scores for Reading and Maths. Wild-bootstrapped standard errors are clustered at the school-level and reported in parentheses. p-val (OLS) reports the p-value for the treatment coefficient estimated by the wild-bootstrapped clustered standard errors, while p-val (RI) reports the p-value using randomized inference method. * denotes p<0.1, ** denotes p<0.05 and *** denotes p<0.01 respectively.

Table 3.4: Impact on Students' Effort on Studies, Parental Support

	Absenteeism	Parent	Tuition		Self-Study	
	Days/Week	Support	At least 1 day	Days/Week	At least 1 day	Days/Week
	(1)	(2)	(3)	(4)	(5)	(6)
PANEL A: Without Individual and School Controls						
Treatment	-0.0747	0.182	-0.0180	-0.110	-0.0771	-0.738
	(0.169)	(0.376)	(0.0317)	(0.200)	(0.0799)	(0.878)
Baseline	0.180***	0.284***	0.463***	0.436***	0.00832	0.123***
	(0.0404)	(0.0369)	(0.0438)	(0.0425)	(0.0439)	(0.0424)
p-val (OLS)	0.659	0.629	0.569	0.584	0.334	0.401
p-val (RI)	0.684	0.634	0.558	0.560	0.350	0.421
R^2	0.028	0.073	0.207	0.191	0.006	0.018
PANEL B: With Individual and School Controls						
Treatment	-0.0958	0.218	-0.0133	-0.0827	-0.0788	-0.736
	(0.194)	(0.445)	(0.0364)	(0.232)	(0.0843)	(0.916)
Baseline	0.164***	0.291***	0.458***	0.429***	0.00566	0.0990**
	(0.0425)	(0.0370)	(0.0443)	(0.0431)	(0.0405)	(0.0414)
p-val (OLS)	0.621	0.623	0.714	0.721	0.350	0.422
p-val (RI)	0.612	0.579	0.683	0.661	0.364	0.416
R^2	0.047	0.097	0.214	0.199	0.051	0.070
Control mean	1.685	14.15	0.222	1.304	0.565	4.920
N	856	856	856	856	856	856

Notes: "Absenteeism" is the number of days in the last week that a student was absent from school. "Parent Support" is a composite index described in Appendix Section 3.B. Tuition in Column (3) takes the value 1 if a student takes private tuition classes and is the number of days/week that the students attends tuition classes in Column (4). Self-study in Column (5) takes a value 1 if a student spent at least 1 day in the last week self-studying and 0 otherwise, and the number of days/week that a student self-studies in Column (6). Individual controls include gender, age, religion, and caste. School controls include language of instruction and total number of boys and girls. Wild-bootstrapped standard errors are clustered at the school-level and reported in parentheses. p-val (OLS) reports the p-value for the treatment coefficient estimated by the wild-bootstrapped clustered standard errors, while p-val (RI) reports the p-value using randomized inference method. * denotes p<0.1, ** denotes p<0.05 and *** denotes p<0.01 respectively.

3.A Appendix Tables

Table A1: Impact by Baseline ASER Levels

	Reading level			Math Score		
Baseline level:	Word	Paragraph	Story	Digits	Subtraction	Division
	(1)	(2)	(3)	(4)	(5)	(6)
PANEL A: Without Individual and School Controls						
Treatment	0.400***	0.828***	0.754***	0.648***	0.880***	0.419***
	(0.112)	(0.131)	(0.125)	(0.172)	(0.0889)	(0.0975)
p-val (OLS)	0.00	0.00	0.00	0.00	0.00	0.00
p-val (RI)	0.00	0.00	0.00	0.00	0.00	0.00
R^2	0.090	0.256	0.231	0.183	0.339	0.130
PANEL B: With Individual and School Controls						
Treatment	0.435***	0.780***	0.761***	0.675***	0.892***	0.416***
	(0.166)	(0.186)	(0.138)	(0.219)	(0.101)	(0.111)
p-val (OLS)	0.00	0.00	0.00	0.00	0.00	0.00
p-val (RI)	0.00	0.00	0.00	0.00	0.00	0.00
R^2	0.156	0.274	0.254	0.263	0.391	0.153
N	193	168	526	71	279	537

Notes: Each column restricts the sample of students to that level of reading/maths at baseline and examines the impact of the treatment on endline scores. Given the low sample size, we combine the levels of Beginner and Letter with Word for ASER Reading (Column 1). Similarly, we combine Beginners, 0-9 and 10-999 as Digits for ASER Maths (Column 4). Individual controls include gender, age, religion, and caste. School controls include language of instruction and the number of boys and girls. Wild-bootstrapped standard errors are clustered at the school-level and reported in parentheses. p-val (OLS) reports the p-value for the treatment coefficient estimated by the wild-bootstrapped clustered standard errors, while p-val (RI) reports the p-value using randomized inference method. * denotes p<0.1, ** denotes p<0.05 and *** denotes p<0.01 respectively.

Table A2: Impact on Parental Support

	Total	Events	Homework	School	Talk
	(1)	(2)	(3)	(4)	(5)
PANEL A: Without Individual and School Controls					
Treatment	0.182	-0.0126	0.0751	0.00638	0.0564
	(0.376)	(0.159)	(0.138)	(0.123)	(0.126)
Baseline	0.284***	0.0575**	0.226***	0.202***	0.235***
	(0.0369)	(0.0285)	(0.0331)	(0.0308)	(0.0311)
p-val (OLS)	0.629	0.937	0.585	0.958	0.655
p-val (RI)	0.634	0.938	0.570	0.955	0.680
R^2	0.073	0.003	0.048	0.037	0.050
PANEL B: With Individual and School Controls					
Treatment	0.218	0.0157	0.0618	0.00692	0.0724
	(0.445)	(0.208)	(0.160)	(0.145)	(0.149)
Baseline	0.291***	0.0532*	0.231***	0.203***	0.244***
	(0.0370)	(0.0275)	(0.0338)	(0.0320)	(0.0311)
p-val (OLS)	0.623	0.940	0.699	0.962	0.628
p-val (RI)	0.579	0.932	0.673	0.957	0.599
R^2	0.097	0.021	0.060	0.045	0.062
N	856	856	856	856	856
Control Mean	14.15	3.322	3.310	3.996	3.519

Notes: Each outcome variable in Columns 2-5 is a measure from 1 (Never)–5 (Always) on how often a parent supervises the studies of the child. Column 1 is the total score across all measures in Columns 2-5. Individual controls include gender, age, religion, and caste. School controls include language of instruction and the number of boys and girls. Wild-bootstrapped standard errors are clustered at the school-level and reported in parentheses. p-val (OLS) reports the p-value for the treatment coefficient estimated by the wild-bootstrapped clustered standard errors, while p-val (RI) reports the p-value using randomized inference method. * denotes p<0.1, ** denotes p<0.05 and *** denotes p<0.01 respectively.

Table A3: Impact on Standardized National Exam Scores (All Students)

	Tamil	English	Maths	Science	Social Science	Total
	(1)	(2)	(3)	(4)	(5)	(6)
PANEL A: Without Individual and School Controls						
Treatment	1.270	1.816	2.040	-0.0995	0.0747	1.008
	(3.338)	(2.378)	(2.236)	(2.856)	(3.358)	(2.234)
p-val (OLS)	0.704	0.445	0.361	0.972	0.982	0.652
p-val (RI)	0.737	0.483	0.399	0.975	0.984	0.706
R^2	0.001	0.003	0.004	0.000	0.000	0.001
PANEL B: With Individual and School Controls						
Treatment	-0.203	2.911	2.440	-1.582	-2.600	0.134
	(2.796)	(2.917)	(2.869)	(3.561)	(2.967)	(2.326)
p-val (OLS)	0.942	0.318	0.395	0.657	0.381	0.954
p-val (RI)	0.939	0.249	0.371	0.600	0.267	0.951
R^2	0.128	0.083	0.065	0.084	0.112	0.100
Control Mean	60.80	48.30	43.18	59.27	56.75	53.70
N	1280	1280	1280	1280	1280	1280

Notes: All outcome variables are the percentage marks scored by a student in their Class X exams. Panel A does not include any controls, while Panel B includes controls for gender and the caste of the students. These are the only controls that are available in the data set across all students provided to us by the school. School controls include the language of instruction and the number boys and girls. Wild-bootstrapped standard errors are clustered at the school-level and reported in parentheses. p-val (OLS) reports the p-value for the treatment coefficient estimated by the wild-bootstrapped clustered standard errors, while p-val (RI) reports the p-value using randomized inference method. * denotes p<0.1, ** denotes p<0.05 and *** denotes p<0.01 respectively.

3.B Program Description, ASER Measurement

3.B.1 Components of Avanti's Program

Table B1: Avanti Program Components Description

Technology: Short videos in the local language that explain concepts through the use of real world examples.	5 mins per class
Peer-learning: Students organized in groups of 6 and tasked with collaboratively solving worksheets. Facilitators intervene to encourage discussion and resolve questions only when necessary.	35-40 mins per class
Trained Facilitators: Facilitators (from the local area) led lectures to summarize key concepts based on facts emerging from an in-class discussion.	15-20 mins per class

3.B.2 ASER Reading and Maths Survey

Table B2: Curriculum Mapping for ASER Survey

ASER Levels	**ASER Reading**	**Grade level**	**ASER Maths**	**Grade level**
Level 1	Beginner		Beginner	
Level 2	Identifying letters	< Grade 1	Number recognition 0 - 9	< Grade 1
Level 3	Reading words	< Grade 1	Number recognition 10 - 99	< Grade 1
Level 4	Reading a paragraph	Grade 1	Subtraction with borrowing	Grades 2 or 3
Level 5	Reading a story	Grade 2	Division with remainder	Grades 3 or 4

3.B.3 Parental Support Index

Table B3: Parent Support Questions

Variable	**Survey Question**
School	How often do your parents help you with your school work?
Talk	How often do your parents talk to you about what you are doing in school?
Homework	How often do your parents ask you about homework?
Events	How often do your parents go to meetings or events at school?

3.C Attrition

Of the 991 students in our baseline sample we only have 887 students in a the endline (an attrition of 10.5 percent). We investigate the differential attrition across treatment and control schools on observable characteristics as well as its impact on our treatment estimates in two ways. First, we report whether there is differential attrition between treatment and control. We estimate the following specification:

$$M_i = \alpha + \beta X_i + \gamma T_i + \delta T_i \times X_i + \varepsilon_i$$

where M_i is a dummy variable that takes the value 1 if the student stays in the sample and 0 if the student drops out between the baseline and endline. δ is the coefficient of interest since it tells us whether characteristics of students who stay in the sample is statistically different on average between control and treatment schools. We report the estimates for δ in Table C1. As reported in the table, the attrition is small in magnitude and statistically insignificant between treatment and control schools for almost all student characteristics (except age and religion, which we use as controls in our analysis).

Table C1: Differential Attrition between Control and Treatment

	Coefficient	S.E.	p-value
	(1)	(2)	(3)
Female	0.02	0.05	0.68
Age	0.05	0.03	0.13
Hindu	0.06	0.06	0.35
SC/ST	0.01	0.05	0.84
OBC	0.02	0.05	0.61
Illiterate	-0.02	0.06	0.81
High-School	-0.03	0.05	0.51
Income > Rs. 10k	0.04	0.08	0.65
ASER Reading	-0.03	0.02	0.27
ASER Maths	-0.04	0.04	0.28
Parental Support	-0.02	0.01	0.01
Life Skills	-0.01	0.01	0.43
Attitudes	0.00	0.01	0.93

In addition, to account for potential endogenous attrition from the sample, we also estimate Lee bounds on the treatment effects on the ASER test scores and the Grade 10 exam scores with bootstrapped standard errors (Lee 2009). Table C2 report the 90th, 95th and 99th percentile confidence intervals for the lower bound (Column 1) and upper bound (Column 2) for reading (Panel A) and maths (Panel B). As we can see, the lower bound on ASER learning is still 0.6σ for reading and 0.26σ for maths.

Table C2: Lee Bounds on Treatment Effects

	Lower bound	Upper bound
	(1)	(2)
Panel A: ASER Reading		
90th percentile	{0.75, 1.30}	{0.85, 1.51}
95th percentile	{0.69, 1.36}	{0.78, 1.57}
99th percentile	{0.59, 1.46}	{0.66, 1.69}
Panel A: ASER Maths		
90th percentile	{0.37, 0.74}	{0.46, 0.88}
95th percentile	{0.33, 0.77}	{0.42, 0.92}
99th percentile	{0.26, 0.84}	{0.34, 1.00}

4

Across the Board: The Impact of Gender Quotas on Corporate Boards in India

Diva Dhar*

Abstract

In 2013, India introduced a new law mandating the inclusion of a woman on the board of all listed companies. I find that the reform was successful in increasing women's representation on corporate boards, but it also surprisingly exacerbated gender pay gaps among board members. Using an established instrumental variables strategy where I instrument on pre-reform variation in female board membership to measure the exogenous change in board membership required by the quota, I find the quota has a positive impact on income, sales, profits and return on assets. In addition, I find evidence of improvements in staff welfare, training and overall employment, but not specifically on women's employment. Overall, I conclude that the quota was successful in increasing female leadership on boards, with gains in firm performance and staff welfare, but with unanticipated widening of gender pay gaps for board members and no significant increase in women's employment. This is the first paper in a developing country setting to rigorously assess the impact of gender quotas on boards.

JEL codes: J24,J3,J7,J78

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4.1 Introduction

Globally, the number of women in leadership positions in business has been rising over the last two decades (Grant Thorton 2020). Despite progress, only 29 per cent of all senior management positions globally are occupied by women (United Nations 2022). India has the third lowest global representation of women managers, ahead only of South Korea and Japan. In 2019, women held only 8 per cent of management roles, 9 per cent of business management roles, and were only 2 per cent of Chief Executive Officers in India (Kersley et al. 2019) Until the 1990s, only 1 per cent of all board directors in the top 200 firms of India were women, and this proportion rose very slowly to 2 per cent by 2000 and 5 per cent by 2010 (Tumbe 2022)

Over the last two decades, a commonly used policy to improve gender parity in leadership has been to institute quotas, in business as in politics. 13 countries implemented boardroom diversity policies in the form of legal gender quotas between 2008 and 2015 (Adams 2016). Some high income countries imposed stringent penalties on non-compliant firms such as Norway, Italy and Belgium whereas other countries such as Germany and the Netherlands opted for soft-law quotas, with no sanctions (The Economist 2018). Most recently, the European Union passed a legislation for gender balance on corporate boards in October 2022 directing listed firms to have at least 40 per cent of non-executive directors from the under-represented sex by 2026. There has, likewise been a growing momentum in developing countries in recent years as well. Kenya and South Africa passed government mandates for women's representation on the boards of state-owned companies, whereas India introduced quotas for public and listed companies (African Development Bank 2015).

Recent work has drawn economists' attention to the application of quotas for women's leadership in business and politics. There is a growing body of work assessing the impact of gender quotas for boards such as in Norway (Bertrand et al. 2019; Ahern and Dittmar 2012; Matsa and Miller 2013), Italy (Ferrari

et al. 2016), Western Europe (Comi et al. 2020) and other countries. These studies have mixed findings on the impact of board quotas on firm and financial performance, social impact and personnel outcomes. For example, gender quotas for boards in Norway reduced firm value (Ahern and Dittmar 2012) and profits (Matsa and Miller 2013) and did not change the participation of women in senior levels of management or in MBA or business programs (Bertrand et al. 2019) These findings are part of a broader literature on women's leadership (Pande and Ford 2009; Hughes et al. 2017).

In India, the literature has focused on the impact of quotas for women's political leadership, showing how they can help align public expenditure with women's needs (Chattopadhyay and Duflo 2004), improve early childhood development outcomes (Pathak and Macours 2017), reduce gender biases and stereotypes and improve perceptions of women's ability (Beaman et al. 2009), increase women's willingness to report crime (Iyer et al. 2012), and raise women's aspirations (Beaman et al. 2012; Bhalotra et al. 2018; Ghani et al. 2013). However, there has not yet been any rigorous study examining the causal impact of gender quotas on *corporate boards* in India.

In this paper, I examine India's introduction of board quotas for women in 2013, mandating all publicly listed firms to have at least one woman on their company boards starting in 2014. I investigate the effects of the gender quotas on the quantity and quality of men's and women's participation on boards, as well as impacts on firm performance and other personnel related outcomes. Following the instrumental variable strategy laid out in Bertrand et al. (2019) and Ahern and Dittmar (2012), I exploit variation in women's leadership on boards prior to the legislation to identify the impact of the quotas. Companies that had women already had to make no changes whereas other companies without female members had to initiate changes by bringing women on board.

I find that the quotas introduced in 2013 did indeed increase gender parity in terms of participation, but they may have widened gender pay gaps for board

membership. Moreover, the reform helped improve firm performance and staff welfare outcomes. To my knowledge, this is one of the first studies assessing board quotas in a developing country setting - where the barriers to women's leadership and the structure of the economy and its corporate sector may lead to different outcomes from higher income countries. The paper adds to the literature and to policy debates on gender quotas by showing how gender equality on boards can contribute to improved firm and personnel outcomes.

The paper is organized as follows. In Section 2, I explore the relevant literature on women's leadership and quotas, in the corporate sector, which has focused largely on high income countries. In Sections 3 and 4, I lay out the research questions as well the data sources and sampling strategy for the study. In Section 5, I lay out stylized facts related to the evolution of women's representation on boards before and after the reform, including the nature, form and remuneration of their participation. Next, in Section 6, I look at the impact of the reform on firm performance and employees in Section 6. Finally, I discuss the conclusion in Section 7.

4.2 Related Literature

There is a growing body of research examining the effects of gender diversity in leadership and board membership. Studies have examined a range of outcomes of interest from improved financial performance, return on assets, stock market valuation and shareholder value, to increased customer and employee satisfaction, greater investor confidence, innovation, social performance and women's labor market outcomes. However, the evidence base is mixed and ambiguous. Two reviews by Pande and Ford (2009) and Hughes et al. (2017) suggest that the evidence on gender quotas in business is limited and inconclusive, especially relative to political quotas, where there is consensus on positive impacts. Moreover, the majority of studies are descriptive, correlational and focused on high income countries. There is a dearth of rigorous evidence, particularly in low-income countries, on the causal impact of quotas on firm performance and other outcomes. Below, I review the

existing literature and findings on implementation, firm performance and social impacts.

First, the evidence suggests that mandating board quotas for women in other countries has been largely successful in increasing female representation on boards (The Economist 2018). Bertrand et al. (2019) and Ferrari et al. (2016) also show that quotas in Norway and Italy have helped positively restructure the board by, for example, increasing the level of qualifications and expertise of board members. For example, the Italian gender quotas increased the share of women and increased the average education qualification of board members (Ferrari et al. 2016). Bertrand et al. (2019) suggest that the Norwegian policy helped make way for previously untapped networks of qualified and able businesswomen, and erased the prior gender gap in educational background.

A number of studies find that greater diversity on boards, in terms of gender, age, race and nationality, is associated with improved firm financial performance (Erhardt et al. 2003; Ararat et al. 2010; Brahma et al. 2021; Liu et al. 2014). Several studies find a positive relationship between female board membership and financial performance across contexts such as the Netherlands, China, Spain, Finland, Russia and Norway (Lückerath-Rovers 2010; Kotiranta et al. 2010; Campbell and Mınguez-Vera 2008; Garanina and Muravyev 2021; Nygaard 2011; Liu et al. 2014). In contrast, Adams and Ferreira (2009) show that the average effect of gender diversity on the performance of American firms is negative, with lower Tobin Q's and return on assets, despite increased monitoring. Other studies also find negligible or negative effects on firm performance, risk, share prices and value (Yang et al. 2019; Comi et al. 2020; Dale-Olsen et al. 2013; Gertsberg et al. 2021). These studies, however, are largely correlational, and face the limitation that better performing companies may just choose to appoint more women leaders.

However, there are a few more causal papers emerging to assess the impact of gender quotas for female board membership on firm performance. For example, Matsa and Miller (2013) use a triple difference identification strategy to indicate

that corporate gender quotas led to a short-term loss of profits, largely driven by increased spending on labor and fewer workforce reductions. Similarly, Yang et al. (2019) find that the Norwegian quotas worsened firm performance and firm risk. In the same vein, Ahern and Dittmar (2012) use an instrumental variable strategy to find that the Norwegian corporate quotas had a substantial negative impact on firm value in the short term, as measured by Tobin's Q. Overall, while there are some indications that firm performance might look worse in the short run, the link between women on the board and longer term firm outcomes remains unclear. As Pande and Ford (2009) and Hughes et al. (2017) note, more research is needed on impacts in the long term, since many policies have been too recently implemented for meaningful implications, and short term costs may translate into greater benefits in the long term.

A few papers also look beyond firm performance outcomes at social, personnel and workplace outcomes. Harjoto et al. (2020) find that the presence of female executives in American corporate social responsibility leadership teams is positively associated with firms' future social performance and can enhance their social objectives. Matsa and Miller (2011) find there is a positive relationship between female board membership in the previous year with the participation of women in executive positions in American companies. In addition, Bloom et al. (2011) find that firms with a higher proportion of female managers and more skilled workers, tend to implement more female friendly workplace practices. This agrees with large scale descriptive survey data presented by Adams and Funk (2012) from Sweden which indicates that female managers may be more stakeholder-oriented and benevolent than men and care more about workers at the lower end of the wage distribution. Additionally, employees might trust female executives more: In Pew's "Women and Leadership" survey in 2015, more American workers reported perceiving female executives as being more honest and ethical. 34 per cent of respondents reported that women were better in this category, relative to 3 per cent who said men were better (64 per cent said there was no difference).

This is in contrast to other studies which find that the positive effects of quotas were concentrated among a small group of insider women. Bertrand et al. (2019) show that the Norwegian quotas had very little discernible impact on women in business beyond its direct effect on the women who made it into boardrooms. A prominent group of Norwegian women (most of them insiders, in non-executive positions), nicknamed the "golden skirts", turned themselves into multiple board directors, following the implementation of quotas. The quotas were not found to have changed broader representation of women in senior management or female students pursuing business degrees or the gender pay gap beyond the boards. This resonates with findings from Flabbi et al. (2019) who find that Italian female executives have a positive impact on women only at the top of the wage distribution, and a negative impact on those at the bottom. In these countries, quotas seem to have had no discernible or beneficial effect on women at lower levels of the corporate hierarchy, and may not have challenged existing gender norms related in companies. These results were not in line with the expectations behind these quotas - that they would encourage companies to promote more women in order to fill the upper echelons faster, which, in turn, would help shrink the wage gap between men and women. However, there are contextual differences in lower income countries which may also lead to divergent effects.

A recent descriptive study of the top 500 firms in the National Stock Exchange in India suggests that unlike Norway, mandating quotas for women on boards in India did not limit benefits to only a small section of insiders. Most appointed women were independent - that is, they did not have a pre-existing relationship with the company or its owners. The policy was deemed successful in significantly enlarging the pool of distinct women serving as directors (Kuppuswamy et al. 2020). However, the study found that independent female members in boards were also less likely to be appointed to prominent boards/key board committees such as compensation or nomination committees. Independent women were particularly less likely to sit on prominent committees, compared to similar male directors who were also independent. Family or ownership ties played a part in enabling the membership of

women in key board committees (Kuppuswamy et al. 2020). However, their study has a restrictive sample of 500 listed companies and does not assess the impact of these policies on firm performance, staff welfare and other variables.

This paper aims to fill a gap in the literature by providing a more comprehensive assessment of the uptake of the quota, and rigorous, causal evidence on the impact of the quota on firm performance and staff welfare outcomes.

4.3 Study Objectives

Corporate boards can play an important role in advising, monitoring and overseeing the CEO and executive function of the firm (Fama and Jensen 1983). This study examines the evolution of women's leadership on corporate boards as well as the impact of board gender quotas legislated in 2013, and enacted in 2014, for publicly listed companies.

The gender quota was introduced as part of the Companies Act legislation, approved by the Indian parliament in August 2013. The reform mandated that all publicly listed companies in India should introduce at least one female board member. The quota came into effect at the end of March 2014, and required compliance within 6 months, that is, by September 2014. A failure to comply could lead to a penalty of Rs 50,000- Rs 50 lakhs (USD 700-USD 70,000).

To better understand the implementation and impact of the quotas, the study poses the following questions:

1. Did the gender quotas succeed in improving female representation on corporate boards?
2. How did the gender quotas change the nature and structure of female representation on boards?
3. How did the gender quotas change gender pay gaps for board members?

4. What was the impact of the quotas for female board representation on firm performance (such as income, profit, sales, return on assets)?

5. What was the impact of the quotas on personnel (such as staff training, welfare, overall hiring and recruitment of female employees)?

Since the legislation was universally applicable to all publicly listed companies, we use a sample of 1948 publicly listed firms in India for which data on board composition and firm performance was available from 2006 to 2020 from different data sources.

4.4 Data

The primary data sources for this study are two popular firm-level datasets in India - the PRIME Board dataset as well as the PROWESS datasets. The PRIME Board dataset provides us up to date information on board membership and composition of actively traded Indian listed companies which between the years of 2006 and 2020. This dataset also provides details on individual board members in these firms for every year such as their names, gender, age, education, board tenure and status. This is a paid, private dataset and is built and managed by a private company -Praxis Consulting & Information Services Pvt. Ltd. From this dataset, I drop all unlisted or private companies from their dataset, and I use their full sample of publicly listed companies for this study. This encompasses 1948 listed companies and their 36,620 board members for the years of 2006 to 2020. It is important to note that this constitutes a near universal sample of listed firms - in 2020, there were 1959 such listed firms on the National Stock Exchange in India (Statista 2022).

The second complementary source of data, the PROWESS dataset, covers additional details for board membership such as their earnings and overall remuneration for their board participation. Most importantly, it provides key data for our sample companies on firm and financial performance as well as personnel and staffing outcomes. In addition, it has firm level details such as industry or sector (e.g. finance, food and beverages, media, manufacturing) and corporate ownership. This

dataset, in turn, draws on audited Annual Reports of companies and information submitted to the Ministry of Company Affairs. This paid dataset is maintained by the Centre for Monitoring Indian Economy (CMIE), an independent non-government entity that serves both as an economic think-tank as well as a business information company.

For the 1948 listed companies with board information present in the PRIME dataset, I use complementary data from PROWESS on firm performance and staffing outcomes for 1905 firms which could be matched for the post-reform period. This constitutes 97.7 per cent of the overall post-reform firm sample, which is used for the instrumental variable analysis to assess the impact of the quotas. In addition, this matched dataset contains information on salary and remuneration details for 32916 board members, or 93.8 per cent of the sample of individual board members. The analysis on gender pay gaps, is thus based, on this sub-sample of matched firms and board members.

It is also important to note that data is not reported or captured for all firms across all years in both datasets, so the panel of 1948 firms is unbalanced.[1]

4.5 Stylized facts and results

4.5.1 Did the gender quotas increase female representation on boards?

First, I look at whether there was compliance and implementation of the gender quotas legislated in 2013 and enacted in 2014, mandating that at at least one woman join the board of all listed companies.

As illustrated in Figure 4.1 below, the legal reform was successful in ensuring near universal compliance, within a couple of years of the introduction of the quota. Prior to the introduction of the act, under half (42.5 per cent) of listed companies had at least one female board member. By 2015, this number had soared to 95

1. I also estimate the results with a balanced panel of 914 firms for which data was present across the years 2006-2020 and find similar results. This analysis is available in the online appendix.

per cent, that is within two years of the announcement of the quota, and 99 per cent by the third year. Near universal compliance was achieved by 2020. The quota was thus successfully adopted universally within a relatively short period of time, ensuring female representation on all listed company boards.

In addition, the reform was also quite successful in spurring an increase in the overall proportion of board members who were female. As shown in Figure 4.2, the proportion of board members who were female rose sharply following the introduction of the quotas. It has subsequently continued to increase steadily over time. At the time of the introduction of the quotas, only around 6 per cent of board members were female. This more than doubled to around 12 per cent within a year. Moreover, even after the initial spurt related to compliance with the quota, the proportion of female board members has continued to rise steadily over time. The overall rate of increase in the proportion of female board members is much higher than before the legislation of the quotas. This can be seen in the steeper slope of the curve in the post-reform period in Figure 4.2. By 2020, the proportion had risen to almost 20 per cent. While only 1 in 5 board members were female by 2020, this was a significant increase from the proportion prior to the quota when only 1 in 20 board members were female. The quotas led to a near quadruple increase in the proportion of women on boards of listed companies.

4.5.2 Did the quotas change the nature and structure of female representation on boards?

Given that the quotas were successfully adopted, I look next at how the quotas changed the form of female and male representation on boards, by comparing the characteristics and engagement of members appointed before and after the reform.

In Table 4.1, I examine the male and female board characteristics averaged over the pre-treatment period (2006-2013) and post-treatment period (2014-2020). I find that the average proportion of female directors nearly triples between these two periods. In absolute numbers, the average number of female board members increases by about 6 times, from 690 to 3978 female directors overall – indicating a

large influx of women joining the ranks of board directors following the introduction of the quota. While the quota only mandates having one female board member, the post-treatment period sees an average of 3 female directors in a company, on average. On the other hand, the size of the board itself grows larger, and the number of male directors in a company also increases from 14 to 18, on average.

On average, these women leaders are slightly younger, and more qualified than their male counterparts – this was true before and after the legislation. The average age of both male and female board members is over 50 in both periods, though it increases by a couple of years following the reform. Women are also more likely to have higher qualifications such as a technical degree, a masters or doctorate degree than their male counterparts. Before the reform, 74 per cent of women on boards had a post-graduate or technical degree, and this increased to 81 per cent following the reform. The proportion of similarly qualified men also increased with the reform from 65 to 74 per cent, but the gap in qualifications between the two genders shrunk slightly by about 2 percentage points.

While more qualified women are joining boards, their tenures are, on average, much shorter than their male peers. The average tenures for women shorten further following the reform, partly given the recency of the legislation and the substantial influx of new women on boards. On the other hand, the average tenure of male board members increases slightly by 1.4 years following the reform. Both men and women are also more likely to hold other directorships following the reform. Women and men are also more likely to be more active, and participate on a greater number of board committees than in the pre-reform period. Women engage in 3.5 committees on average, whereas men are on nearly 4 committees, on average.

One interesting change relates to the independence of male and female board directors. Independence implies that there is no familial, financial or material relationship of the board member with the owners or the promoters of the firms - that they are not 'insiders'. Before the legislation, women were substantially less likely to be independent directors, suggesting a pre-existing relationship with the company

ownership. 53 per cent of women were independent directors compared to 62 per cent of men. Tumbe (2022) shows that, historically, the primary mechanism for women's entry in the top corporate boardrooms has been through family businesses and family ties. This is similar to other developing countries like Brazil, where Lazzaretti and Godoi (2016) suggest that the main reason for female board member nominations has been family ties, rather than skills. However, following the Indian legislation, I find that there is a reversal in this trend. Women are more likely to be independent (67%) post-reform compared to men (55%). Based on a survey of 192 women directors after the reform, Vohra (2020) finds that directors indicated that they were primarily hired from their professional networks, or otherwise through nominations from promoters, investors, or government authorities.

By mandating women's membership on boards, the quotas thus led to a large influx of educated, independent women joining boards, rather than an increasing number of proxies for male family members. This suggests that companies did not try to just "game" the reform, and did see it as more than tokenism or a box ticking exercise.

However, it is important to see if these actions also changed women's participation in more consequential ways. Men and women's contributions to the board include participation in different committees related to the board. Panel B in Table 4.1 shows the distribution of male and female board members across different committees within a company, before and after the reform. These specific committees of the Board provide advice and suggestions to the Board for their final decision-making, oversight and recommendations. The table shows that women's participation on boards differs substantially from their male counterparts. While the share of women across all committees has increased following the reform, especially in committees such as for nomination and remuneration, there continues to be sectoral sex segregation in the committees, similar to the findings from Kuppuswamy et al. (2020) from the top 500 listed firms. Since men outnumber women on the board, they do so on all committees as well. However, committees such

as Ethics committees or Nomination and Remuneration committees continue to have a greater concentration of women in their composition, compared to other committees which are perceived to be more influential. On the other hand, Business Development and Management committees continue to have a relatively higher concentration of men. While the reform helped increase women's participation in all committees, there was still gender biased sectoral segregation in responsibilities of board members following the reform. Some of this distribution is possibly in line with prevalent gender stereotypes, where areas such as ethics are deemed more "female" and business development as more "male", the latter being considered more important. However, following the reform, I observe that women are also breaking some of these barriers, and joining more consequential committees such as Audit, Risk and Finance committees in greater numbers. Following the Nomination and Remuneration committees, the Audit, Risk and Finance committees saw the highest increase in participation from female directors following the reform, indicating their participation in more prominent and "male" domains.

4.5.3 Did the quotas change gender pay gaps for board members?

I also look at the gender gaps in board member salaries and overall remuneration, which includes other items such as sitting fees, retirement benefits, bonus commissions etc. Figure 4.3, Panels A and B, capture the evolution of inflation-adjusted mean salaries and total remuneration for male and female board members from 2006 to 2020, before and after the reform. It is interesting to note that while there is some fluctuation and overlap in salaries and remuneration, women tend to earn slightly more than men before the reform. However, following the legislation, a significant gender gap emerges in the salaries and remuneration. Men and women's salary and remuneration trends notably diverge with the reform. Overall, men's salaries increase steadily over time, whereas women's salaries stagnate (Panel A). The gender gap for overall remunerations also widens further following the legislation, as men's total remuneration increases but women's remuneration falls in real terms

(Panel B). Thus, while the proportion of educated, qualified female board members increased on boards following the reform, as seen in the last section, their relative remuneration remains significantly below their male peers. I investigate this gender gap further going beyond the means.

I use regression analysis to control for other underlying differences to understand changes in earnings for board members by gender, following the reform. In order to capture these changes, I estimate the following equation for the pre and post-reform periods, as done in Bertrand et al. (2019):

$$Y_{ift} = \alpha_0 + \beta_1 Female_{ift} + \beta_2 X_{ift} + \gamma_f + \lambda_t + \theta_s + \varepsilon_{it} \tag{4.1}$$

where Y, the outcome of interest comprises of log (salaries) or log (total remuneration) for individual i in firm f in year t, $Female$ is a dummy for gender and whether a board member is a woman or not. X_{ift} is a vector of individual controls such as age, education, tenure, independent status, number of other directorships. It also include dummies for participation in different committees (eg ethics committee, nomination and remuneration committees). λ_t is a set of year dummies. Finally, I also use specifications with and without firm and sector fixed effects captured by γ_f and θ_s respectively.

As Table 4.2 shows, while the gender gap in salaries and remuneration was small and in favor of women prior to the reform, it widened significantly following the reform. Prior to the reform, women earned slightly more - by 11 and 14 per cent - in salaries and remuneration respectively, as shown in Column 1 for Panel A and Panel B respectively. However, this difference does not account for their individual characteristics, such as their age or education, or the sectors or firms in which they work. Adding individual controls, firm and sector fixed effects erodes the coefficient for the gender pay gap prior to the reform. Women's salaries and remuneration are up to 5 and 9 per cent lower respectively, relative to men within the sector they work in, though the difference is not significant (Column 3, Panel A and B).

Similarly, their overall remuneration is 14 per cent lower relative to men within the same firms, as seen in Column 5 for Panel B.

Following the reform, the gender pay gap does not decrease, and if anything, widens in most specifications, for salaries as well as for remuneration. Without controlling for individual, firm or sector characteristics, women earn 22 per cent less in salaries (Column 2, Panel A) and 82 per cent less in overall remuneration (Column 2, Panel B) following the reform, although they were ahead of men on average prior to the reform. This is a significant widening of the gender pay gap as a whole. However, controlling for individual characteristics, committee, firm and sectoral participation helps explain a lot, though not all, of the pay gap. Controlling for individual characteristics such as independence, tenure and differences in sectors in which women join, women still earn 8 to 24 per cent less than men in terms of salaries and remuneration (Columns 4, Panel A and B). Controlling for firm fixed effects, still means women earn approximately 30 per cent less in terms of salaries and remuneration (Column 6, Panels A and Panel B) in the post-reform period.

These results are puzzling, since the gender pay gap following the reform persists or widens even after controlling for the entry of more qualified, educated, independent women joining boards, and the different engagement and contributions to board committees and sectors. It is possible that there are unobservable characteristics such as gender differences in risk-taking and competitiveness (Gneezy et al. 2003; Niederle and Vesterlund 2007; 2010) or the premium for joining boards lowers for new women, given the increased supply of eligible, independent female board members. While this paper is not able to shed light on the drivers, this is an important and intriguing phenomenon which requires further investigation in future research.

4.6 Did the board quotas have an impact on firm performance and staff welfare?

In this section, I look at the impact of the gender quotas on firm performance and staff welfare and training. I first present the summary statistics for key firm outcome variables, followed by the specific identification strategy and results.

4.6.1 Summary Statistics

First, I present some summary statistics on the firms in our sample for key firm performance and staff welfare variables before and after the reform, averaged over the pre-treatment period (2006-2013) and post-treatment period (2014-2020) in Table 4.3. I find that the average annual real income for firms increases by 33 per cent from 28.5 to 38.1 (10 billion rupees) in the post-reform period, while looking at total income. Similarly, net sales increase significantly as well by over 25 per cent in the post-reform period. There is also a significant increase in total assets, which increase by more than 75 per cent over the two periods. Annual net profits were negative in both periods, on average, but post-reform losses are a third of what they had been prior to the reform. There is also an increase in staff welfare and staff training expenses, by 21 and 52 per cent respectively.

However, there are a few important downward trends as well. The return on assets decreases, almost by half, in the post-reform period. There is an important change in staffing and employment as well. First, the average number of employees decreases, by a fifth, from 5058 to 4090 employees. Secondly, while not significant, the average number of female employees also decreases by a third.

4.6.2 Identification strategy

I use an instrumental variable (IV) identification strategy to determine the effect of the gender quotas for board members on firm performance outcomes such as total income, assets, sales, return on assets and staff and welfare outcomes such as expenditure on staff welfare, training and female employment. I adopt the

IV strategy established previously in Ahern and Dittmar (2012) and Bertrand et al. (2019) to assess the Norwegian gender board quotas. This IV strategy relies on the fact that pre-reform variation in female board representation can be used to capture exogenous variation in the mandated changes in the proportion of female board members. The logic is as follows – the pre-reform female board membership in 2013 would not be affected by the subsequent quotas introduced in late 2013, enacted in 2014, but is a good predictor for post-reform variation. For example, the publicly listed companies that started with women on their board before the reform would have had to make no changes compared to the ones that did not. In particular, focusing on the post-treatment period (2014-2020), I estimate the following baseline regression based on Bertrand et al. (2019):

$$Y_{jt} = \alpha_0 + \beta_1 FemaleDummy_{jt} + \gamma_j + \lambda_t + \varepsilon_{jt} \tag{4.2}$$

where Y_{jt} is the outcome of interest in firm j at time t, such as the total income, sales, value of assets, return on assets, staff welfare allocation, staff training allocation, number of employees and number of female employees. γ_j are firm fixed effects, and λ_t are year fixed effects. $FemaleDummy_{jt}$ is a binary variable that takes the value of 1 if female board members are present in firm j at time t and 0 if otherwise, which is in turn instrumented with $FemaleDummy_{j2013}$ interacted with year fixed effects. [2]

As the first stage regression results presented in Table 4.4 show, the instrument itself is promising. The dependent variable is the binary variable that takes the value of 1 if any female board members are present in the company following the reform, and 0 if there are none. The instruments are the female dummy variable in 2013 interacted with year dummies, to control for any extraneous time effects or

2. Note that Ahern and Dittmar (2012) and Bertrand et al. (2019) use the variable that captures the percentage of female board members in Norway, given the quota stipulated a minimum proportion of female members. I also show alternative specifications with the percentage as well as the number of female board members, but my preferred specification is a binary variable for the presence of a female board member, given the Indian law mandates the inclusion of only one female member

shocks that might differentially affect the dependent variable. The regressions also include year dummies, with industry fixed effects, with standard errors clustered at the industry level. As we see in Table 4.4, the point estimates on the instrumental variables show that they are significantly and positively associated. The firms who had a woman on their board in 2013 are most likely to have one right after the reform, in compliance with the rule. The coefficient is smaller over time, indicating lower explanatory power in later years, as adoption increases. However, given an R squared of 0.81, I observe high explanatory power overall for the dependent variable. Overall, the first stage results indicate that this is indeed a viable instrumental variable strategy.

I also check and control for any potential threats to this identification strategy, following Bertrand et al. (2019), on parallel trends. One possibility is that firms that had women on their board in 2013, and were thus differentially impacted by the reform, were also on different trends related to the outcomes. I conduct analyses to explore any pre-reform level and time trend variation in 2012 to 2013 in in Tables 4.8 and 4.10. Of interest is the estimated coefficient on the female dummy in 2013 interacted with the year, where year is a linear time effect. Notably, I observe no statistically significant difference in time trends pre-reform for a host of indicators for firm performance such as income, sales, profits and total assets, and personnel outcomes such as staff welfare and number of women employees. However, there is statistical evidence of some variation in the variables for the profits, return on assets, staff training and number of employees, which suggest that the growth in those particular outcomes was larger for firms that started with women on their board, thereby possibly biasing downwards the IV estimates for this outcome. Similarly, I also check for differences in levels for those outcomes at baseline in Tables 4.7 and 4.9, and identify pre-reform differences for variables such as staff training, number of employees and return on assets. Given these pre-reform differences, I ensure we control for baseline levels across all specifications. Finally, I also test for the exclusion restriction by ruling out any near-term direct effects of the instrument by dropping early years of the post-reform period, in a robustness check explained

below. This rules out any spurious correlations between the pre-reform presence of women with subsequent changes for firm and personnel outcomes, unrelated to the reform-driven changes in the board.

4.6.3 Impacts

I now present the main IV results on the effects of firm performance and personnel outcomes in Tables 4.5 and 4.6.

As seen in Table 4.5 from Columns 1-5, there is strong, consistent evidence that the gender quotas to mandate female board membership had significant positive gains for key firm performance outcomes such as total income, net sales, profits and return on assets in the post-reform period. The inclusion of a female board member is associated with a 20 per cent increase in total income, a 30 per cent increase in net sales and a 50 per cent increase in net profits from the pre-reform period. Although return on assets declines on average for firms in the post-reform period as seen in Table 4.3, female board membership is associated with a positive impact of nearly 30 per cent of the pre-reform period (Table 4.5, Column 5). However, I find a negative impact on total assets in this period although the number is not statistically significant.

Next, we turn to the impact of the quotas on personnel outcomes based on the IV strategy. I look specifically at the data for expenditures for staff welfare and staff training, as well as the number of employees and female employment. As Table 4.6 shows, the quotas for female board membership are associated with an increase in staff welfare and staff training costs, indicating a greater allocation and concern for employee welfare and development. This is consistent with explanations that women are more altruistic and long term oriented (Matsa and Miller 2013; Silverman 2003; Andreoni and Vesterlund 2001). I also find a positive and significant impact of the quotas on employee growth and hiring, which increased by 65 per cent relative to the pre-reform period. However, while there is positive overall effect on number of female employees, despite general decline in this period, the coefficient is not significant.

These results are largely consistent, though with smaller coefficients, even with alternative specifications. These results are discussed below and shown in Appendix Tables A1 to A4.

4.6.4 Robustness Checks and Alternative Specifications

In order to rule out any possibility of near term direct effects of female board membership prior to the reform, I conduct the IV analyses focusing on later years 2016-2020, as shown in Tables 4.11 and 4.12. I drop the first two years following the reform to address any concerns that the board members in 2013 may have exercised some influence as a result of their past decisions. Regardless, I find that the effects are consistent with the broader results. In fact, there is an additional positive effect for net profits, strengthening the case for women's board membership for firm performance. The impacts on personnel outcomes are also largely consistent with the main specification. However, the effect on staff training allocation, while positive, is no longer significant.

I also run alternative specifications where I replace $FemaleDummy_{jt}$ with a) the number of women board members in a company and b) the percentage share of female board members in a company. These are, in turn, instrumented with the number of women board members in 2013 and the percentage share of female board members in 2013 respectively, both of which are interacted with year fixed effects, as in the main specification. In both these cases, the instruments are promising based on the first-stage regressions.[3]

The results from these alternative specifications are presented in Annexure Tables A1-A4. These results are consistent with the key findings of the analysis above with positive impacts on firm performance and personnel outcomes. Both specifications find a positive impact of female board membership on total income, net sales, net profits and return on assets. One key difference is that both alternate specifications also find a positive effect of the reform on the firm's net profits, and the first

3. These additional first-stage regression tables and further pre-trends analyses on firm performance and staff welfare variables are available in the online appendix

specification also finds a small positive effect on total assets. These findings underline the broader story of an overall positive impact of the reforms on firm performance. In addition, both specifications also find a positive and significant impact on staff-related outcomes such as staff welfare, staff training and overall staffing, consistent with the main specification. The effect on women's employment, once again, while positive is not statistically significant.

4.7 Conclusion

This paper examines the evolution of women's leadership, subsequent to the introduction of a gender quota introduced for boards of listed companies in India in 2013, and its impact on staff training and welfare. To my knowledge, this is the first large sample study in India to examine the causal impact of women's board membership in the corporate sector. It is also one of the first studies globally to examine impacts of companies' investments in employee welfare and training.

I find that there is rapid and universal compliance with the law, within a few years of its introduction. The gender quota leads to an influx of new and more educated and independent women directors on boards. Unlike countries like Norway and Brazil, the majority of new female directors are not insiders or 'golden skirts'. However, their participation largely continues to follow gendered patterns with higher participation in committees such as ethics or nomination and remuneration committees and lower participation in more prominent committees such as business development committees. An important finding in this paper is that despite a well-intentioned reform for gender diversity, the quota appears to have widened gender pay gaps for board members. Even after controlling for differences in age, education, experience, tenure, independence, committee participation and other firm and sector characteristics, we find that gender pay gaps persist or widen. This is an interesting area for further investigation in the future.

Using a recognized instrumental variable strategy from the literature, instrumenting on predetermined variation in female board membership, I also find that the gender

quota had significant downstream impacts on firm performance and employee outcomes. Increased participation from women on corporate boards, following the reform, translates into improved sales, total income, net profits and return on assets. In addition, I find increased investment and allocation towards staff training and welfare, as well as growth in the number of employees. There is no significant impact, however, on female employment. These results are robust and consistent across multiple specifications. These results demonstrate that gender quotas can be successful instruments to improve women's participation in leadership positions, with positive effects for firm performance as well as personnel outcomes. However, improved participation by women in the boardroom does not seem to increase gender diversity in the workforce. Overall, I find the women's empowerment effects of the quota are therefore relatively weak. While the quota increases women's participation in corporate boards, female board members themselves do not seem to benefit in terms of relative pay (to male board members), nor do they enable greater diversification of the general workforce (i.e. non-board members). This suggests that broader reform might be necessary to increase women's participation across different levels of firms.

These results make an important contribution to the literature on women's leadership, by providing a fresh example of the impact of gender quotas from a developing country context with a rapidly growing corporate sector. Future research efforts on women's corporate quotas should also examine the mechanisms and channels driving these downstream impacts.

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Figures

Figure 4.1: Percentage of listed companies with any female board member

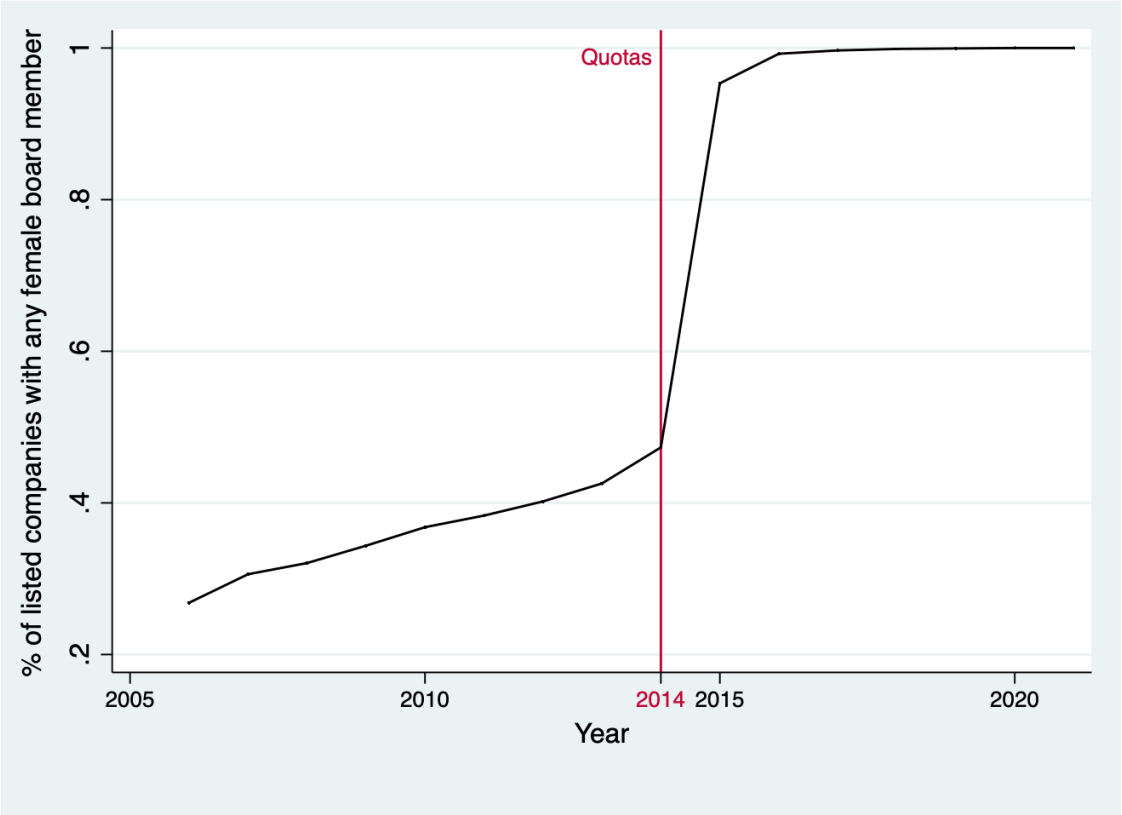


Figure 4.2: Percentage of female board members in a listed company

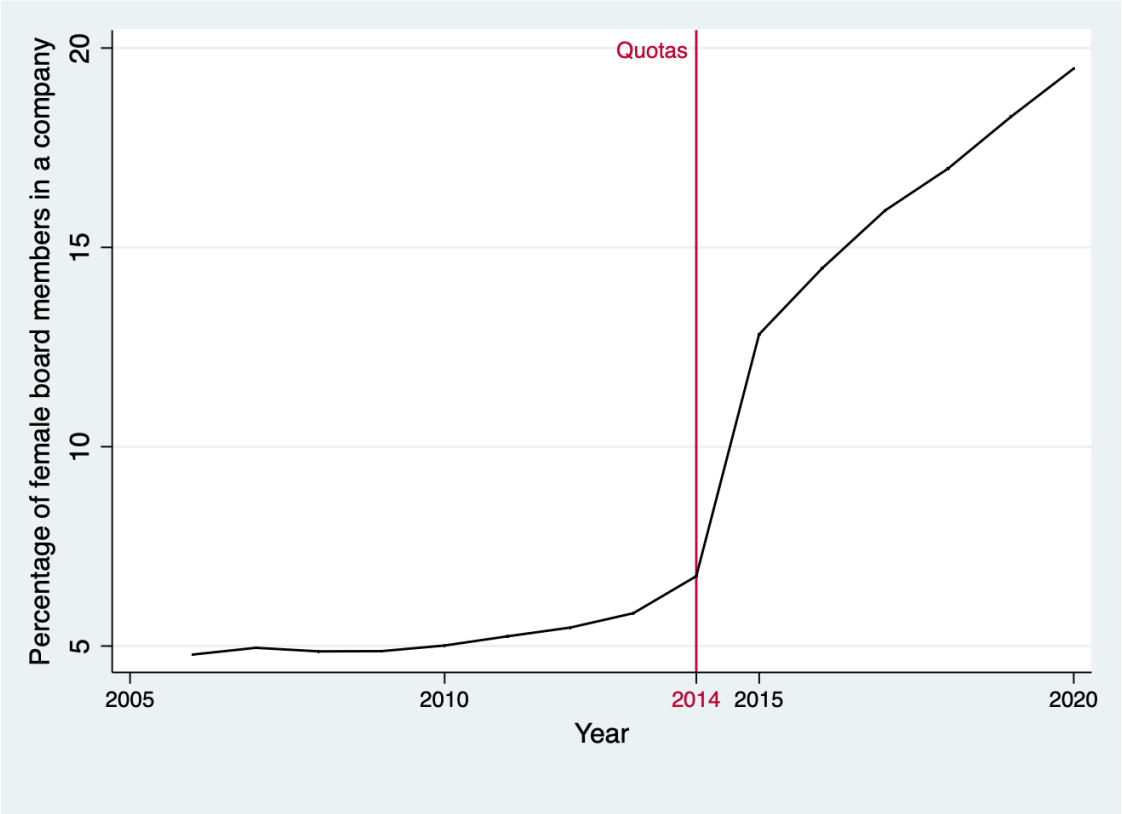
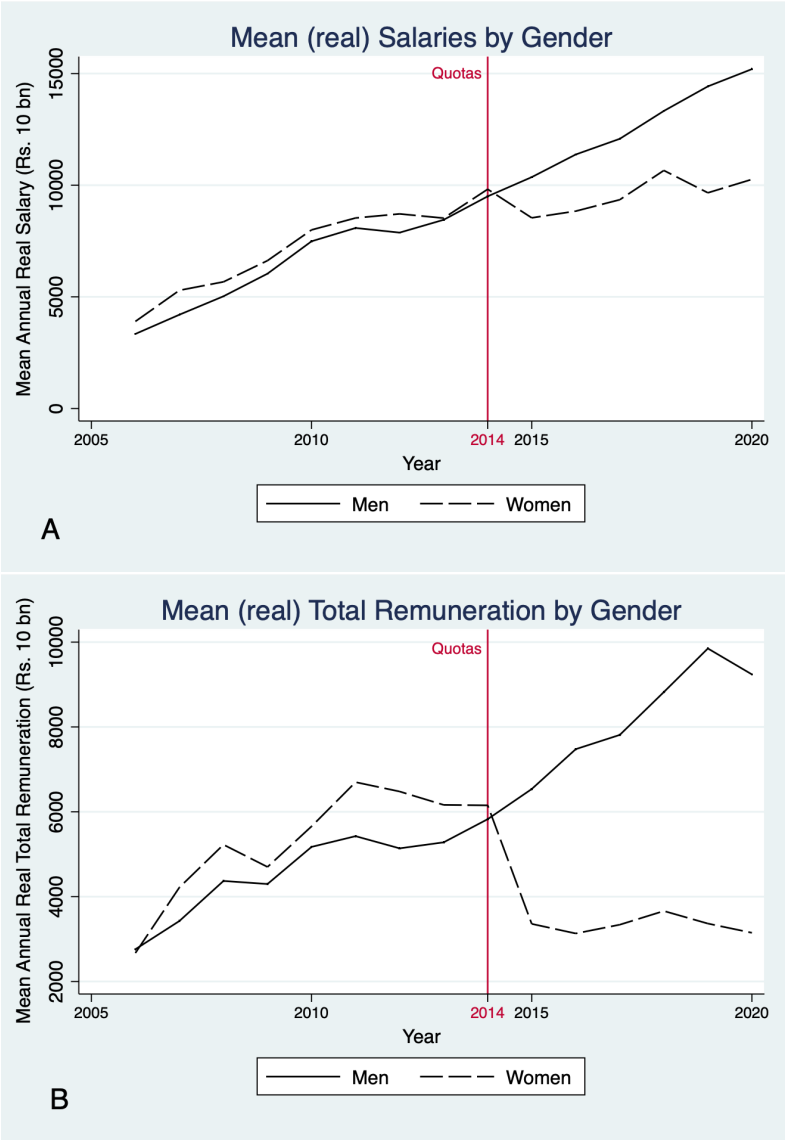


Figure 4.3: Mean (real) Salaries and remuneration by Gender



Tables

Table 4.1: Summary Statistics

Variable/Committee Name	Female directors			Male directors		
	Pre-treatment (2006-2013)	**Post-treatment (2014-2020)**	**Difference**	**Pre-treatment (2006-2013)**	**Post-treatment (2014-2020)**	**Difference**
Panel A. Board member characteristics						
Percentage of directors by gender	5.51	15.88	10.37***	94.48	84.11	-10.37***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Average number of directors	690.22	3978.80	3288.58***	11724.08	20347.28	8623.19***
	(0.571)	(3.151)	(4.142)	(7.987)	(5.191)	(9.132)
Average number of directors per company	0.92	3.18	2.25***	14.56	18.30	3.73***
	(0.006)	(0.007)	(0.010)	(0.027)	(0.028)	(0.042)
Average age of directors (years)	53.81	55.39	1.58***	58.33	60.58	2.24***
	(0.152)	(0.083)	(0.181)	(0.041)	(0.035)	(0.054)
Percentage of directors with a post-graduate or technical degree	74.28	81.08	6.80***	65.66	74.16	8.49***
	(0.006)	(0.002)	(0.006)	(0.001)	(0.001)	(0.002)
Average tenure (years)	7.58	5.05	-2.53***	8.60	9.98	1.37***
	(0.097)	(0.036)	(0.093)	(0.027)	(0.024)	(0.038)
Average number of other directorships held	0.31	1.86	1.54***	0.38	1.87	1.49***
	(0.012)	(0.009)	(0.021)	(0.004)	(0.004)	(0.006)
Average number of committees per director of	2.71	3.48	0.76***	3.08	3.93	0.84***
	(0.020)	(0.010)	(0.024)	(0.005)	(0.004)	(0.007)
Percentage of directors who are independent	53.09	67.18	14.08***	62.71	55	-7.71***
	(0.018)	(0.002)	(0.017)	(0.004)	(0.001)	(0.004)
Panel B. Participation in committees within firms						

Continued on next page

Table 4.1: – continued from previous page

	Female directors			Male directors		
Variable/Committee Name	**Pre-treatment (2006-2013)**	**Post-treatment (2014-2020)**	**Difference**	**Pre-treatment (2006-2013)**	**Post-treatment (2014-2020)**	**Difference**
Audit, Risk, Finance committees	4.37	14.08	9.71***	95.62	85.91	-9.71***
	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)
Business Development, Management committees	2.84	6.61	3.77***	97.15	93.38	-3.77***
	(0.005)	(0.006)	(0.009)	(0.005)	(0.006)	(0.009)
Nomination & remuneration committees	4.36	16.46	12.09***	95.63	83.53	-12.09***
	(0.001)	(0.002)	(0.003)	(0.001)	(0.002)	(0.003)
Assistant Committees (HR, Legal, IT, Admin)	7.44	13.40	5.96***	92.55	86.59	-5.96***
	(0.012)	(0.010)	(0.018)	(0.012)	(0.010)	(0.018)
Ethics Committee	12.37	18.39	6.01***	87.62	81.60	-6.01***
	(0.016)	(0.003)	(0.019)	(0.016)	(0.003)	(0.019)
Investment, Empl/Shareholder reln & Grievance redressal committees	5.18	14.25	9.06***	94.81	85.74	-9.06***
	(0.001)	(0.002)	(0.003)	(0.001)	(0.002)	(0.003)
Other Committees	5.48	10.96	5.47***	94.51	89.03	-5.47***
	(0.002)	(0.002)	(0.004)	(0.002)	(0.002)	(0.004)
N Board members	651	3220		9803	13898	
N firms	1414	1900		1414	1900	

Notes: Standard errors in parentheses. ***, **, and * indicate significance at the 1, 5, and 10 percent critical level. Data for Independence status is available only for 2013 pre-treatment so we use 2013 as the main year in this case.

Table 4.2: Gender gap in salaries and total remuneration

Dependent variable	**Before act (2006-2013)**	**After act (2014-2020)**	**Before act (2006-2013)**	**After act (2014-2020)**	**Before act (2006-2013)**	**After act (2014-2020)**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Panel A. Log(salary)						
Female	0.116***	-0.222***	-0.050	-0.074***	0.008	-0.301***
	(0.036)	(0.025)	(0.095)	(0.027)	(0.057)	(0.022)
Male mean (Rs.10 bn)	7088.48	14124.21	7088.48	14124.21	7088.48	14124.21
	(13989.06)	(22721.14)	(13989.06)	(22721.14)	(13989.06)	(22721.14)
Female mean (Rs.10 bn)	8820.41	12412	8820.41	12412	8820.41	12412
	(13748.83)	(17101.44)	(13748.83)	(17101.44)	(13748.83)	(17101.44)
Controls	No	No	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Sector fixed effects	No	No	Yes	Yes	Yes	Yes
Firm fixed effects	No	No	No	No	Yes	Yes
Observations	21,152	38,941	2,633	31,587	2,633	31,587
R-squared	0.054	0.015	0.145	0.124	0.915	0.729
Panel B. Log(Total remuneration)						
Female	0.141***	-0.823***	-0.090	-0.243***	-0.145**	-0.274***
	(0.036)	(0.016)	(0.075)	(0.016)	(0.062)	(0.012)
Male mean (Rs.10 bn)	4383.94	8438.509	4383.94	8438.509	4383.94	8438.509
	(18498.42)	(32369.49)	(18498.42)	(32369.49)	(18498.42)	(32369.49)
Female mean (Rs.10 bn)	5758.64	3595.75	5758.64	3595.75	5758.64	3595.75
	(28619.89)	(21621.87)	(28619.89)	(21621.87)	(28619.89)	(21621.87)
Controls	No	No	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Sector fixed effects	No	No	Yes	Yes	Yes	Yes
Firm fixed effects	No	No	No	No	Yes	Yes
Observations	73,258	138,797	10,051	114,077	10,051	114,077
R-squared	0.009	0.023	0.377	0.322	0.716	0.668

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. The sample of firms considered here is 1905 listed firms in the Prime database for which we had information on the ages and education of board members as well as their salaries. The outcome of interest is log(salaries) and log(total remuneration). Total remuneration includes salaries of board members, along with other incomes earned such as sitting fees, retirement benefits, bonus commission etc. Year FE are included along with individual controls (age and age squared, years of education and years of education squared, tenure, independent status and number of total other directorships). We estimate the equation separately for the pre-reform years (2006-2013) and the post-reform years (2014-2020) using the population of individuals serving as board members in a given year. To account for changes in the number and composition of firms over time, we also estimate a version of the equation that includes sector fixed effects (columns 3 & 4) and another that includes both firm and sector fixed effects (columns 5 & 6).

Table 4.3: Summary Statistics- Firm performance characteristics

Variable/ Indicator	**Before act (2006-2013)**	**After act (2014-2020)**	**Difference**
Average annual income (Rs. 10 bn)	28.48 (1.754)	38.14 (2.046)	9.66*** (2.792)
Average annual net sales (Rs. 10 bn)	24.88 (1.660)	31.39 (1.816)	6.51** (2.531)
Average annual profits after tax (Rs. 10 bn)	2.33 (0.124)	2.38 (0.192)	0.05 (0.244)
Average total assets (Rs. 10 bn)	49.39 (2.552)	87.77 (4.840)	38.37*** (5.946)
Average annual return on assets (%)	4.95 (0.100)	2.49 (0.114)	-2.46*** (0.157)
Average annual staff welfare expenses (Rs. 10 mn)	106.44 (6.068)	128.70 (6.658)	22.25 (9.277)
Average annual staff training expenses (Rs. 10 mn)	45.71 (5.461)	69.71 (7.792)	24.00** (9.541)
Average number of employees	5058.52 (235.752)	4090.43 (156.283)	-968.08*** (281.742)
Average number of women employees	1238.22 (161.518)	795.49 (53.905)	-442.72 (314.356)
N firms	1297	1948	

Notes: Standard errors in parentheses. ***, **, and * indicate significance at the 1, 5, and 10 percent critical level. The figures in crore rupees are in nominal terms.

Table 4.4: First stage regression (with female dummy)

Dependent variable: Female Dummy (2014-2020)		
Any female board member in year 2013 *		
	2014 Dummy	0.911 (0.006)***
	2015 Dummy	0.081 (0.008)**
	2016 Dummy	0.013 (0.002)**
	2017 Dummy	0.005 (0.001)*
	2018 Dummy	0.002 (0.001)**
	2019 Dummy	0.001 (0.000)**
	2020 Dummy	0.000 (0.000)
2014 dummy		-0.911 (0.006)***
2015 Dummy		-0.081 (0.008)**
2016 Dummy		-0.013 (0.002)**
2017 Dummy		-0.005 (0.001)*
2018 Dummy		-0.002 (0.001)**
2019 Dummy		-0.001 (0.000)**
Industry fixed effects		Yes
Observations		8,809
R-squared		0.808

Notes: Standard errors in parentheses and are clustered at industry level. *** p<0.01, ** p<0.05, * p<0.1. We instrument for the female dummy with female dummy in 2013 interacted with year fixed effects. The sample of interest here is 1948 listed companies for which board member data from Prime was merged with Prowess. We focus on the treatment years 2014-2020 for these firms. Year FE & Industry FE are also included.

Table 4.5: Effect of female board membership on key firm performance variables (female dummy)

Dependent variable	**Total income (Rs. 10bn)**	**Net Sales (Rs. 10bn)**	**Net Profits (Rs. 10bn)**	**Total Assets (Rs. 10bn)**	**Return on Assets (%)**
Any female board member in year t	5.618***	7.816***	1.267***	-44.918	1.806***
	(1.223)	(0.446)	(0.161)	(29.661)	(0.340)
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes
Baseline analog	Yes	Yes	Yes	Yes	Yes
Baseline mean (2006-13)	28.48	24.88	2.33	49.39	4.95
	(1.754)	(1.660)	(0.124)	(2.552)	(0.100)
Observations	8,386	8,168	8,395	8,401	8,390
R-squared	0.922	0.922	0.485	0.872	0.033

Notes: Standard errors in parentheses and are clustered at industry level. *** p<0.01, ** p<0.05, * p<0.1. We instrument for the female dummy with female dummy in 2013 interacted with year fixed effects. The sample of interest here is 1948 listed companies for which board member data from Prime was merged with Prowess. We focus on the treatment years 2014-2020 for these firms. Year FE & Industry FE are included. The baseline analog, which is the annual change in that variable pre-reform, is also added as a control.

Table 4.6: Effect of female board membership on staff welfare variables (female dummy)

Dependent variable	**Staff Welfare expenditure (Rs. 10mn)**	**Staff Training expenditure (Rs. 10mn)**	**Number of employees**	**Number of women employees**
Any female board member in year t	89.440***	22.070***	3,337***	909.559
	(8.336)	(3.466)	(229.980)	(937.777)
Year fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
Baseline analog	Yes	Yes	Yes	Yes
Baseline mean (2006-13)	106.44	45.71	5058.52	1238.22
	(6.068)	(5.461)	(235.752)	(161.518)
Observations	7,844	610	7,288	1,844
R-squared	0.547	0.562	0.754	0.028

Notes: Standard errors in parentheses and are clustered at industry level. *** p<0.01, ** p<0.05, * p<0.1. We instrument for the female dummy with female dummy in 2013 interacted with year fixed effects. The sample of interest here is 1948 listed companies for which board member data from Prime was merged with Prowess. We focus on the treatment years 2014-2020 for these firms. Year FE & Industry FE are included. The baseline analog, which is the annual change in that variable pre-reform, is also added as a control.

Table 4.7: Effect of female board membership on key firm performance variables pre-reform (2012-2013- using female dummy in 2013 as main independent variable)

Dependent variable	**Total income (Rs. 10 bn)**	**Net Sales (Rs. 10 bn)**	**Net Profits (Rs. 10 bn)**	**Total Assets (Rs. 10 bn)**	**Return on Assets (%)**
Any female board member in year 2013	2,303	-1,534	663.5	75,443	1.315**
	(6,967)	(13,316)	(432.3)	(48,155)	(0.260)
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes
Mean (2012-2013)	35.55	30.88	2.45	63.69	3.05
	(201.785)	(190.267)	(12.884)	(288.101)	(9.285)
Observations	1,221	1,192	1,221	1,221	1,221
R-squared	0.367	0.528	0.535	0.369	0.031

Notes: Standard errors in parentheses and are clustered at industry level. *** p<0.01, ** p<0.05, * p<0.1. The sample of interest here is 1948 listed companies for which board member data from Prime was merged with Prowess. We focus on the pre-treatment years 2012-2013 for these firms. Total assets and total number of employees are added as controls. Industry and Year FE are included as well.

Table 4.8: Effect of female board membership on key firm performance variables pre-reform (2012-2013- using female dummy in 2013*linear time trend as main independent variable)

Dependent variable	**Total income (Rs.10bn)**	**Net Sales (Rs.10bn)**	**Net Profits (Rs.10bn)**	**Total Assets (Rs.10bn)**	**Return on Assets (%)**
Any female board member in year 2013* linear time trend	3,649	976.8	1,258***	46,283	1.498***
	(4,393)	(9,436)	(109.3)	(27,798)	(0.0787)
Industry fixed effects	Yes	Yes	Yes	Yes	Yes
Mean (2012-2013)	35.55	30.88	2.45	63.69	3.05
	(201.785)	(190.267)	(12.884)	(288.101)	(9.285)
Observations	1,221	1,192	1,221	1,221	1,221
R-squared	0.367	0.528	0.535	0.363	0.030

Notes: Standard errors in parentheses and are clustered at industry level. *** p<0.01, ** p<0.05, * p<0.1. The sample of interest here is 1948 listed companies for which board member data from Prime was merged with Prowess. We focus on the pre-treatment years 2012-2013 for these firms. Total assets and total number of employees are added as controls. Since a time trend is added here, Year FE are not added but Industry FE are included above.

Table 4.9: Effect of female board membership in staff welfare variables pre-reform (2012-2013- using female dummy in 2013 as main independent variable)

Dependent variable	**Staff Welfare expenditure** **(Rs. 10mn)**	**Staff Training expenditure** **(Rs. 10mn)**	**Number of employees**	**Number of women employees**
Any female board member in year 2013	33.25	14.58**	3,141***	-226.8*
	(24.99)	(1.759)	(23.72)	(55.39)
Year fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
Mean (2012-2013)	122.12 (639.064)	51.40 (180.118)	5750.78 (20200.570)	1153.95 (1462.332)
Observations	1,169	139	1,221	41
R-squared	0.571	0.737	0.129	0.562

Notes: Standard errors in parentheses and are clustered at industry level. *** p<0.01, ** p<0.05, * p<0.1. The sample of interest here is 1948 listed companies for which board member data from Prime was merged with Prowess. We focus on the pre-treatment years 2012-2013 for these firms. Total assets and total number of employees are added as controls. Industry and Year FE are included as well.

Table 4.10: Effect of female board membership in staff welfare variables pre-reform (2012-2013- using female dummy in 2013*linear time trend as main independent variable)

Dependent variable	**Staff Welfare** **(Rs. 10mn)**	**Staff Training** **(Rs. 10mn)**	**Number of employees**	**Number of women employees**
Any female board member in year 2013*linear time trend	13.88	26.62**	782.3**	-91.05
	(20.45)	(5.580)	(136.1)	(62.72)
Industry fixed effects	Yes	Yes	Yes	Yes
Mean (2012-2013)	122.12 (639.064)	51.40 (180.118)	5750.78 (20200.570)	1153.95 (1462.332)
Observations	1,169	139	1,221	41
R-squared	0.571	0.737	0.123	0.556

Notes: Standard errors in parentheses and are clustered at industry level. *** p<0.01, ** p<0.05, * p<0.1. The sample of interest here is 1948 listed companies for which board member data from Prime was merged with Prowess. We focus on the pre-treatment years 2012-2013 for these firms. Total assets and total number of employees are added as controls. Since a time trend is added here, Year FE are not added but Industry FE are included above.

Table 4.11: Robustness check- Effect of female board membership on key firm performance variables (female dummy, years 2016-2020)

Dependent variable	**Total income (Rs. 10bn)**	**Net Sales (Rs. 10bn)**	**Net Profits (Rs. 10bn)**	**Total Assets (Rs. 10bn)**	**Return on Assets (%)**
Any female board member in year t	349.730***	369.141***	42.623***	-3442**	102.7**
	(73.028)	(98.137)	(14.253)	(1553)	(40.980)
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes
Baseline analog	Yes	Yes	Yes	Yes	Yes
Baseline mean (2006-13)	28.48	24.88	2.33	49.39	4.95
	(1.754)	(1.660)	(0.124)	(2.552)	(0.100)
Observations	5,948	5,793	5,955	5,957	5,950
R-squared	0.903	0.896	0.442	0.829	0.008

Notes: Standard errors in parentheses and are clustered at industry level. *** p<0.01, ** p<0.05, * p<0.1. We instrument for the female dummy with female dummy in 2013 interacted with year fixed effects. The sample of interest here is 1948 listed companies for which board member data from Prime was merged with Prowess. We focus on the treatment years 2016-2020 for these firms. Year FE & Industry FE are included. The baseline analog, which is the annual change in that variable pre-reform, is also added as a control.

Table 4.12: Robustness check- Effect of female board membership on staff welfare variables (female dummy, years 2016-2020)

Dependent variable	**Staff Welfare expenditure (Rs. 10mn)**	**Staff Training expenditure (Rs. 10mn)**	**Number of employees**	**Number of women employees**
Any female board member in year t	6,510***	1,535	183,566***	-5,726
	(2,276)	(2,069)	(66,041)	(8,795)
Year fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
Baseline analog	Yes	Yes	Yes	Yes
Baseline mean (2006-13)	106.44	45.71	5058.52	1238.22
	(6.068)	(5.461)	(235.752)	(161.518)
Observations	5,548	402	5,597	1,721
R-squared	0.320		0.475	0.007

Notes: Standard errors in parentheses and are clustered at industry level. *** p<0.01, ** p<0.05, * p<0.1. We instrument for the female dummy with female dummy in 2013 interacted with year fixed effects. The sample of interest here is 1948 listed companies for which board member data from Prime was merged with Prowess. We focus on the treatment years 2016-2020 for these firms. Year FE & Industry FE are included. The baseline analog, which is the annual change in that variable pre-reform, is also added as a control.

4.A Appendix

Table A1: Effect of female board membership on key firm performance variables (with number of women)

Dependent variable	**Total income (Rs. 10bn)**	**Net Sales (Rs. 10bn)**	**Net Profits (Rs. 10bn)**	**Total Assets (Rs. 10bn)**	**Return on Assets (%)**
No. of female board members in year t	21.178***	16.603***	1.640***	50.624*	0.772***
	(1.913)	(1.299)	(0.390)	*(0.214)	
			(27.959)		
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	8,386	8,168	8,395	8,401	8,390
R-squared	0.020	0.014	0.017	0.265	0.004

Notes: Standard errors in parentheses and are clustered at industry level. *** p<0.01, ** p<0.05, * p<0.1. We instrument for the number of female board members with the number of female board members in 2013 interacted with year fixed effects. The sample of interest here is 1948 listed companies for which board member data from Prime was merged with Prowess. We focus on the treatment years 2014-2020 for these firms. Year FE & Industry FE are also included.

Table A2: Effect of female board membership on staff welfare variables (with number of women)

Dependent variable	**Staff Welfare expenditure (Rs. 10mn)**	**Staff Training expenditure (Rs. 10mn)**	**Number of employees**	**Number of women employees**
No. of female board members in year t	60.45***	15.07***	1,312***	40.19
	(3.317)	(1.962)	(278.2)	(56.61)
Year fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
Observations	7,844	610	7,288	1,844
R-squared	0.020	0.061	0.043	0.027

Notes: Standard errors in parentheses and are clustered at industry level. *** p<0.01, ** p<0.05, * p<0.1. We instrument for the number of female board members with the number of female board members in 2013 interacted with year fixed effects. The sample of interest here is 1948 listed companies for which board member data from Prime was merged with Prowess. We focus on the treatment years 2014-2020 for these firms. Year FE & Industry FE are also included.

Table A3: Effect of female board membership on key firm performance variables (with percentage of women)

Dependent variable	**Total income (Rs. 10bn)**	**Net Sales (Rs. 10bn)**	**Net Profits (Rs. 10bn)**	**Total Assets (Rs. 10bn)**	**Return on Assets (%)**
Pct Women on Board in year t	108.448***	64.471***	13.516**	446.759	7.862***
	(36.141)	(5.082)	(5.855)	(408.564)	(2.886)
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	8,386	8,168	8,395	8,401	8,390
R-squared	0.006	0.001	0.006	0.254	

Notes: Standard errors in parentheses and are clustered at industry level. *** p<0.01, ** p<0.05, * p<0.1. We instrument for the percentage of female board members with the percentage of female board members in 2013 interacted with year fixed effects. The sample of interest here is 1948 listed companies for which board member data from Prime was merged with Prowess. We focus on the treatment years 2014-2020 for these firms. Year FE & Industry FE are also included.

Table A4: Effect of female board membership on staff welfare variables (with percentage of women)

Dependent variable	**Staff Welfare expenditure (Rs. 10mn)**	**Staff Training expenditure (Rs. 10mn)**	**Number of employees**	**Number of women employees**
Pct Women on Board in year t	344.3***	243.6***	10,079*	226.1
	(6.227)	(9.697)	(5,635)	(1,642)
Year fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
Observations	7,844	610	7,288	1,844
R-squared	0.547	0.558	0.751	0.028

Notes: Standard errors in parentheses and are clustered at industry level. *** p<0.01, ** p<0.05, * p<0.1. We instrument for the percentage of female board members with the percentage of female board members in 2013 interacted with year fixed effects. The sample of interest here is 1948 listed companies for which board member data from Prime was merged with Prowess. We focus on the treatment years 2014-2020 for these firms. Year FE & Industry FE are also included.

Online Appendix

1. First stage regressions for alternative specifications

Table 1.1. First stage regression (with number of women)

Dependent variable: Number of women on board (2014-2020)		
Number of female board members in 2013 *		
	2014 Dummy	0.997 (0.00612)***
	2015 Dummy	0.730 (0.0259)***
	2016 Dummy	0.704 (0.0179)***
	2017 Dummy	0.694 (0.0168)***
	2018 Dummy	0.723 (0.0104)***
	2019 Dummy	0.770 (0.0158)***
	2020 Dummy	0.769 (0.0140)***
2015 Dummy		1.309 (0.0529)***
2016 Dummy		1.575 (0.0438)***
2017 Dummy		1.778 (0.0418)***
2018 Dummy		2.097 (0.0456)***
2019 Dummy		2.416 (0.0499)***
2020 Dummy		2.930 (0.0507)***
Industry fixed effects		Yes
Observations		8,809
R-squared		0.465

Notes: Standard errors in parentheses and are clustered at industry level. *** p<0.01, ** p<0.05, * p<0.1. We instrument for the number of female board members with the number of female board members in 2013 interacted with year fixed effects. The sample of interest here is 1948 listed companies for which board member data from Prime was merged with Prowess. We focus on the treatment years 2014-2020 for these firms. Year FE & Industry FE are also included.

Table 1.2. First stage regression (with percentage of women)

Dependent variable: Percentage of women (2014-2020)		
Percentage of Women on Board in 2013 *		
	2014 Dummy	0.937 (0.00525)***
	2015 Dummy	0.593 (0.0269)***
	2016 Dummy	0.531 (0.0230)***
	2017 Dummy	0.496 (0.0208)***
	2018 Dummy	0.487 (0.0178)***
	2019 Dummy	0.467 (0.0167)***
	2020 Dummy	0.442 (0.00873)***
2015 Dummy		0.0678 (0.00258)***
2016 Dummy		0.0768 (0.00190)***
2017 Dummy		0.0807 (0.00178)***
2018 Dummy		0.0846 (0.00132)***
2019 Dummy		0.0915 (0.00125)***
2020 Dummy		0.0988 (0.00060)***
Industry fixed effects		Yes
Observations		9965
R-squared		0.386

Notes: Standard errors in parentheses and are clustered at industry level. *** p<0.01, ** p<0.05, * p<0.1. We instrument for Percentage Women on Board with Percentage Women on Board in 2013 interacted with year fixed effects. The sample of interest here is 1948 listed companies for which board member data from Prime was merged with Prowess. We focus on the treatment years 2014-2020 for these firms. Year FE & Industry FE are also included.

2. Pre-trends for alternative specifications

Table 2.1 Checking for pre-trends in key firm performance variables (with number of women)

Dependent variable	**Total income (Rs.10mn)**	**Net Sales (Rs.10mn)**	**Profits after tax (Rs.10mn)**	**Total Assets (Rs.10mn)**	**Return on Assets (%)**
No. of women on board in year 2013* year	0.184	-0.175	0.148**	12.22	0.001***
	(0.268)	(0.466)	(0.0306)	(10.01)	(1.42e-05)
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes
Mean (2006-2013)	28480	24880	2330	49390	4.95
	(1754)	(1660)	(124)	(2552)	(0.100)
Observations	4,072	3,925	4,072	4,072	4,070
R-squared	0.354	0.541	0.530	0.325	0.072

Notes: Standard errors in parentheses and are clustered at industry level. *** p<0.01, ** p<0.05, * p<0.1. We instrument for the female dummy with female dummy in 2013 interacted with year fixed effects. The sample of interest here is 1948 listed companies for which board member data from Prime was merged with Prowess. We focus on the pre-treatment years 2006-2013 for these firms. Total assets and number of employees are added as controls and Industry and Year FE are included as well.

Table 2.2 Checking for pre-trends in key staff welfare variables (with number of women)

Dependent variable	**Staff Welfare expenditure (Rs. 10mn)**	**Staff Training expenditure (Rs. 10mn)**	**Number of employees**	**Number of women employees**
No. of women on board in year 2013* year	0.002**	0.001	0.136**	-0.0217
	(6.46e-05)	(0.000)	(0.025)	(0.016)
Year fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
Mean (2006-2013)	106.44	45.71	5058.52	1238.22
	(6.068)	(5.461)	(235.752)	(161.518)
Observations	3,810	449	4,072	66
R-squared	0.596	0.608	0.134	0.498

Notes: Standard errors in parentheses and are clustered at industry level. *** p<0.01, ** p<0.05, * p<0.1. We instrument for the female dummy with female dummy in 2013 interacted with year fixed effects. The sample of interest here is 1948 listed companies for which board member data from Prime was merged with Prowess. We focus on the pre-treatment years 2006-2013 for these firms. Total assets and number of employees are added as controls and Industry and Year FE are included as well.

Table 2.3 Checking for pre-trends in key firm performance variables (with percentage of women)

Dependent variable	**Total income (Rs.10mn)**	**Net Sales (Rs.10mn)**	**Profits after tax (Rs.10mn)**	**Total Assets (Rs.10mn)**	**Return on Assets (%)**
Pct of women on board in year 2013* year	-35.89	-14.52	-0.436	113.8	0.001***
	(16.61)	(11.29)	(0.994)	(151.7)	(6.98e-05)
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes
Mean (2006-2013)	28480	24880	2330	49390	4.95
	(1754)	(1660)	(124)	(2552)	(0.100)
Observations	4,072	3,925	4,072	4,072	4,070
R-squared	0.355	0.541	0.529	0.312	0.067

Notes: Standard errors in parentheses and are clustered at industry level. *** p<0.01, ** p<0.05, * p<0.1. We instrument for the female dummy with female dummy in 2013 interacted with year fixed effects. The sample of interest here is 1948 listed companies for which board member data from Prime was merged with Prowess. We focus on the pre-treatment years 2006-2013 for these firms. Total assets and number of employees are added as controls and Industry and Year FE are included as well.

Table 2.4 Checking for pre-trends in key staff welfare variables (with percentage of women)

Dependent variable	**Staff Welfare expenditure (Rs. 10mn)**	**Staff Training expenditure (Rs. 10mn)**	**Number of employees**	**Number of women employees**
Pct of women on board in year 2013* year	-0.055	0.025**	0.519	-1.647
	(0.024)	(0.003)	(0.597)	(0.740)
Year fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
Mean (2006-2013)	106.44	45.71	5058.52	1238.22
	(6.068)	(5.461)	(235.752)	(161.518)
Observations	3,810	449	4,072	66
R-squared	0.596	0.608	0.133	0.504

Notes: Standard errors in parentheses and are clustered at industry level. *** p<0.01, ** p<0.05, * p<0.1. We instrument for the female dummy with female dummy in 2013 interacted with year fixed effects. The sample of interest here is 1948 listed companies for which board member data from Prime was merged with Prowess. We focus on the pre-treatment years 2006-2013 for these firms. Total assets and number of employees are added as controls and Industry and Year FE are included as well.

3. Balanced sample analysis

Table 3.1 Gender gap in salaries and total remuneration

Dependent variable	**Before companies act (2006-2013)**	**After companies act (2014-2020)**	**Before companies act (2006-2013)**	**After companies act (2014-2020)**
	(1)	**(2)**	**(3)**	**(4)**
Panel A. Log(salary)				
Female	0.0344	-0.259***	-0.0705	-0.373***
	(0.0542)	(0.0526)	(0.0526)	(0.0459)
Male mean	14.99	15.74	14.99	15.74
	(1.316)	(1.355)	(1.316)	(1.355)
Female mean	15.09	15.45	15.09	15.45
	(1.340)	(1.497)	(1.340)	(1.497)
Controls	Yes	Yes	Yes	Yes
Firm fixed effects	No	No	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Observations	7,886	7,280	7,886	7,280
R-squared	0.094	0.048	0.627	0.664
Panel B. Log(Total remuneration)				
Female	-0.114*	-0.827***	-0.262***	-0.849***
	(0.0593)	(0.0394)	(0.0540)	(0.0329)
Male mean	12.99	13.73	12.99	13.73
	(2.371)	(2.311)	(2.371)	(2.311)
Female mean	13.04	12.99	13.04	12.99
	(2.398)	(2.087)	(2.398)	(2.087)
Controls	Yes	Yes	Yes	Yes
Firm fixed effects	No	No	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Observations	24,466	25,515	24,466	25,515
R-squared	0.053	0.046	0.399	0.429

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. The sample of firms considered here is 914 listed firms which existed in the Prime database in 2008 and which were used across years to maintain a balanced sample. We use the information on 885 firms for which we had information on the ages and education of board members as well as their salaries. The outcomes of interest are log(salaries) and log(total remuneration). Total remuneration includes salaries of board members, along with other incomes earned such as sitting fees, retirement benefits, bonus commission etc. Year and Firm FE are included along with individual controls (age and age squared, years of education and years of education squared). We estimate the equation separately for the pre-reform years (2006-2013) and the postreform years (2014-2020) using the population of individuals serving as board members in a given year.

Table 3.2. First stage regression for balanced sample (with female dummy)

Dependent variable: Female Dummy (2014-2020)		
Any female board member in year 2013 *		
	2014 Dummy	0.900 (0.009)***
	2015 Dummy	0.090 ((0.004)***
	2016 Dummy	0.009 (0.005)
	2017 Dummy	0.003 (0.002)
	2018 Dummy	0.000 (0.000)
	2019 Dummy	0.000 (0.000)
	2020 Dummy	0.000 (0.000)
2015 Dummy		0.810 (0.006)***
2016 Dummy		0.890 (0.014)***
2017 Dummy		0.896 (0.012)***
2018 Dummy		0.900 (0.0098)***
2019 Dummy		0.900 (0.009)***
2020 Dummy		0.900 (0.009)***
Industry fixed effects		Yes
Observations		6,398
R-squared		0.799

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. We instrument for the gender dummy with gender dummy in 2013 interacted with year fixed effects. The sample of interest here is 914 listed companies in the balanced sample for which board member data from Prime was merged with Prowess. We focus on the treatment years 2014-2020 for these firms. Year FE, Industry FE & baseline analogs are also included.

Table 3.3. Effect of female board membership on key performance variables (female dummy)

Dependent variable	**Total income (Rs.10bn)**	**Net Sales (Rs.10bn)**	**Profits after tax (Rs.10bn)**	**Total Assets (Rs.10bn)**	**Return on Assets (%)**
Any female board member in year t	6.638***	9.649***	1.525***	-61.054	0.923***
	(1.529)	(0.412)	(0.326)	(38.304)	(0.185)
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes
Baseline analog	Yes	Yes	Yes	Yes	Yes
Mean (2006-2013)	56.310	46.203	3.506	131.395	2.819
	(3.359)	(2.984)	(0.309)	(7.942)	(0.130)
Observations	6,265	6,106	6,267	6,270	6,265
R-squared	0.923	0.923	0.477	0.873	0.033

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. We instrument for the gender dummy with gender dummy in 2013 interacted with year fixed effects. The sample of interest here is 914 listed companies in the balanced sample for which board member data from Prime was merged with Prowess. We focus on the treatment years 2014-2020 for these firms. Year FE, Industry FE & baseline analogs are also included.

Table 3.4. Effect of female board membership on key staff welfare variables (female dummy)

Dependent variable	**Staff welfare expenditure (Rs.10mn)**	**Staff training expenditure (Rs.10mn)**	**Number of employees**	**Number of women employees**
Any female board member in year t	109.5***	20.40***	4,042***	1,053
	(8.624)	(4.517)	(112.5)	(1,052)
Year fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
Baseline analog	Yes	Yes	Yes	Yes
Mean (2006-2013)	186.730	76.595	5520.629	866.861
	(10.719)	(8.718)	(246.740)	(72.633)
Observations	5,921	483	5,549	1,542
R-squared	0.546	0.562	0.760	0.028

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. We instrument for the gender dummy with gender dummy in 2013 interacted with year fixed effects. The sample of interest here is 914 listed companies in the balanced sample for which board member data from Prime was merged with Prowess. We focus on the treatment years 2014-2020 for these firms. Year FE, Industry FE & baseline analogs are also included.

5
Conclusion

Investing in women's human capital development is key not only for promoting gender equality and women's overall social and economic well-being, it is critical for economic growth and poverty reduction. Women's human capital development can enable higher productivity, income, agency and improve overall standard of living and economic growth.

The papers presented in this thesis contribute to an important and policy relevant question of women's human capital development in India. They focus specifically on addressing barriers related to women and girls' advancement in their educational and professional outcomes. Through rigorous empirical analyses and engagement a with a range of partners including government, non-profit organizations and the private sector, these papers shed light on key barriers to women's education, work force participation and corporate leadership in India.

In particular, the three papers answered the following questions summarized below:

1. Does a woman's employment status and relative income, as well as the intention to continue working after marriage, affect the marital interest she receives from male suitors in the marriage market?

2. Can a post-primary remedial education program improve learning and educational outcomes for girls (and boys) in secondary school?

3. Does the introduction of gender quotas on boards change female representation, participation and pay for corporate boards? What is the impact on firm performance, personnel and women's employment outcomes?

To help answer the first question, I present experimental evidence in Chapter 2 from the first ever correspondence study on a matrimonial website. I show that there is a sizeable marriage market penalty for women who are interested in pursuing work after marriage. Women who express an interest in working after marriage receive significantly lower marital interest relative to women who are willing to give up work after marriage, or those who have never worked. However, surprisingly, for women who plan to work after marriage, a higher relative income may act as a carrot. Men are more likely to respond to working women who earn more, rather than those who earn less.

I also test alternate hypotheses to explain these marital preferences from grooms and their families. I determine that marital responses are driven largely by preferences related to gender norms around marriage and work, although income can act as an inducement. I also find that these preferences are predominant in relatively higher castes which uphold more conservative gender beliefs. Given the ubiquitousness of marriage for women in India, this marriage market penalty for women's careers may be an important consideration driving women's labor supply decisions.

I address the second question by conducting a randomized evaluation of a technology-aided post-primary remedial education program in India. The after-school program was introduced for secondary school students by Avanti Fellows and the Chennai Municipal Corporation (CMC) in a context with severe learning deficiencies. Students in Grade 9 in CMC schools demonstrated Grade 3 competencies, on average, but were being taught the grade-based curriculum during the school day. Avanti's intensive remedial education program was rolled out in 12 randomly selected treatment schools out of 24 schools in the study. The program, run by trained

young facilitators, involved the use of technology aids such as pre-recorded videos, lectures and worksheets, along with facilitated team work, peer learning and student collaboration.

My co-authors and I find that the program was highly effective and cost-effective at improving competencies in basic reading and math scores for both male and female students. Yet, the program failed to translate into gains on a standard national Grade 10 exam, which is used to determine future academic and employment choices. We infer that while remedial education at post-primary levels can indeed be effective in improving basic learning outcomes, it is too late in the day to overcome the accumulation of deficiencies. Our findings emphasize the need to rethink post-primary educational initiatives in the context of high learning gaps in advanced needs. They underline the importance of remedial education and 'Teaching at the Right Level' based on the student's current level rather than teaching based on the grade-level curriculum.

Finally, to answer the third question, I evaluate a gender quota introduced for boards of all listed companies in India in 2013. To my knowledge, this paper is one of the first robust empirical analyses of gender quotas for boards from India or any other developing country. I assess how the quota affects trends in women's leadership and participation in the corporate sector. I find that the reform was successful, and in a period of a few years, was taken up by nearly all listed companies. The reform succeeded in increasing women's representation on corporate boards. Despite increased gender diversity on boards, women continued to be underrepresented in more prominent board committees such as business development, and tended to participate more in committees such as ethics. I also find the quota resulted in worsening gender pay gaps for board membership. Finally, I apply an instrumental variables strategy where I instrument on pre-reform variation in women's leadership, to evaluate the impact on firm and personnel outcomes. I show that the law improved firm performance, recruitment as well as allocation for staff training and welfare. However, I find no effect on women's employment and recruitment in the

firms. Overall, I conclude the quota had mixed effects on women's empowerment – while women's representation on boards increased, the pay gaps worsened, and there was no additional recruitment or addition of women employees.

Overall, these papers make an important academic contribution to the growing literature on gender equality and human capital in the development economics literature. They strengthen our understanding of constraints facing women's labor market and educational outcomes in India, including normative barriers, marriage market penalties and severe learning deficiencies in advanced grades. This body of work also examines policies and programs implemented to address gaps in women's education and leadership, such as a post-primary remedial education after-school programs in government schools in India, as well as a legal reforms introducing gender quotas for company boards. The research points to nuanced and complex impacts of these programs evaluated in Chapters 3 and 4. In Chapter 3, Avanti's post-primary remedial education program greatly improves basic learning outcomes, but does not lead to gains in grade level performance and test scores. In Chapter 4, we find that quotas succeed in increasing women's boardroom participation, but also unintentionally increase gender pay gaps for board membership, and do not translate to greater employment for women.

These results also hold important policy implications for shaping programs related to women's human capital development. Accounting for and tackling gender norms related to women's work and male social status may be key for shaping women's marriage and labor supply outcomes. The findings suggest that gender quotas, even with universal uptake may not be sufficient on their own to deliver genuine empowerment effects for women. Legal quotas may need to be strengthened or complemented with additional initiatives to deliver the promise of empowering women leaders and diversifying the work force. Lastly, the evidence points to the need to restructure post-primary educational initiatives to teach students based on their learning levels rather than by the set grade level-curriculum. It also emphasizes

the importance of starting remedial education programs at the primary level itself, to prevent insurmountable deficiencies in learning outcomes in higher grades.