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Women's Employment and Natural Shocks

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Women's Employment and Natural Shocks

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Abstract

We employ georeferenced data and longitudinal household panel survey data to investigate the impact of the dramatic flooding that hit Bangladesh from August-September 2014 on women's employment and empowerment. Development economics models suggest an increase in household members' labour supply as a shock-coping strategy. Our difference-in-differences estimates confirm this assumption: women's employment probability increases by approximately 13 percentage points. Correcting for selection bias due to the initial employment status of women, we also find significant increases in the probability of non-employed women entering employment, in the average monthly income of employed women and in the probability of women engaging in autonomous wage-earning activities. Finally, we show that the greater earning capacity of employed women—instrumented by the intensity of flooding in the villages where women live—contributes to raising their bargaining power within the household as measured by the Women's Empowerment in Agriculture Index and by economic decision-making indicators.

Keywords: Bangladesh; Flood; Shock-coping strategy; Women's employment; Intrahousehold bargaining

JEL Classification: F66; J16; Q12; Q54.

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1 Introduction

In many developing countries, the employment of women is vulnerable to labour market weaknesses and cultural norms and traditions. This situation is often stationary or at best, improving in the very long run. Unexpected idiosyncratic shocks might speed up changes that would not have occurred otherwise. For example, natural shocks may increase the employment of women as a coping strategy to sustain household economic conditions. In this paper, we exploit the occurrence of a dramatic flooding event in Bangladesh to investigate whether natural shocks affect women's employment outcomes. Since women's employment in low-income countries often means unpaid work for the household farm or business, we ask whether an increase in employment translates into income-generating activities outside the household and whether own earnings from working outside the household increase women's empowerment.

Previous research on women's labour supply has sought to explain the determinants of female labour force participation by focusing on aspects such as, among others, education, fertility and social norms (Eckstein & Wolpin, 1989; Cullen & Gruber, 2000; Gaddis & Klasen, 2014). Klasen (2019) reviews the literature on the supply- and demand-side factors that affect women's decisions to work. Goldin (1995) was the first to hypothesize that female labour force participation has a U-shaped relationship with economic growth, dropping in the early stages of development and increasing when society shifts to a more industrialised economy. Several studies that have tested this hypothesis have found heterogeneous trends in female labour force participation by country, across urban and rural sectors, by policy and by macroeconomic conditions (Luci, 2009; Tam, 2011; Gaddis & Klasen, 2014; Lahoti & Swaminathan, 2016). For the relationship between women's employment and economic development, Sarkar, Sahoo, and Klasen (2019) find that increasing local economic development and a higher income for other members of the household lead to a lower probability of working among women.

Regarding the impact of idiosyncratic shocks, some studies have evaluated the consequences on women's labour supply and earnings of political crises and wars (Smith & Ward, 1985; Acemoglu, Autor, & Lyle, 2004; Goldin & Olivetti, 2013), while others show that the female labour supply may act as an insurance mechanism against idiosyncratic earnings risk within the family (Attanasio, Low, & Sánchez-Marcos, 2005). Bhalotra and Umana-Aponte (2010), in their multi-country analysis of

the developing world, find evidence of increases in women's labour force participation in contexts of high income volatility.

For the role of women's employment in Bangladesh, Rasul et al. (2016) show that a programme that transferred assets and skills to the poorest women to enhance employment in higher-return occupations was effective in reducing extreme poverty. For empowerment, Anderson and Eswaran (2009) find that women induced to work by economic hardship experience an increase in their bargaining power, but only in the case of employment off of their husbands' farms.

Our paper is therefore related to the strands of literature that investigate the effects of women's ownership of production assets (Agarwal & Bina, 1994), access to credit programmes (Hashemi, Schuler, & Riley, 1996; Anderson & Baland, 2002) and participation in wage-earning activities (Kelkar, Nathan, & Jahan, 2003) on their autonomy. According to these studies, new earning opportunities for women have significant implications for their households, for their decision-making power, as well as for their education, health status, fertility and investments in children (Atkin, 2009; Jensen, 2012; Heath & Mobarak, 2015).

In Bangladesh, the economic growth of the 1990s was accompanied by an increase in women's labour force participation rate from 23 percent in 1990 to 36 percent in 2020 (source: World Bank). This rise has been explained by numerous factors: the increase in agricultural yields brought about by the *Green Revolution* that, starting in the 1960s, thanks to the introduction of new fertilizers, pesticides and modern irrigation equipment, increased harvests by approximately 150 percent (Headey & Hoddinott, 2016); the rapid decline in the fertility rate from 4.4 percent in 1990 to 2 percent in 2020 (source: World Bank); and the diffusion of the garment industry beginning in the 1990s, which has grown at a rate of 17 percent per year, as approximately 80 percent of the 4 million people employed in this sector are women. In addition, the rise in female education and in the enrolment rate that went from half the rate of boys in 1970 to surpass it in recent years have contributed to boosting women's labour force participation. However, the percentage of women who worked without pay on family farms or in family businesses to total female employment ranged from 46 percent to 27 percent in the period 2014-2020, quite a large number, especially when compared to the 6 to 7.5 percent for males in the same period (source: World Bank, ILO estimates).

As in the majority of South Asian countries, in Bangladesh, flooding phenomena are quite com-

mon during the monsoon season. The flooding that hit Bangladesh starting in mid-August 2014 was particularly dramatic, affecting over 3 million people until the end of September. The flood inundated large rural fields, especially in the northeastern part of the country where it severely damaged crops and, in particular, paddies covering approximately 77 percent of the total crop area in Bangladesh.

Our causal analysis makes two contributions to the literature. First, focusing on women's employment as a fundamental element of household welfare, we measure the effect of floods on women's employment outcomes. Second, we identify the relationship between female economic autonomy and women's bargaining power—deemed to be positive in Anderson and Eswaran (2009)—through the employment outcomes enhanced by the shock.

We first present, as a theoretical background to our empirical analysis, a before-and-after-shock model with two rural production sectors, the net-buyer/small household farm sector and the net-seller/large household farm sector. We show how, under some realistic assumptions for a rural developing economy, women working for their net-buyer farms can be induced to move to work on the net-seller farms either to ensure household survival or simply to be more productive/earn more. Under certain assumptions, in this way, women gain command of their own independent earnings, thus increasing their autonomy.

For the empirical analysis, we obtain georeferenced data from NASA satellites on the share of inundated areas for each sampled village where households reside and combine it with panel survey data on households from the *Bangladesh Integrated Household Survey* for the period before and after the shock to examine its impact on female employment. Using a difference-in-differences approach, we estimate the effect of this continuous treatment on the following employment outcomes: 1) the probability of employment; 2) the probability of non-employed women entering employment, correcting for selection; 3) monthly income for women who are employed at baseline, correcting for selection; and 4) the probability of engaging in independent earning activities for women working for the family business/farm, correcting for double selection. Finally, we investigate whether employment outcomes and, in particular, the probability of entering an independent earning activity—instrumented by the shock—help increase women's bargaining power within households as measured by the Women's Empowerment in Agriculture Index (WEAI) (Alkire et al., 2013). Following our theoretical model, we

also conduct a heterogeneity analysis of the same outcomes across net-buyer and net-seller households. As a robustness check for the effect on women's bargaining power, we use additional indicators based solely on economic factors. We also perform a parallel trends test using nighttime light data to approximate the local level of economic activity.

We find that women's probability of employment and earnings increase significantly after the shock. Moreover, the probability of women gaining earning capacity through their work, if instrumented by the intensity of the flood shock, contributes to raising their empowerment within the household. Our heterogeneity analysis shows that these results are driven by women living on net-buyer household farms, supporting our assumption that these women are the women who are the most affected by the shock. Moreover, using indicators that focus on economic decision-making power, we find that this increased earning capacity after the flood has boosted women's decision-making power within the household. Finally, our test does not reject the assumption of parallel trends.

The structure of the paper is as follows. After illustrating our theoretical background model in Section 2, in Section 3, we describe the data and the variables used for the empirical analysis. In Section 4 we explain our research strategy. We present our results in Section 5 and some concluding remarks in Section 6.

2 Theoretical model

Our background theoretical model draws on the literature on agricultural household models (Singh, Squire, & Strauss, 1986; Key, Sadoulet, & Janvry, 2000; Taylor & Adelman, 2003) that describes farm and off-farm work participation choices of rural household members as functions of the local economic development, of the demand for off-farm goods and services and of the agro-ecological conditions.

In line with the *collective approach* (Apps & Rees, 1988; Chiappori, 1992) in our household model the partners have two distinct utility functions. Individual utilities depend on leisure l, on private goods purchased on the market y, on public goods produced with domestic work Q^D and on farm goods produced on the household farm Q^F.

In the cooperative scenario, the couple jointly maximises:

$$\alpha U_f + (1-\alpha)U_m \tag{1}$$

$$\alpha U_f(l_f, y_f, Q^D, Q^F) + (1-\alpha)U_m(l_m, y_m, Q^D, Q^F) \tag{2}$$

where $\alpha = f(\bar{U}_f, \bar{U}_m) = \frac{\bar{U}_f}{\bar{U}_f + \bar{U}_m}$ and $\bar{U}_f, \bar{U}_m$ are male and female utilities in the non-cooperative scenario. The weight given to female utility, α, is a proxy of her bargaining power and it is increasing in the reservation utility $\bar{U}_f$ she would obtain in case cooperation breaks down—where the more common scenario employed in the literature on developing countries is that of non-cooperative behaviour within marriage (Lundberg & Pollak, 1993)—and decreasing in the reservation utility of her partner.

Since the market position of rural households before the shock is crucial in the determination of its impact, we distinguish two types of rural households, net buyer households (NB) if the value of what they buy is higher than the value of what they sell, and net seller households (NS) if the reverse is true. Moreover, we assume that being NS is positively related with land size, since the model applies to a labour intensive agricultural production, where economies of scale increase with a higher level of employment, especially after a wage reduction. Instead, we assume NB to have small land holdings.[1]

The utility maximisation is subject to the following constraints: the production function of domestic goods, where we assume, for simplicity, that women in the household are the only producers:

$$Q^D = h(H_f^D) \tag{3}$$

The household farm production function, that depends on the size of land L, material inputs X, location specific characteristics ϕ, such as local climate and soil fertility (Huffman & El-Osta, 1997), work of both partners $H^F and H_m^F$ and hired wage-work H^w :

$$Q^F = f(L, H_f^F, H_m^F, H^M, X, \phi) \tag{4}$$

[1]The positive relationship between land size and the probability of being NS is supported by the data we use. The average landholding size of net buyer households is around 75 *decimals* while the average landholding size of net sellers is almost the double, 140 *decimals* (i.e. around 5600 squared metres, where decimals are among the most common units of measure used for land size in Southeast Asia and one *decimal* corresponds to around 40 squared metres).

where $H^M = H_m^M + H_f^M$.

We differentiate time and budget constraints by NB and NS households. Our model has two periods separated by an exogenous negative shock. Starting with NS, in period 1 the husband uses his time for working on the household farm, H_m^F, and leisure, l_m. We assume, therefore, that in larger land-holdings the husband—who is generally the land owner— will devote all his working time to farming on his own land instead of working in the market. Hired labour requires supervision and this implicit cost is increasing with the amount of land (Anderson & Eswaran, 2009). We suppose, as a consequence, that family labour, inclusive of supervision costs, is cheaper and this would induce households to exhaust all available family labour on their farms before resorting to external labour. For this reason, the wife spends her time working on the household farm H_f^F, doing domestic work H_f^D and having some leisure l_f. Therefore, their time constraints become:

$$\bar{T} = H_m^F + l_m,\ H_m^F > 0 \tag{5}$$

$$\bar{T} = H_f^F + H_f^D + l_f \tag{6}$$

where $\bar{T}$ is the time endowment of both partners.

The budget constraint for NS is:

$$P_y Y = P_Q^F(Q^F - C) - WH^M \tag{7}$$

.

where $Y = y_f + y_m$, C is the amount of farm goods consumed by the household and W is the market wage. We assume that NS sell to both urban residents and rural NB.

In NB, at time 1 the husband uses his time for working on the farm, H_m^F, working on the market H_m^M, and leisure, l_m. The wife has the same time allocation as in net seller households. Their time constraints become:

$$\bar{T_m} = H_m^F + H_m^M + l_m \tag{8}$$

$$\bar{T_f} = H_f^F + H_f^M + H_f^D + l_f \tag{9}$$

and their budget constraint is:

$$P_y Y = WH_f^M + WH_m^M + P_Q^F(Q^F - C) \tag{10}$$

where the last term on the right hand side is negative and amounts to the value of farm goods bought from NS.

In line with the evidence on gender productivity gaps (Quisumbing, 1996; Ali, Bowen, Deininger, & Duponchel, 2016) we assume that women's marginal productivity of labour is lower than men's, so that in equilibrium $W_f < W_m$; we also assume that NS benefit from economies of scale so that the marginal productivity of labour with respect to NB is higher for both women and men. Figure 1 illustrates the labour supply and labour demand equilibria in terms of number of workers and total wage per worker in the NB and NS labour markets - points $E1_f^{NB}$, $E1_m^{NB}$ and E_f^{NS}, E_m^{NS} respectively. Since the four points represent full-employment equilibria, even if wages/value of the marginal productivity of labour in the NS market is higher than in the NB market (for both men and women), the workers could not move from NB to NS.

In our simplified model of dual-earner households in which, independently of the wage/income level of the husband, women are required to work, in both markets there exist a female survival wage w_{surv}, that represents a minimum value of women's marginal productivity, below which the household could not produce the necessary output for survival (or for food security of the household) $Q^F_{surv.}$. Below it, women would be forced to look for wage employment in the NS labour market.

In period 2 the exogenous negative shock shifts downwards the production function of farm goods of both NS and NB. Figure 2 shows: the production function of NB where the input on the horizontal axis for the production of Q^F is the time spent working on the farm by the wife, H_f^F; the production function of domestic work and the time required to produce it, H_f^D; the output of the time spent working on the farm by the husband, Q_m^F. H_f^D represents a fixed share of time devoted to housework and leisure. After the shock, the production function of farm work would shift down to $Q^F = g(H_f^F)$ where $g^{'}(H_f^F) < f^{'}(H_f^F)$. Given the equality between the marginal productivity of labor and the wage rate, under our assumptions at any new equilibrium, wages of the NS market are higher with respect to the NB market. This is in line with the evidence found by Mueller and Quisumbing (2011) that shows that after the 1998 'flood of the century' in Bangladesh wages of agricultural workers who moved towards non-agricultural employment, experienced a lower reduction in wages. In our case, NB workers move to the more productive and less disadvantaged NS farms where wages were less affected.

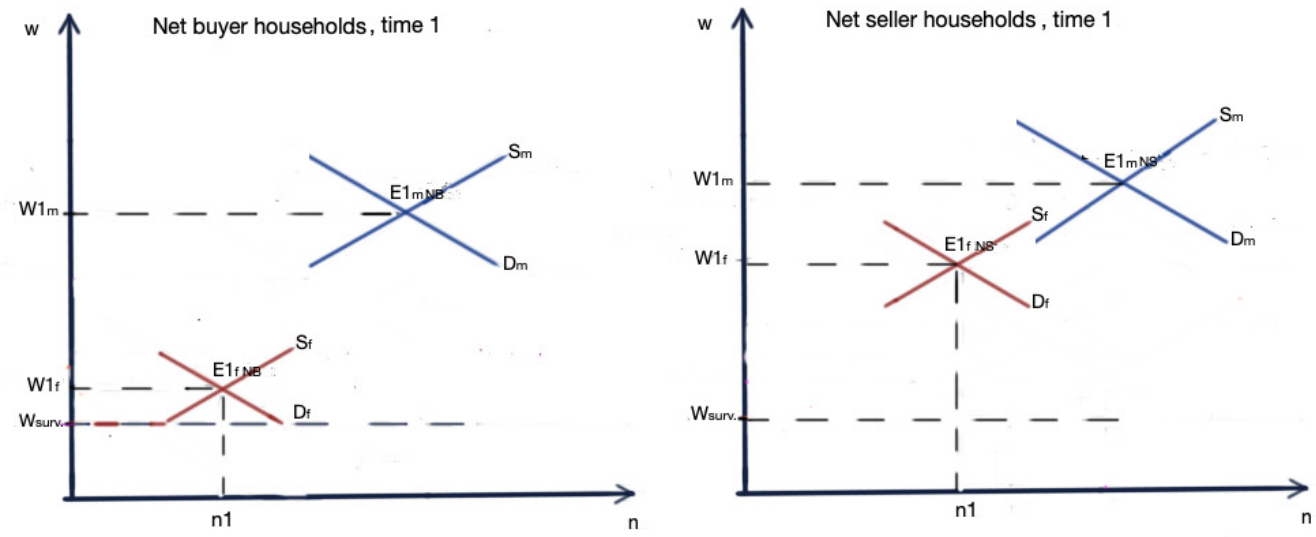
As a consequence of the shock, for NB the labour demand would shrink from D^{NB} to D'^{NB}. For equal shifts of the demand curve for both females and males, we assume that the new equilibrium for the husband, $E2_m^{NB}$, would still be above the equilibrium for the wife, $E2_f^{NB}$. Given this scenario, at $E2_f^{NB}$ all working women would face a wage equal or lower than w_{surv} so that they would be induced to moving to work in the NS market. In the NS market the drop in marginal productivity would imply a downward shift of the demand function from D^{NS} to D'^{NS}. The labour supply curve would instead increase. Assuming a larger shift of the supply curve with respect to the demand curve, the new equilibrium in our example would be $E2_f^{NS}$ where w is lower than $E1_f^{NS}$—because of the drop in marginal productivity—but higher with respect to $E1_f^{NB}$. The number of employed women, n, is then increased with respect to period 1. The NS market will employ women first, as they are remunerated with a lower wage with respect to men, satisfying its labour demand with the number of women coming from the NB market.

Moving from the NB to the NS market represents for the wife a shift from working on the husband's farm to engaging in an independent wage-earning activity. The higher wage rate she receives in the NS market [2]—represented in Figure 2 by the tangency point between her indifference curve and the new budget constraint given the wage received in the NS market, $W2_f^{NS}$—similarly to Anderson and Eswaran (2009) induces her to work off her husband's farm (or to work more off if she was already working off the farm).

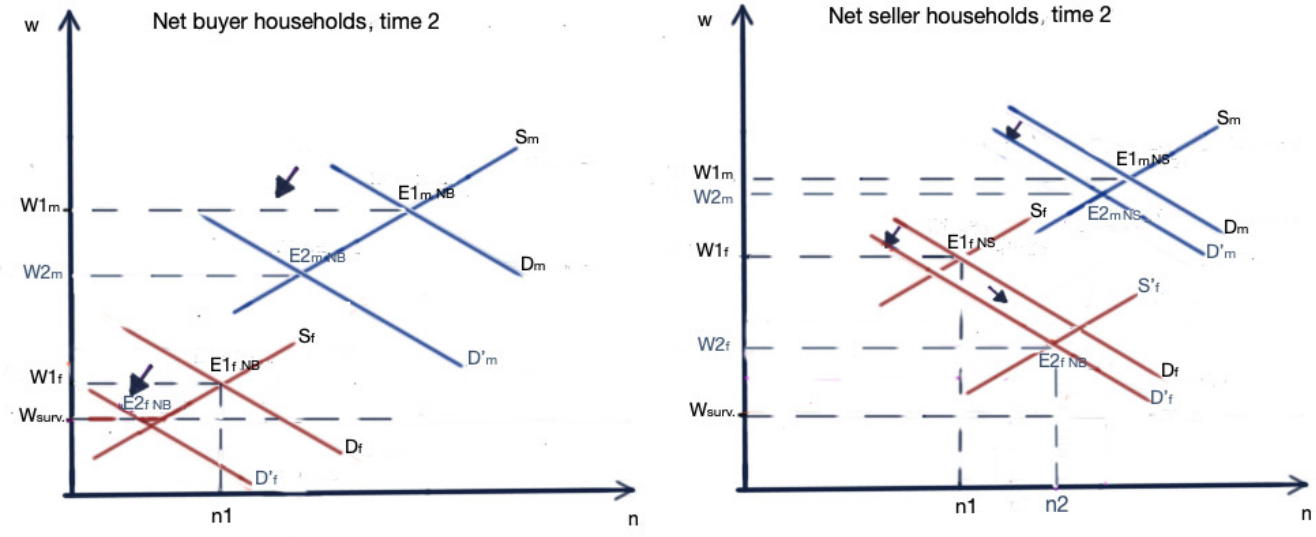
As a consequence, the wife will curtail the share of her time devoted to work on the household farm. Since H_f^F and H_m^F are assumed to be substitutes in the production of a minimum $Q_{surv.}^F$ (represented in Figure 2 by the sum of Q_m^F and Q_f^F), to maintain this output unvaried the husband will increase his working time devoting a larger part of it to working on the farm. The drop in the husband utility, due mainly to a drop in l_m and in the consumption of the private good, y_m, would decrease his threat utility $\hat{U_m}$. In a non-cooperative scenario $\hat{U_f}$ would raise—because of the wife's increased earning capacity and consumption of the market goods y_f and increased leisure l_f—thus leading to an increase in the indicator of her autonomy, α.

[2]It is worth noting that in our empirical analysis women employed on the husband's farm work without pay, while they earn an independent income only if they have some earnings from an economic activity in the local labor market. Therefore, our conjectures on the impact of increasing wage rate on female autonomy are applicable to the impact of the shift from unpaid to paid work in the empirical model.

Figure 1. Labour market equilibria for NB and NS



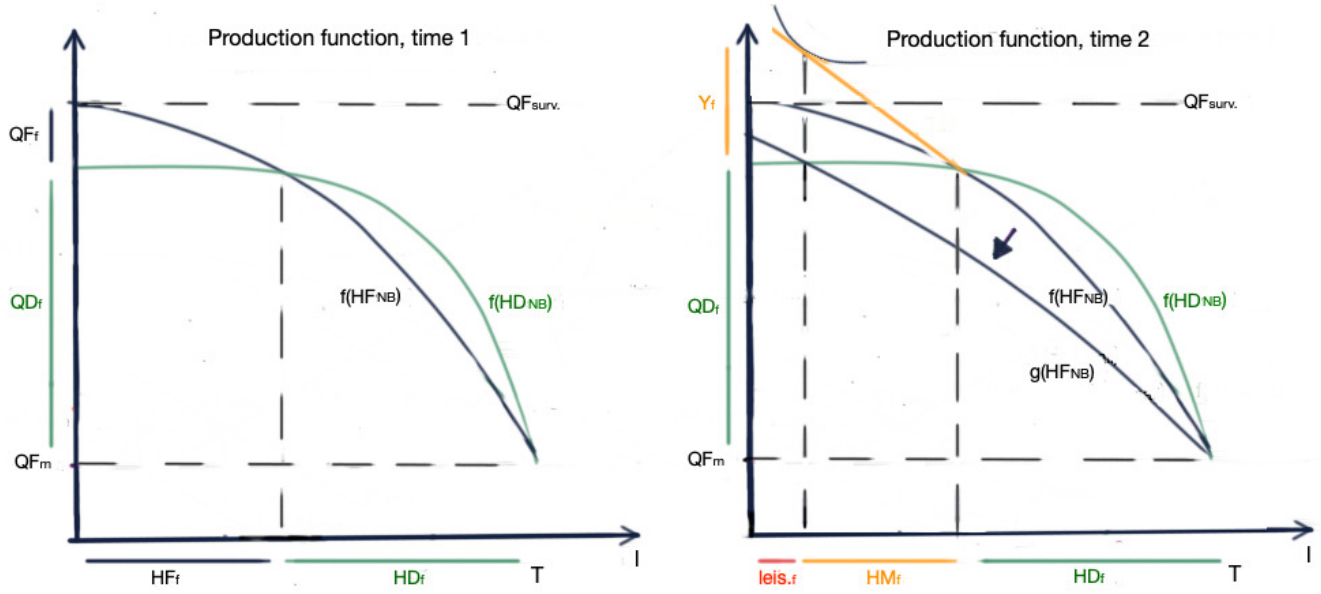
(a) Time 1



(b) Time 2

Note: Time 1 and Time 2 represent the periods before and after the shock, respectively. w represents the value of the marginal productivity of labour in both markets. At time 1, w is figurative since women work without pay. At time 2, w is effectively paid to women who have moved from NB to NS.

Figure 2. NB production functions and budget constraints before and after the shock



Note: The figure shows the production functions for farm work before ($f^{'}(H_f^F)$ and after the shock ($g^{'}(H_f^F)$ for *net buyers*.

3 Data sources and variables

3.1 Georeferenced data

To measure the impact of natural shocks at the local level, we employ village exposure to inundation as continuous treatment for our analysis. For this purpose, we use the *NASA Flooding Map*, composed of 250-m resolution images obtained by applying the LANCE processing system to MODIS products.[3] The satellite images determine flooded areas as water observations falling outside normal water levels, taking as reference another MODIS product, MOD44W.

According to the Official Report of the *Bangladesh Water Development Board* of the National Government for 2014, rainfall intensity during the monsoon season exceeded that of previous years and reached the maximum peak toward the end of August, as shown in Figure 3. Therefore, we employ composite satellite images for an interval of 15 days between the end of August and mid-September.[4]

We define our treatment as the share of areas, in each village where sampled households reside, that were recognized as flooded in the first days of September resulting from the accumulated rainfall of the last two weeks of August. Figure A1 in the Appendix illustrates MODIS satellite images for the period before the flooding, July 2014—already in the monsoon season—and for the period considered. Flood zones—coloured in orange, to be distinguished from normal surface water in blue—are clearly more numerous in the second picture, in particular in the northeastern part of the country.

The unit of analysis for our treatment are the 318 surveyed rural villages that are nationally representative of the country's rural areas. For each village in the sample we calculate the share of pixels (where pixel resolution is 250 m) identified as "flooded" in a 5-kilometre radius, where the average number of pixels in the calculated radius is approximately 3,800. To check for robustness, we also repeat our tests for 2- and 10-kilometre radiuses.

[3]The data can be publicly accessed at https://floodmap.modaps.eosdis.nasa.gov.

[4]The NASA composite product for the period August 31st-September 15th, by combining information from daily images and "smoothing" high-frequency variations, overcomes the issue of sensing measurement errors due to clouds that prevent the satellite from obtaining a precise image, identifying a pixel area as "flooded" if it is recognized as such at least twice.

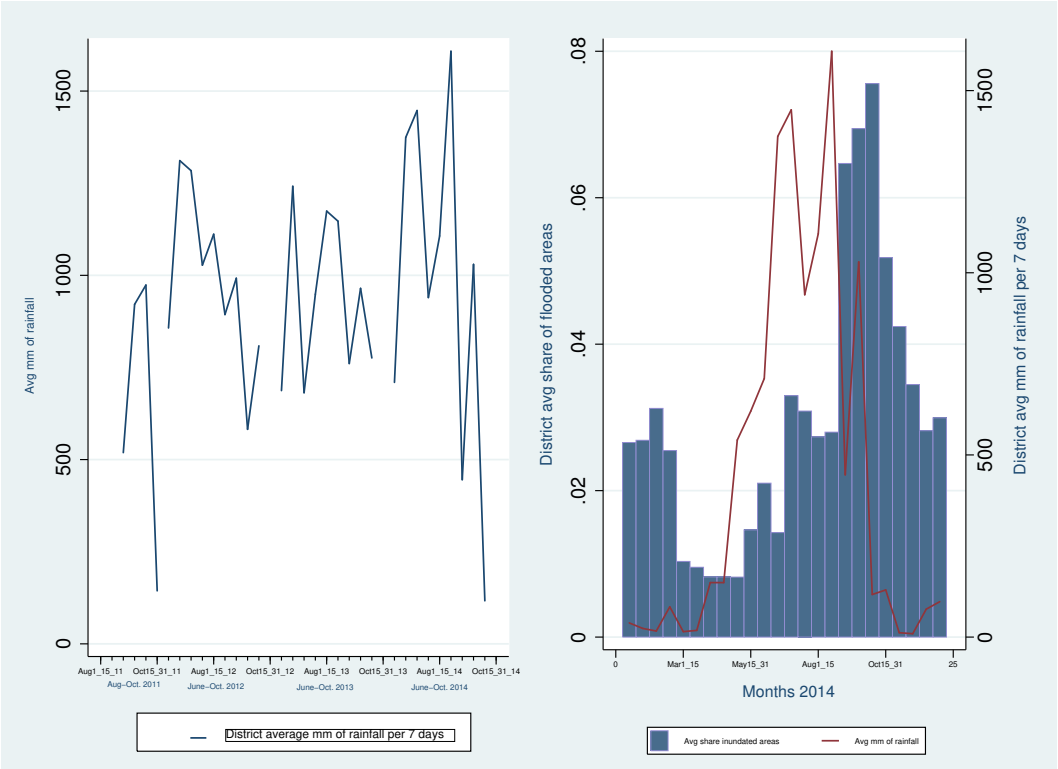
As in Gröger and Zylberberg (2016), the 5-kilometre radius presumably represents the area where rural households have their agricultural activities. The treatment variable corresponds therefore to the probability of a "pixel area" in the village being inundated in the period considered. Figure A2 in the Appendix shows the percentage of inundated areas during flooding with respect to normal periods. With the treatment specification of the 5-kilometre radius, the mean share of submerged area corresponds to 18 percent, with a maximum of 94 percent, while in normal periods, the mean is 8 percent and the maximum is approximately 45 percent. However, to understand the economic consequences of flooding, it is important to highlight that in some villages stream water did not flow away immediately after the flood, probably because of differences in soil absorption (see Figure A2). In line with the literature, this measure of treatment proxies the village-level damage the flood caused to rural areas and cultivations. Figure 4 illustrates the geographic distribution and the intensity of the treatment variable during the flooding (August 31st-September 15th).

A potential problem of endogeneity stems from the fact that villages may differ in some geographical characteristics that affect both the probability of being treated and the outcomes of interest. To take account of this issue, we control for the village propensity to be submerged by water during normal times as measured by the percentage of water coverage in the 5-kilometre radius in July 2014, and we include region and wave fixed effects.

3.2 Household survey and women's sample

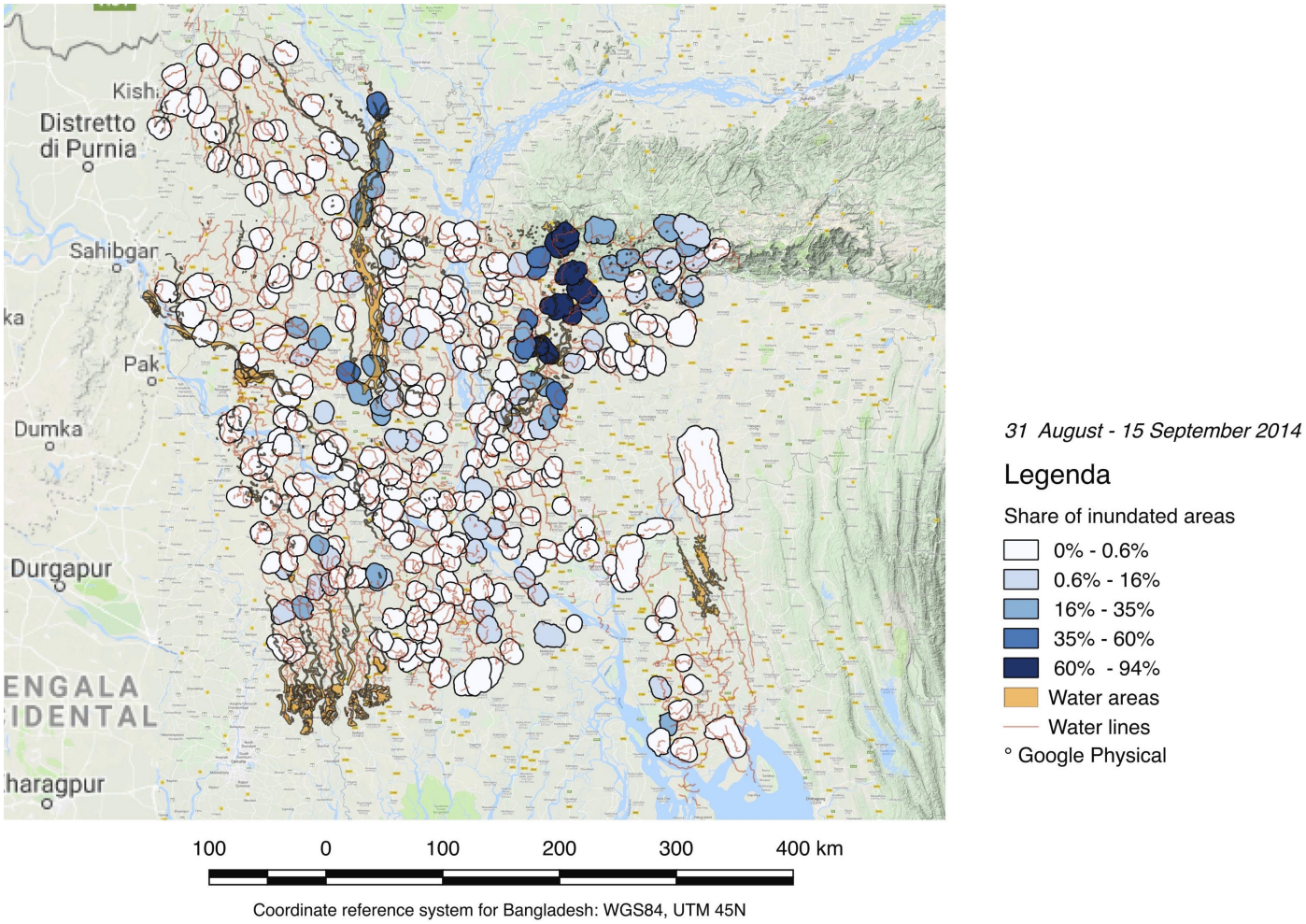
We employ the *Bangladesh Integrated Household Survey* (BIHS), a panel study conducted by IFPRI in two rounds, the first in 2011-2012 (October 2011-June 2012) and the second in 2015 (January-June 2015). This survey has national coverage and is representative of the rural areas in all seven divisions of the country. The survey longitudinally follows approximately 6,500 households and 29,000 individuals, each of whom reports information on employment status, working hours, monthly income and other labour variables. The attrition rates are 4.4 and 22 percent at the household and individual levels, respectively. We perform an attrition analysis to address the problem of potential bias due to the correlation between the occurrence of flooding and the failure to track displaced households—according to national statistics, approximately 57,000 families were displaced between August and

Figure 3. Two-week average cumulative rainfall in millimetres and the share of flooded areas in Bangladeshi villages for the period 2010-2014



Note: In panel A, the figure shows the rainfall intensity during the monsoon periods between 2010 and 2014, measured as the average tenth of a millimetre of accumulated rainfall over a period of 15 days in all Bangladeshi villages and obtained from NASA Integrated Multi-satellite Retrievals for GPM. In Panel B, the same measure for rainfall is combined with the average share of inundated areas in all villages in 2014, calculated from NASA MODIS satellite images.

Figure 4. Geographical distribution of treatment



Note: The map illustrates the share of inundated areas for each 5-km radius around the 318 villages in the sample. Authors' calculations are based on products from the NASA LANCE processing system applied to MODIS images from the Terra and Aqua satellites with 250 m resolution, where flooding is determined as water observations falling outside normal water levels. This figure is drawn from Giannelli and Canessa (forthcoming), Section 3.1, Figure 2.

September 2014 (Ministry of Disaster Management and Relief, 2014)—or households that might have chosen to leave to avoid the dramatic consequences of the shock. We run a regression on all households and individuals in the dataset where the outcome variable is a dummy equal to one for each household tracked in the second wave, and the main explanatory variable is the treatment—the share of inundated areas in a 5-kilometre radius around each village. The coefficient on the treatment variable is not significantly different from zero, thus ruling out the possibility of this bias (see Appendix, Section A.2, table A1).

From the total sample of 14,292 women, we select women aged 15 or older in 2012 so that our panel sample consists of 7,808 women.[5] Table 1 presents the descriptive statistics for our sample at baseline (2012). With a mean age of approximately 38 years, the vast majority of sampled women were married (91 percent), and only 13 percent reported being household heads. Forty-five percent had no formal education, 28 percent had completed secondary school, and 6 percent had a tertiary education.

[5]In choosing this age range, we have followed the World Bank statistics on labour force participation in Bangladesh, which refer to people aged 15 or older.

Table 1. Descriptive statistics of the panel sample in 2012

	Obs.	Mean	Std. Dev.	Min.	Max.
Women's household and individual characteristics					
Age	7,808*	37.39	15.00	15	99
Marital status: Married	7,808	0.91	0.27	0	1
Household head	7,808	0.13	0.33	0	1
Number of children < 10	7,808	1.72	1.24	0	10
Household monthly income excluding women's income ($/10^5$)	7,808	4.73	1.94	0	9.93
Education					
No formal education	7,808	.45	.49		
Primary educated	7,808	.25	.43		
Secondary educated	7,808	.28	.44		
Tertiary educated	7,808	.065	.24		
Employment (%)					
Employed in both rounds (n. 4,390)	7,808	56.22			
Employed in 2012 but not in 2015 (n. 786)	7,808	10.06			
Not employed in 2012 but employed in 2015 (n. 1,290)	7,808	16.52			
Not employed in both rounds (n.1,341)	7,808	17.17			
Paid worker in both rounds (n. 3,697)	7,808	47.34			
Paid worker in 2012 and unpaid in 2015 (n. 356)	7,808	4.55			
Unpaid worker in 2012 and paid in 2015 (n. 266)	7,808	3.40			
Unpaid worker in both rounds (n. 71)	7,808	0.91			
Employed with earning capacity in both rounds (n. 2,709)	7,808	34.69			
Employed with earning capacity in 2012 and without in 2015 (n. 430)	7,808	5.51			
Employed without earning capacity in 2012 and with in 2015 (n. 1,038)	7,808	13.29			
Employed without earning capacity in both rounds (n. 211)	7,808	2.70			
Avg monthly income of women employed at baseline $PPP	5,176	22.08	57.02	0	1260.13
Net seller/buyer household status					
Net seller households (n. 2,776)	7,808	35.55			
Net buyer households (n. 5,032)	7,808	64.45			
Women's empowerment					
Women's Empowerment in Agriculture Index	5,673	.52	.20	0	1
Decision-making indicators (derived with factor analysis)					
Participation in household decision-making	5,673	0	1	-0.92	1.70
Sole decision-making	5,673	0	1	-0.31	5.43
Joint with husband decision-making	5,673	0	1	-0.77	1.94
Joint with others decision-making	5,673	0	1	-0.80	1.80
Georeferenced variables					
Share of inundated areas per village, 1-15 September 2014	7,808	0.19	0.37	0	0.94
Share of inundated areas per village, 1-15 July 2014	7,808	0.07	0.09	0.0002	0.45
Avg. monthly mm rainfall in 2011	7,808	10.62	10.64	0	88.70
Avg. monthly night-time light intensity 2011	7,808	457.75	107.80	255.473	846.43

*Note:** The total number refers to the sample of women aged 15 years or older surveyed in 2012 and re-tracked in 2015. All monetary values are expressed in PPP-adjusted USD in constant prices.

We define women as employed if in the preceding week, they reported having been working for pay as wage/salaried workers or self-employed workers or to have been working without pay in the family business or not working but having a job (only a few observations are in this category). We define all other women in the sample as non-employed.[6]

According to this definition, 56 percent and 17 percent of women were employed and non-employed, respectively; in both waves, 10 percent exited employment and 16.5 percent entered employment. Women's average monthly income was around $22 PPP. Examples of common occupations are work on the family crop or homestead farm for either paid or unpaid self-employment or work as an agricultural wage labourer.

Since women may engage in more than one economic activity—approximately 93 percent of women are employed in at least one of these agricultural activities—we define a woman as a 'paid worker' if at least one of these activities was paid and an 'unpaid worker' if neither of these activities was paid. Using these criteria, the number of unpaid women at baseline was approximately 6.5 percent of total employment, a figure that represents women who earn no money from their work, a lower value than the estimated statistic on unpaid family workers (46 percent in 2014, see Section 1).[7] In fact, among women that we consider to be paid workers, there are women who have only one or a few low-paying jobs outside the household, while all remaining work is done for the household. To use a less restrictive definition of unpaid work, we also investigate as an outcome the probability of being employed and simultaneously reporting having some 'earning capacity'. We build this dummy variable using the question "Are you now doing any work or business that brings in cash, additional food, or allows you to accumulate assets for your household? ".[8] We select women who at baseline declare themselves to be employed and answer no to the above question, and we investigate the

[6]This variable is based on Question C01 on employment status from Module C: Employment in the questionnaire. In the household survey for 2012, women in this category were students (5 percent), retired/too old/disabled/did not work but had a job (4 percent), or housewives (22 percent), and only 0.08 percent did not work but had looked for a job. The latter represent unemployed women: in this context, unemployment as defined in standard statistics is a meaningless concept.

[7]ILO estimates define contributing family workers as "workers who hold self-employment jobs as own-account workers in a market-oriented establishment operated by a related person living in the same household"and therefore might include women who could also have paid employment.

[8]Question Z1 01, Module Z1: Work Earnings and Expenses.

probability that they answer yes in the follow-up survey. Women who respond 'no' at baseline make up 24 percent of women in employment.

The Women's Empowerment in Agriculture Index

The questionnaire also includes a specific section intended to measure women's empowerment by means of the Women's Empowerment in Agriculture Index (WEAI),a survey-based index designed to assess women's empowerment in agricultural households. This section is administered to households that have a primary male and a primary female respondent, and for this reason, the number of observations is reduced relative to the preceding sections.[9]

The index consists of two components: the *5DE score* and the *Gender Parity Index* (GPI), whose weights in the final index are 90 and 10 percent, respectively. The 5DE score is a weighted average of 10 indicators of women's adequacy that are grouped in the following five domains: (1) decisions over agricultural production, (2) access to and decision-making power over productive resources, (3) control over use of income, (4) leadership in the community, and (5) time allocation.[10] Women are considered *adequate* on each indicator if the women reach or exceed the specified threshold for that domain.

The GPI requires that the *5DE score* be measured for both the principal male and female respondents in dual-adult households.[11] Women are defined as empowered according to the GPI if their achievements in terms of their *5DE score* are equal to or higher than those of the primary male respondent in their households. Table A2 in the Appendix reports the five components of the *5DE score* and their subcomponents with the relative weights used to construct the index and the percentage of women in our sample that are considered *adequate* in each dimension for the two years.

[9]This index was initially developed as an evaluation tool for the Feed the Future Program of the United States Agency for International Development (USAID) by the Oxford Poverty and Human Development Initiative (Alkire et al., 2013) and the International Food Policy Research Institute (IFPRI), but it has been largely applied in the literature (Sraboni, Malapit, Quisumbing, & Ahmed, 2014; Sell & Minot, 2018) as it represents an integrated measurement of women's empowerment.

[10]See Alkire et al. (2013) for a complete description of the index.

[11]Using information for all the dimensions of the *5DE score*, we calculated the GPI, since we also have data on the primary male respondent in the household.

4 Method

We proceed in steps, gradually selecting the sample of women for each outcome of interest. We evaluate the impact of the flood shock on the following outcomes: i) the probability of employment; ii) the probability of entering employment if not employed at baseline; iii) monthly income if not employed at baseline; iv) the probability of engaging in an independent earning activity if employed without pay on the family farm or in a family business at baseline; v) the probability of being employed with earning capacity if employed with no earning capacity at baseline; and vi) bargaining power. In our setting, flooding should not impact the latter outcome directly but only indirectly through its effects on i) to v). We estimate all models with FE and estimate model vi) by 2SLS.

4.1 Impact of the flood shock on the probability of employment

We estimate a difference-in-differences model, employing the share of inundated areas in a buffer of 5 kilometres around the villages where surveyed households live as the treatment, as follows:

$$Y_{ihvrt} = \alpha_0 + \beta_0 t_{=2015} + \beta_1 T_v * t_{=2015} + \beta_2 P_v * t_{=2015} + \beta_3 X_{iht} + \beta_4 W_{rt} + \alpha_i + \epsilon_{ihvrt} \quad (1)$$

where Y_{ihvrt} is the employment probability dummy for each woman i in household h residing in village v in region r at time t; T_v is the treatment variable, namely, the share of inundated pixels for each village v; $t_{=2015}$ is the dummy for the second year; and β_1 is the difference-in-differences coefficient for treatment. P_v is the share of inundated areas within the same radius around the villages during the non-flooded period (July 2014). Controlling for P_v allows us to identify changes in the outcome of interest over time due to treatment for villages that have the same propensity to be inundated in normal times. X_{iht} represents women's individual and household sociodemographic characteristics.[12] W_{rt} are interactions between waves and regions of residence at baseline to account for changes in regional characteristics over time. α_i are individual fixed effects. The error term ϵ_{ihvrt} is clustered at the lower administrative level of sub-districts, called upazila, which are the second lowest tier of regional administration in Bangladesh after villages.

[12] X_{iht} includes the number of children in the family, total household income excluding own income, the woman's age at baseline, a dummy equal to one for women with a tertiary education, a dummy equal to one for married women and a dummy equal to one for female heads of household.

4.2 Impact of the flood shock on the probability of entering employment if not employed at baseline

We select the sample of women who are not employed at baseline and include a correction term for selection bias due to their initial non-employment status in the second stage difference-in-differences regression. We therefore estimate the following first stage[13]:

$$Nonemp_{ihvr} = \gamma Z_{ihvr} + u_{ihvr} \;\; with \; u_{ihvr} \sim N(0,1) \tag{2}$$

where $Nonemp_{ihvr}$ is a dummy variable for non-employment at baseline and Z_{ihvr} are the baseline characteristics of women that influence their probability of working. Following Klasen (2019), we add two exclusion restrictions to the female controls in our main regression: the average monthly rainfall (in millimetres) accumulated in the 5-kilometre radius around each village where women resided in 2011, and the average monthly nighttime light intensity at the village level for the same year.[14] Since the literature shows that periods of drought lead to higher female labour force participation (Bhalotra & Umana-Aponte, 2010), the level of rainfall in 2011 is expected to influence women's choice to work in 2012 without affecting their labour status in 2015. Similarly, according to Henderson, Storeygard, and Weil (2012), more intense nighttime lights indicate a higher level of local economic activity in 2011, and this should be correlated with a lower female employment rate in the next year—according to the *feminization U-hypothesis*—but be uncorrelated with their entry into employment in 2015. From the first stage, we obtain an inverse Mills ratio to be included in the second-stage difference-

[13]We follow Amuedo-Dorantes and Pozo (2002), where Heckman's two-step procedure is preferred to the Tobit model because the latter produces inconsistent estimates in the presence of heteroscedasticity and because of the possibility of including different regressors.

[14]The data source for rain gauge is the NASA Integrated Multi-satellite Retrievals for GPM (IMERG) that provides the Day-1 multi-satellite precipitation product at a resolution of 0.25 degrees; for the nighttime light data, we employ the NOAA/NCEI products that collect measures of nighttime light intensity at 750-meter resolution from the Visible Infrared Imaging Radiometer Suite (VIIRS)—a NASA instrument providing detailed images with different bandwidths of light—and filtering them from the noise due to stray light, lightning, lunar illumination, and cloud cover. These data can be publicly accessed at $https://www.ngdc.noaa.gov/eog/viirs/download_dnb_composites.html$.

in-differences equation:

$$Y_{ihvrt} = \alpha_0 + \beta_0 t_{=2015} + \beta_1 T_v * t_{=2015} + \beta_2 P_v * t_{=2015} + \beta_3 X_{iht} + \beta_4 W_{rt} + \alpha_i + \lambda_{Nonemp_{ihvr}} * t_{=2015} + \epsilon_{ihvrt} \quad (3)$$

Including the fitted correction term $\lambda_{Nonemp_{ihvr}}$ in our main regression, we correct the variance-covariance matrix of the error terms to account for heteroscedasticity and the correlation across errors due to the inclusion of the inverse Mills ratio following the methodology employed by Greene (1981).

4.3 Impact of the flood shock on monthly income if employed at baseline

We use the same correction term (with an opposite sign) and Heckman's two-step procedure to estimate the impact of the flood on the monthly income (expressed in $ PPP in constant prices with CPI 2010=100.00 as the reference period to remove the effect of inflation) of women who were employed at baseline. We sum earnings across all reported economic activities.

4.4 Impact of the flood shock on the probability of engaging in an independent wage-earning activity

As mentioned above, we focus on two outcomes. First, we select employed women who declare that they work without pay and investigate the probability of switching from working without pay for the family business to working for pay after the shock. The second outcome is a proxy for earning capacity, which we build by selecting women at baseline who declare that they are employed but have no earning capacity at baseline to investigate the probability that they answer yes in the follow-up. For both outcomes, we follow the methodology employed by Tunali (1986) to estimate a double selection model. We run a bivariate probit regression to estimate the probabilities of 1) being employed and 2) working unpaid/having no earning capacity at baseline to take into account the correlation between the errors in the two selection processes, assuming that the two choices are not independent ($\rho_{uv} \not\equiv 0$).

$$Emp_{ihvr} = \gamma Z_{ihvr} + u_{ihvr} \quad (4)$$

$$FamilyFarm_{ihvr} = \delta W_{ihvr} + v_{ihvr} \tag{5}$$

From the bivariate probit regression, we obtain two correction terms:

$$\lambda_{1ihvr} = \varphi(Z'_{ihvr}\hat{\gamma}) * \phi(\frac{W'_{ihvr}\hat{\delta} - \rho Z'_{ihvr}\hat{\gamma}}{(1-\rho^2)^{\frac{1}{2}}}) * \phi_2(W'_{ihvr}\hat{\delta}, Z'_{ihvr}\hat{\gamma}, \rho) \tag{6}$$

$$\lambda_{2ihvr} = \varphi(W'_{ihvr}\hat{\delta}) * \phi(\frac{Z'_{ihvr}\hat{\gamma} - \rho W'_{ihvr}\hat{\delta}}{(1-\rho^2)^{\frac{1}{2}}}) * \phi_2(W'_{ihvr}\hat{\delta}, Z'_{ihvr}\hat{\gamma}, \rho) \tag{7}$$

that are then inserted in the difference-in-differences regression.

$$Y_{ihvrt} = \alpha_0 + \beta_0 t_{=2015} + \beta_1 T_v * t_{=2015} + \beta_2 P_v + \beta_3 X_{iht} + \beta_4 W_{rt} + \alpha_i + \lambda_{1ihvr} * t_{=2015} + \lambda_{2ihvr} * t_{=2015} + \epsilon_{ihvrt} \tag{8}$$

4.5 Impact of the flood shock on women's bargaining power

As mentioned above, we aim to causally identify the relationship between female economic autonomy and women's bargaining power—assumed to be positive in Anderson and Eswaran (2009)—through the increased probability of paid employment due to the shock. The increase in female employment is estimated using the different intensities of the flood shock as an instrument, following the methodology employed by Lohmann and Lechtenfeld (2015). Female employment is in fact a potentially endogenous estimator of female autonomy and is related to unobserved characteristics, such as individual and household attitudes towards female conditions, which would influence both women's employment status and their decision-making power, thus leading to biased estimates. The different intensities of the flood shock serve as an exogenous source of variation in labour force participation in the following model[15]:

$$\begin{cases} Lab.Outcomes_{ihvrt} = \delta_0 + \gamma_0 t_{=2015} + \gamma_1 T_v * t_{=2015} + \gamma_2 P_v * t_{=2015} + \gamma_3 X_{iht} + \gamma_4 W_{rt} + \alpha_i + \epsilon_{ihvrt}, \\ WEAI_{ihvrt} = \alpha_0 + \beta_0 t_{=2015} + \beta_1 \hat{Lab.Outcomes}_{ihvrt} + \beta_2 P_v * t_{=2015} + \beta_3 X_{iht} + \beta_4 W_{rt} + \alpha_i + \lambda_{1ihvr} * t_{=2015} + \lambda_{2ihvr} * t_{=2015} + \epsilon_{ihvrt} \end{cases} \tag{9}$$

In the first stage, we predict labour outcomes as already described to check whether an increase in women's probability of working for pay (for women working without pay at baseline) or of acquiring an earning capacity (for women working without an earning capacity at baseline) determines an improvement in women's bargaining power in the second stage.

[15]Note that the two correction terms, $\lambda_{1ihvr} + \lambda_{2ihvr}$, are not inserted when the estimation is run on the whole sample to investigate the variation in overall female labour force participation.

5 Results

5.1 Impact of the flood shock on women's employment outcomes

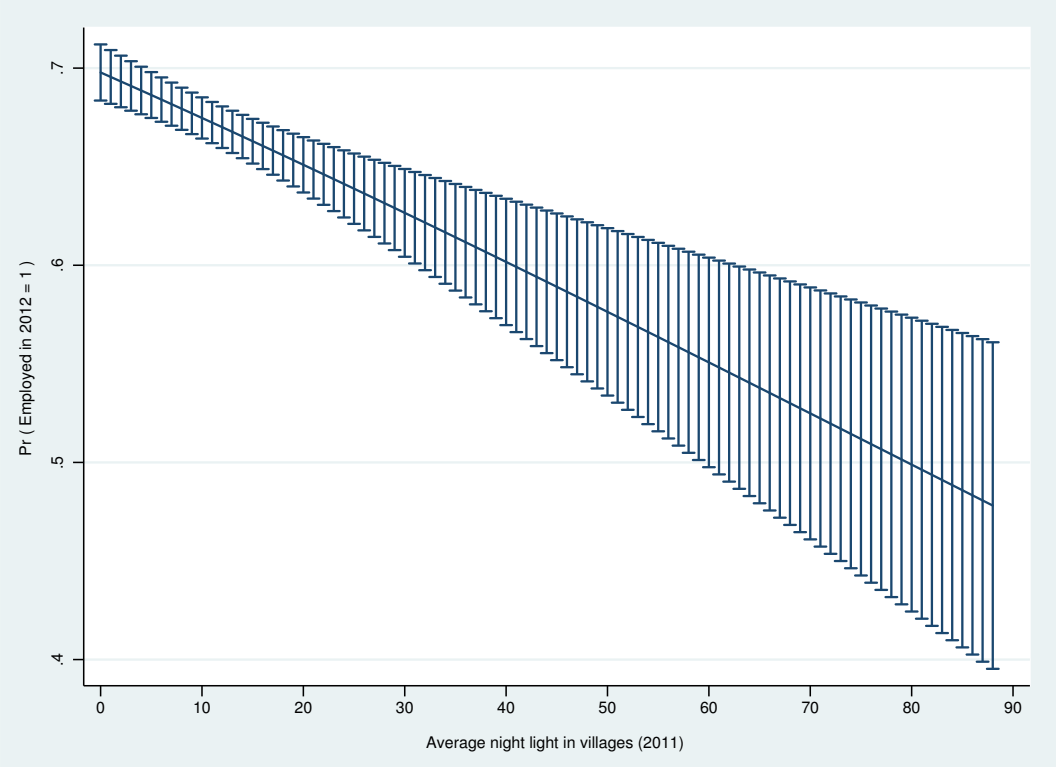
In this section, we present the estimates of the equations presented in Section 4 regarding the impact of the flood shock on the probability of employment, on the probability of entering employment if not employed at baseline and on monthly income if employed at baseline. Table 2 col. (A) shows the estimated coefficients for Eq. 1. The difference-in-differences coefficient indicates the variation in the outcome between the two waves in those villages totally inundated by flooding with respect to unaffected villages.[16] We find that the probability of employment increases by 13 percentage points between the two waves as an effect of the shock.

Regarding the impact of the flood shock on the probability of entering employment, we first estimate Eq. 2 to derive the Mill's ratio. Table A3 reports the coefficients from the probit regression of the probability of being employed at baseline. For the exclusion restrictions, we find that a higher level of rainfall, meaning a lower vulnerability to drought, as well as higher local economic growth—proxied by nighttime light intensity—are correlated with a lower probability of employment, consistent with the U-shaped relationship hypothesis. Figure 5 plots the estimated negative relationship between local economic development and women's employment at baseline. Since our sample includes only rural households, we do not observe the second increasing segment of the U-shaped relationship that represents the shift to an industrial and service-based formal economy, as in Sarkar et al. (2019). Table 2 col. (B) shows the estimated coefficients for Eq. 3. The probability of non-employed women entering employment after the shock increases by 17 percentage points. The selection correction $\lambda_{Nonemp,i}$ has a significant and positive effect on this outcome.

Table 2 col. (C) shows the estimated coefficients for the impact of the shock on average monthly income conditional on being employed at baseline. Employed women's earnings increase by $11 PPP. Multiplying the coefficient by the maximum share of inundation, i.e., 0.94, and dividing it by the average monthly income of the pre-shock period (approximately $22 PPP), we estimate that women's earnings increase by nearly 50 percent after the flooding. Part of this increase is due to a shift from

[16] The coefficients represent the impact on the outcomes for a shift in the continuous treatment from 0 percent to 100 percent. However, the maximum share of inundated areas is 94 percent, so by multiplying the regression coefficients by 0.94, we obtain the difference-in-differences impact between the most and least affected households.

Figure 5. Relationship between the employment of women at baseline and local economic development, proxied by nighttime lights



Source: Authors' calculations from BIHS data and NASA Integrated Multi-satellite Retrievals for GPM for rainfall data.

Table 2. Impact of the flood shock on the probability of being employed, on the probability of entering employment, and on average monthly income, FE estimates

	(A) Employment	(B) Entry into empl.	(C) Monthly income PPP
Year 2015	-0.0246	0.107	-30.75***
	(0.0279)	(0.0908)	(6.979)
Treatment (DiD)	0.130**	0.171*	11.01*
	(0.0530)	(0.0876)	(6.329)
year*share of inundated areas, July 2014	-0.319***	-0.630***	59.18*
	(0.112)	(0.192)	(32.62)
year*Eastern Bengal	0.0172	-0.0985***	-0.854
	(0.0182)	(0.0342)	(3.012)
year*Central Bengal	0.0140	-0.0966***	-0.109
	(0.0179)	(0.0346)	(2.809)
year*Southern Bengal	-0.00683	-0.0752**	1.754
	(0.0191)	(0.0374)	(2.909)
Higher educ.	0.0626	-0.282***	21.69*
	(0.0406)	(0.0441)	(13.10)
N. children	-0.00298	0.00792	-1.131
	(0.00625)	(0.00988)	(1.063)
Household income excluding own income (ln)	0.00516	0.00714	-1.390**
	(0.00347)	(0.00560)	(0.613)
Age	-0.00203	0.000629	0.245
	(0.00255)	(0.00376)	(0.455)
Marital status married	-0.0960***	-0.0786**	-0.240
	(0.0230)	(0.0392)	(3.806)
Being head of household	0.00943	0.0775*	6.776*
	(0.0228)	(0.0405)	(3.824)
year*$Lambda_{Non-emp.}$		0.387***	
		(0.0693)	
year*$Lambda_{Emp.}$			50.49***
			(11.25)
Constant	0.804***	0.0231	19.64
	(0.0999)	(0.146)	(17.83)
Number of observations	15,616	5,262	10,352
Number of women	7,808	2,631	5,176

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

Note: The regression is estimated for all women aged 15 or older in col. A, on women unemployed in 2012 in col. B, and on women employed in 2012 in col. C. All monetary values are expressed in PPP-adjusted USD in constant prices.

unpaid work in family businesses to paid work outside the household, as shown in the next subsection (as mentioned above, women working without pay on the household farm are included in the baseline

sample of employed women). The selection correction for being employed at baseline has a significant and positive effect on the outcome.

5.2 Impact of the flood shock on the probability of engaging in an independent wage-earning activity and of gaining earning capacity

Table 3 shows the coefficients for Eq. 8 estimated for the two outcomes described in Section 4.4.

Regarding the first outcome, the probability of switching from unpaid work to paid work increases by 67 percentage points in those villages where the share of inundated areas reached the maximum (col. A). The probability of gaining earning capacity instead increased by 13 percentage points, but this estimate is not significant.

Table 3. Impact of the flood shock on paid work and earning capacity, FE estimates

	(A) Paid employment outside hh farm	(B) Earning capacity
Year 2015	0.469**	0.831***
	(0.193)	(0.137)
Treament (DiD)	0.672***	0.126
	(0.247)	(0.106)
year*share of inundated areas, July 2014	-0.944**	-0.532**
	(0.444)	(0.229)
year*Eastern Bengal	-0.124	0.0754**
	(0.0869)	(0.0334)
year*Southern Bengal	0.0771	0.143***
	(0.0787)	(0.0327)
year*Central Bengal	0.0747	0.0412
	(0.0734)	(0.0336)
Higher educ.	-0.228	0.178
	(0.293)	(0.167)
N. children	-0.0463**	-0.00968
	(0.0230)	(0.0119)
Household income excluding own income (ln)	-0.00182	-0.00123
	(0.0163)	(0.00691)
Age	-0.00650	-0.00782
	(0.0119)	(0.00520)
Marital status married	-0.254*	-0.0664
	(0.147)	(0.0520)
Being head of household	0.261**	0.0211
	(0.124)	(0.0427)
year*$Lambda_1$	-0.0721	0.195
	(0.164)	(0.150)
year*$Lambda_2$	0.0760	-0.248
	(0.169)	(0.207)
Constant	0.569	0.361*
	(0.442)	(0.201)
Number of observations	674	2,500
Number of women	337	1,250

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

Note: The regression is estimated for all women aged 15 or older working without pay in 2012 (col. A) and working without earning capacity in 2012 (col. B). All monetary values are expressed in PPP-adjusted USD in constant prices.

5.3 Impact of the flood shock on women's bargaining power through employment

As mentioned above, we aim to understand whether the labour outcomes that were positively affected by the flood have increased women's bargaining power. Note that the section of the questionnaire regarding the WEAI is administered only to the primary male and female respondents in the household, for whom the empowerment problem is likely to be the most relevant. This is indeed the case: Table 4, reporting the estimated coefficients for Eq. 9, shows that the acquired earning capacity leads to a significant increase in the WEAI of 0.61 (the Index ranges between 0 and 1) and the coefficient on treatment in the first stage is also significant—the probability of gaining earning capacity increases by 26 percentage points—which is different from Table 3, where all women in the sample were included. Instead, neither becoming employed nor having declared having shifted from unpaid to paid work after the shock has a significant effects on the WEAI. In the former case, the interpretation might be that simply becoming employed (paid or unpaid) is not enough to gain bargaining power; in the latter case, this result might be due to the way we have built the unpaid employment variable, which is less adequate than the variable "earning capacity" when we need to proxy for control over earnings (see Section 3.2 on this point).

Table 4. Impact of employment, paid work and earning capacity on women's bargaining power, FE IV-2SLS estimates

	(A)		(B)	(C)		
	(1)	(2)	(3)	(4)	(5)	(6)
	(1st stage)	(2nd stage)	(1st stage)	(2nd stage)	(1st stage)	(2nd stage)
	Employment	WEAI	Paid work	WEAI	Earning capacity	WEAI
Year 2015	-0.0700**	0.0782***	0.808***	-0.0494	0.524**	-0.279
	(0.0306)	(0.0284)	(0.264)	(0.368)	(0.205)	(0.243)
Treatment (DiD)	0.115*		0.472**		0.263**	
	(0.0588)		(0.233)		(0.118)	
Employment		0.438				
		(0.324)				
Paid work				-0.0592		
				(0.392)		
Earning capacity						0.611*
						(0.370)
year*share of inundated areas, July 2014	-0.400***	0.0354	-1.094***	0.357	-0.494*	0.0931
	(0.124)	(0.0898)	(0.401)	(0.233)	(0.255)	(0.183)
year*Eastern Bengal	0.0346*	0.0300*	0.0402	0.0306	0.120**	-0.00999
	(0.0201)	(0.0170)	(0.0854)	(0.0745)	(0.0481)	(0.0529)
year*Central Bengal	0.0282	0.000966	0.0830	0.144**	0.237***	-0.109
	(0.0190)	(0.0149)	(0.0725)	(0.0662)	(0.0449)	(0.0867)
year*Southern Bengal	0.0130	0.0535***	0.0620	0.205***	0.143***	0.0291
	(0.0206)	(0.0126)	(0.0697)	(0.0576)	(0.0490)	(0.0514)
Higher educ.	0.145	-0.125	-0.0861	-0.124	0.0272	0.0679
	(0.0957)	(0.0767)	(0.347)	(0.277)	(0.183)	(0.153)
N. children	0.00474	0.00523	-0.0157	-0.0280	-0.0234	0.0103
	(0.00739)	(0.00497)	(0.0243)	(0.0198)	(0.0164)	(0.0155)
Household income excluding own income (ln)	0.00403	-0.00135	-0.00308	-0.00529	-0.00725	-0.0111
	(0.00383)	(0.00273)	(0.0159)	(0.0128)	(0.00837)	(0.00771)
Age	0.000426	-0.000431	-0.00577	0.00544	-0.00726	-0.00166
	(0.00275)	(0.00175)	(0.0107)	(0.00864)	(0.00666)	(0.00610)
Marital status married	-0.116***	-0.0286	0.0357	-0.122	-0.0966	-0.00965
	(0.0256)	(0.0410)	(0.212)	(0.168)	(0.0645)	(0.0677)
Being head of household	-0.00385	-0.0284*	0.116	-0.0733	0.00498	-0.0129
	(0.0237)	(0.0151)	(0.119)	(0.102)	(0.0520)	(0.0434)
year*$Lambda_1$			-0.0763	0.0484	0.312**	0.0358
			(0.134)	(0.110)	(0.143)	(0.153)
year*$Lambda_2$			0.0793	-0.0506	-0.199	-0.0420
			(0.136)	(0.111)	(0.219)	(0.185)
Constant	0.834***	0.233	0.218	0.566	0.167**	0.552***
	(0.106)	(0.279)	(0.438)	(0.358)	(0.0838)	(0.0975)
Number of observations	11,348	11,348	488	488	2,122	2,122
Number of women	5,674	5,674	244	244	1,061	1,061

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

Note: The sample includes employed women aged 15 or older. The regression is estimated for the sample of all women (panel A), the sub-samples of women working without pay in 2012 (panel B) and of women working without earning capacity in 2012 (panel C). The section dedicated to the WEAI in the questionnaire is administered to households that have a primary male and a primary female respondent, and for this reason, the number of observations is reduced relative to the preceding sections when we use the WEAI. All monetary values are expressed in PPP-adjusted USD in constant prices.

We also estimate the same model for each of the ten components of the WEAI. Table 5 shows the estimated impacts. Four indicators are positive and significant at the 10 percent level, namely, contributing to decisions regarding household production, speaking in public, enjoying leisure time, and being members of groups (e.g., credit/microfinance groups, mutual help or insurance groups, or civic groups). These results confirm the importance of a comprehensive index such as the WEAI and its components to analyse the different aspects of women's empowerment.

Table 5. Impact of earning capacity on the WEAI components, FE IV-2SLS estimates

	1st stage	2nd stage									
	Earning capacity	Input prod. decisions	RAI	Owning assets	Transferring assets	Credit decisions	Income control	Group member	Speaking in public	Workload	Leisure
Year 2015	0.524**	-1.283**	1.852***	1.002***	1.172***	-0.0532	-0.000999	-0.622	-0.00100	1.463***	0.163
	(0.205)	(0.536)	(0.462)	(0.0305)	(0.284)	(0.568)	(0.390)	(0.475)	(0.620)	(0.391)	(0.446)
Treatment (DiD)	0.263**										
	(0.118)										
Earning capacity		1.348*	-0.784	-0.000981	0.498	1.343	-0.213	1.252*	1.641*	-0.0957	1.191*
		(0.805)	(0.694)	(0.0457)	(0.427)	(0.852)	(0.586)	(0.713)	(0.931)	(0.586)	(0.669)
year*share of inundated areas, July 2014		-0.228	-0.279	-0.00795	-0.0994	0.317	-0.405	0.240	-0.0973	-0.0616	0.452
		(0.376)	(0.324)	(0.0214)	(0.199)	(0.398)	(0.274)	(0.333)	(0.435)	(0.274)	(0.312)
year*Eastern Bengal	0.120**	-0.201*	0.0751	-0.00462	-0.0430	-0.128	-0.0560	0.274***	-0.220*	0.109	-0.111
	(0.0481)	(0.111)	(0.0959)	(0.00632)	(0.0590)	(0.118)	(0.0810)	(0.0986)	(0.129)	(0.0811)	(0.0925)
year*Central Bengal	0.237***	-0.281	0.150	0.000383	-0.0950	-0.267	-0.0641	0.226	-0.269	0.00132	-0.0825
	(0.0449)	(0.185)	(0.160)	(0.0105)	(0.0982)	(0.196)	(0.135)	(0.164)	(0.214)	(0.135)	(0.154)
year*Southern Bengal	0.143***	-0.112	0.101	0.000494	-0.0831	-0.0816	-0.0475	0.254***	-0.114	0.0891	-0.0548
	(0.0490)	(0.110)	(0.0946)	(0.00624)	(0.0582)	(0.116)	(0.0799)	(0.0973)	(0.127)	(0.0800)	(0.0913)
Higher educ	0.0272	-0.0442	0.0194	-0.00360	-0.0148	-0.0249	-0.0265	0.298	0.147	0.0246	-0.0394
	(0.183)	(0.314)	(0.271)	(0.0178)	(0.166)	(0.332)	(0.229)	(0.278)	(0.363)	(0.229)	(0.261)
N. children	-0.0234	0.0621*	-0.0285	0.00357*	-0.00535	-0.00737	0.0374	0.0227	0.0278	-0.0417*	0.0154
	(0.0164)	(0.0324)	(0.0279)	(0.00184)	(0.0172)	(0.0343)	(0.0236)	(0.0287)	(0.0375)	(0.0236)	(0.0269)
Household income excluding own income (ln)	-0.00725	-0.0144	0.0223*	-3.79e-05	0.0123	0.0189	-0.0325***	-0.0180	-0.0291	-0.0169	0.00871
	(0.00837)	(0.0157)	(0.0136)	(0.000894)	(0.00834)	(0.0167)	(0.0115)	(0.0139)	(0.0182)	(0.0115)	(0.0131)
Age		0.00950	-0.00480	1.07e-06	0.00735	0.00859	0.00410	0.00843	0.00107	-0.00201	-0.00504
		(0.0127)	(0.0109)	(0.000719)	(0.00671)	(0.0134)	(0.00921)	(0.0112)	(0.0146)	(0.00922)	(0.0105)
Marital status married	-0.0966	-0.182	-0.00273	0.00217	0.166**	0.0390	-0.268***	-0.0163	0.0120	0.193*	0.158
	(0.0645)	(0.142)	(0.122)	(0.00804)	(0.0751)	(0.150)	(0.103)	(0.125)	(0.164)	(0.103)	(0.118)
Being head of household	0.00498	-0.208**	0.113	-0.000853	0.0805*	0.174*	-0.265***	-0.0152	0.00941	0.0872	-0.0137
	(0.0520)	(0.0891)	(0.0768)	(0.00506)	(0.0472)	(0.0943)	(0.0648)	(0.0789)	(0.103)	(0.0649)	(0.0740)
year*$Lambda_1$	0.312**	-1.190***	0.620**	-0.00574	0.0811	-0.141	-0.324	-0.147	0.0594	0.444*	-0.0657
	(0.143)	(0.326)	(0.281)	(0.0185)	(0.173)	(0.345)	(0.238)	(0.289)	(0.378)	(0.238)	(0.271)
year*$Lambda_2$	-0.199	1.478***	-0.825**	0.00515	-0.390*	-0.164	0.735***	0.139	-0.436	-0.718***	-0.0498
	(0.219)	(0.382)	(0.329)	(0.0217)	(0.202)	(0.404)	(0.278)	(0.338)	(0.441)	(0.278)	(0.317)
Constant	0.167**	-0.185	0.105	-0.00798	-0.490	-0.456	0.235	-0.259	0.0330	0.0321	-0.0314
	(0.0838)	(0.570)	(0.491)	(0.0323)	(0.302)	(0.603)	(0.414)	(0.504)	(0.659)	(0.415)	(0.473)
Number of observations	2,122	2,122	2,122	2,122	2,122	2,122	2,122	2,122	2,122	2,122	2,122
Number of women	1,061	1,061	1,061	1,061	1,061	1,061	1,061	1,061	1,061	1,061	1,061

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

Note: The regression is estimated for the sample of women aged 15 or older who are employed without earning capacity in 2012. The outcomes are the ten components of the *5De score* and the *Gender Parity Index*. All monetary values are expressed in PPP-adjusted USD in constant prices.

5.4 Heterogeneity analysis

Differentiating by net buyer and net seller households

To deepen our understanding of the effects of flooding, we conduct a heterogeneity analysis following the theoretical model we presented in Section 2. We expect that among rural households, those households that are less self-sufficient in terms of food security are more vulnerable to natural shocks. To this end, we evaluate the differences in women's employment and empowerment outcomes according to the household's position in the local market as a net seller or net buyer. We therefore estimate our benchmark specification differentiating between net food buyer and net food seller households.[17]

Table 6 for net buyers and Table 7 for net sellers show that only on the farms of net seller households (col. 1, Panel A) does women's employment increase significantly by approximately 27 percentage points. This might mean that only the sector of net-seller households—those households with higher productivity and wages in our theoretical model—has employed women who were not employed at baseline in either sector. Women belonging to net buyer households experience a significant increase of 70 percentage points in the probability of shifting from working on the family farm to working in paid employment, while no significant effect is present for net seller households (col. 3, Panel B). However, the number of women in this sample is rather small. Based on a more numerous and therefore more reliable sample, the results for earning capacity (41 percent increase) confirm the positive effect of the shock for net buyers (col. 5, Panel C). Regarding the effect on the WEAI, we do not find any significant effect of the shift from unpaid to paid work, as before. Instead, we find that the positive effect of the increased earning capacity on the WEAI observed for the whole sample is exclusively driven by women in net buyer households (col. 6, Panel C).

[17] Using yearly information on kilograms of each food item cultivated and sold in the market and on the corresponding quantities purchased, we define net sellers as households for which the total amount of items sold is higher than the amount purchased and the sample of net buyers as households for which the reverse is true.

Table 6. Impact of employment, paid work and earning capacity on women's bargaining power in net buyer households, FE IV-2SLS estimates

	(A)		(B)		(C)	
	(1)	(2)	(3)	(4)	(5)	(6)
	(1st stage)	(2nd stage)	(1st stage)	(2nd stage)	(1st stage)	(2nd stage)
	Employment	WEAI	Paid work	WEAI	Earning capacity	WEAI
Year 2015	-0.0335	-0.122	0.897**	-0.313	0.721***	-0.240
	(0.0400)	(1.089)	(0.402)	(0.395)	(0.257)	(0.280)
Treatment (DiD)	-0.0133		0.703***		0.409***	
	(0.0764)		(0.268)		(0.149)	
Employment		-5.217				
		(31.30)				
Paid work				-0.0896		
				(0.294)		
Earning capacity						0.521*
						(0.290)
year*share of inundated areas, July 2014	-0.347**	-1.901	-1.210***	0.492**	-0.810***	0.246
	(0.153)	(11.50)	(0.436)	(0.219)	(0.299)	(0.230)
year*Eastern Bengal	0.00486	0.0746	-0.105	-0.00487	0.128**	-0.0119
	(0.0259)	(0.206)	(0.109)	(0.0785)	(0.0584)	(0.0540)
year*Central Bengal	0.0191	0.103	-0.00586	0.0881	0.236***	-0.133*
	(0.0256)	(0.617)	(0.0917)	(0.0707)	(0.0566)	(0.0737)
year*Southern Bengal	-0.0242	-0.0682	0.00347	0.177***	0.179***	0.0138
	(0.0274)	(0.734)	(0.0846)	(0.0652)	(0.0608)	(0.0552)
Higher educ.	0.106	0.452	-0.151	-0.166	-0.112	-0.0472
	(0.115)	(3.378)	(0.358)	(0.279)	(0.260)	(0.212)
N. children	0.0103	0.0648	-0.0453	-0.0630**	-0.0250	-0.00316
	(0.00924)	(0.326)	(0.0325)	(0.0275)	(0.0196)	(0.0167)
Household income excluding own income (ln)	0.00115	0.00575	0.00874	-0.0116	-0.00375	-0.0127
	(0.00475)	(0.0446)	(0.0201)	(0.0156)	(0.00972)	(0.00803)
Age	0.000991	0.00484	-0.00651	0.00290 -0.00226	-0.00126	
	(0.00383)	(0.0367)	(0.0119)	(0.00941)	(0.00266)	(0.00510)
Marital status married	-0.102***	-0.596	0.0481	-0.492*	-0.0467	-0.0377
	(0.0328)	(3.206)	(0.352)	(0.271)	(0.0826)	(0.0694)
Being head of household	-0.0265	-0.174	0.193	-0.0351	0.000647	-0.0280
	(0.0297)	(0.846)	(0.161)	(0.133)	(0.0610)	(0.0492)
year*$Lambda_1$			-0.0589	0.168	0.368**	0.0947
			(0.168)	(0.130)	(0.177)	(0.168)
year*$Lambda_2$			0.0624	-0.169	-0.353	-0.0801
			(0.170)	(0.131)	(0.271)	(0.226)
Constant	0.814***	4.838	0.224	1.139***	0.115	0.623***
	(0.148)	(25.52)	(0.550)	(0.435)	(0.104)	(0.0929)
Number of observations	7,182	7,182	296	296	1,366	1,366
Number of women	3,591	3,591	148	148	683	683

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

Note: The regression is estimated for the sample of women aged 15 or older belonging to net buyer households (panel A) and is further restricted to women working without pay in 2012 (panel B) and those working without earning capacity in 2012 (panel C). All monetary values are expressed in PPP-adjusted USD in constant prices.

Table 7. Impact of employment, paid work and earning capacity on women's bargaining power in net seller households, FE IV-2SLS estimates

	(A)		(B)		(C)	
	(1)	(2)	(3)	(4)	(5)	(6)
	(1st stage)	(2nd stage)	(1st stage)	(2nd stage)	(1st stage)	(2nd stage)
	Employment	WEAI	Paid work	WEAI	Earning capacity	WEAI
Year 2015	-0.125***	0.0513	0.935	0.119	0.145	0.0137
	(0.0476)	(0.0331)	(0.849)	(2.502)	(0.348)	(1.054)
Treatment (DiD)	0.272***		-0.188		-0.0668	
	(0.0940)		(0.609)		(0.206)	
Employment		0.156				
		(0.186)				
Paid work				-0.109		
				(2.716)		
Earning capacity						-1.520
						(5.451)
year*share of inundated areas, July 2014	-0.475**	-0.179**	-0.574	0.0389	0.323	0.146
	(0.213)	(0.0718)	(1.152)	(2.480)	(0.515)	(1.317)
year*Eastern Bengal	0.0893***	0.0344	0.284*	0.0730	0.0647	0.149
	(0.0329)	(0.0245)	(0.153)	(0.759)	(0.0894)	(0.425)
year*Central Bengal	0.0396	0.0246	0.200	0.203	0.209***	0.418
	(0.0278)	(0.0165)	(0.132)	(0.573)	(0.0765)	(1.193)
year*Southern Bengal	0.0702**	0.0560***	0.164	0.247	0.0444	0.191
	(0.0309)	(0.0185)	(0.129)	(0.480)	(0.0862)	(0.341)
Higher educ.	0.223	-0.00373			0.165	0.509
	(0.175)	(0.105)			(0.259)	(1.003)
N. children	-0.00865	-0.00107	0.0281	0.0118	-0.0181	-0.000156
	(0.0124)	(0.00678)	(0.0388)	(0.0783)	(0.0307)	(0.115)
Household income excluding own income (ln)	0.00926	-0.000456	-0.0268	0.00347	-0.0193	-0.0535
	(0.00653)	(0.00389)	(0.0298)	(0.0759)	(0.0176)	(0.108)
Age	-1.71e-05	-0.000272	0.0336	0.0299 -0.00276	-0.00526	
	(0.00390)	(0.00210)	(0.0301)	(0.0882) (0.00966)	(0.00310)	
Marital status married	-0.143***	-0.0876**	-0.0988	-0.0595	-0.160	-0.331
	(0.0408)	(0.0347)	(0.285)	(0.343)	(0.106)	(0.879)
Being head of household	0.0362	-0.0265	0.142	-0.00295	0.0681	0.166
	(0.0393)	(0.0222)	(0.211)	(0.453)	(0.105)	(0.405)
year*$Lambda_1$			-0.0296	-0.0743	0.160	0.310
			(0.248)	(0.235)	(0.251)	(1.051)
year*$Lambda_2$			-0.0526	0.0327	0.171	0.365
			(0.312)	(0.268)	(0.385)	(1.029)
Constant	0.854***	0.495***	-1.001	-0.512	0.266*	1.050
	(0.150)	(0.181)	(1.110)	(2.666)	(0.154)	(1.460)
Number of observations	4,166	4,166	192	192	756	756
Number of women	2,083	2,083	96	96	378	378

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

Note: The regression is estimated for the sample of women aged 15 or older belonging to net seller households (panel A) and is further restricted to women working without pay in 2012 (panel B) and those working without earning capacity in 2012 (panel C). All monetary values are expressed in PPP-adjusted USD in constant prices.

5.5 Robustness checks

To check the robustness of these results, we focus on three aspects of the analysis.

First, since some women exited paid employment or lost earning capacity after the shock (see Table 1), it could be argued that, for these women, the impact of the flood may have been negative because they lost their jobs. In other words, if some women have gained in terms of their earning capacity—as our evidence indicates—some other women may have lost their earning capacity because of the shock, so that the sign of the overall causal effect on women's labour may be negative or positive depending on the prevalence of the positive or of the negative effects. To verify this possibility, we estimated the same model for women who reported having become unpaid workers or having lost earning capacity between the two waves. Table A4 in the Appendix shows that the coefficients on the treatment variables are not significant in either case, thus confirming that the impact of the shock on women's labour is only positive.

The second robustness check concerns the validity of the parallel trends assumption for our difference-in-differences estimation. To this end, we test whether differently treated villages would have followed similar trends in the absence of the flood.[18] However, with only two panel waves available for the sample considered, we repeat the estimation as if the flood had occurred two years before, in 2012, employing nighttime light data for the pre-treatment period. As in Section 4.2, we use the amount of light observed from the satellites to proxy the level of economic activity in the absence of more traditional measures. In particular, we compute the yearly average of the monthly composite measure for the intensity of the nighttime lights in 2012 and 2013. We then regress the average estimated light in the 5-km radius around each village in the sample on the flooding treatment variable, adding the propensity to be inundated in normal times and region-wave fixed effects as controls, to check whether there are ex ante correlations between treatment and the trends in the outcomes. To prove the reliability of this test, we compare the results of the placebo test with the results obtained by regressing the same type of outcome on the treatment for the period when the flood actually hit, running the same difference-in-differences estimation for the years 2012 and 2015.[19]

The results of the placebo test conducted for the period preceding the occurrence of the flooding,

[18] This paragraph draws on Giannelli and Canessa (forthcoming), Section 4.3, Table 3.

[19] Since we do not have information at the household level, all the variables—dependent, explanatory and control—are at village level, the estimation being a test for pre-treatment differences across these units of observation.

namely, 2012 and 2013, confirm that the outcome of interest would have followed parallel trends in differently treated villages in the absence of the shock. In fact, the coefficients for the correlation between the treatment and the variation in nighttime lights over time are statistically significant in neither the OLS nor the fixed effects regressions (see Table A5 in the Appendix). Instead, running the same regression for the years 2012 and 2015, we observe that the effect of the treatment led to a significant drop in nighttime light intensity of 0.09 units, where the unit of measurement is nanowatts/cm^2/steradian (nw/cm^2/sr). Despite the limits of this estimation in which the more informative labour outcomes are substituted with the single indicator of nighttime lights, this test supports the hypothesis of equality in the pre-treatment trends in economic growth among differently treated villages. In this case, any significant differences among villages should be due to women's labour decisions.

The third robustness check focuses on women's empowerment as measured by indicators other than the WEAI. Given our specific interest in the impact of the shock on women's earning capacity, we employ factor analysis to construct an additional measure of empowerment using questions about economic decision-making and who makes decisions in the household. The questions used in the WEAI index are instead about the respondents' feeling of "the extent to which they can make their own personal decisions". Women are considered *adequate* if they are able to participate in household decisions "to at least a moderate extent". Module WG01 in the questionnaire asks 'Who is it that normally makes decisions?' for each of the following aspects of household life: agricultural production, the purchase of agricultural inputs, the types of crops to be grown, taking crops to the market, raising livestock, non-farm business activities, own wage or salary employment and minor household expenditures.[20] For each type of decision, we construct dummies equal to 1 if i) the woman has some role in household decision-making (0 if the husband or someone else decides alone); ii) the woman decides alone (0 otherwise); iii) the woman decides jointly with her husband (0 otherwise);

[20]Module WG01 also asks about some non-economic decisions regarding health care issues, means of protection from violence, expressions of religious faith, time allocations for different daily tasks, and family planning and birth control methods. These questions were dropped from the follow-up survey so that we are not able to use them. These non-economic aspects of family life, however, are already taken into account in the so-called *RAI* index (Relative Autonomy Index; Alkire et al. (2013)), which is one component of the WEAI index that we have also analysed and presented in Table 5.

iv) the woman decides jointly either with her husband or with someone else inside the household or with someone else outside the household (0 otherwise). We convert these variables into indexes using the first factor extracted from the factor analysis. The first factor is then employed as the dependent variable in the second-stage estimation as a latent construct of women's autonomy.

Table 8 shows the results of the 2SLS regressions with these factors as outcomes. Col. (A) reports the coefficients for the first stage, which is the same for each factor (and the same as that for the results in Table 4). The coefficients show that an increased earning capacity after the shock does indeed increase women's decision-making power within the household. The largest impact—6.7, significant at the 5 percent level—is on women having some role in household decision-making, either alone or jointly (col. B). Disentangling this effect, we find that most of the impact is on women making decisions jointly with their husbands (col. D). The joint decision-making factor improves further for decisions made with someone else inside or outside the household (col. E). While making decisions alone is not impacted significantly (col. C), the positive difference between col. B and col. E, which excludes sole decision-making, suggests that we cannot completely discard an impact on this factor. These results, obtained by employing factor analysis as an alternative measure to the WEAI, confirm that increasing women's labour contributes to enhancing women's decision-making power within the household. This robustness check is thus relevant for showing that the impact of a natural shock on women's labour and earning capacity has allowed them to become more involved in household decision-making.

Table 8. Impact of earning capacity on women's decision-making indicators, FE IV-2SLS estimates

	(A)	(B)	(C)	(D)	(E)
	(1st stage) Earning capacity	(2nd stage) Participation in household decision-making	(2nd stage) Sole decision-making	(2nd stage) Joint with husband decision-making	(2nd stage) Joint with others decision-making
Year 2015	0.517**	-3.209	-0.919	-3.478*	-3.442
	(0.205)	(2.205)	(1.192)	(1.921)	(2.109)
Treatment (DiD)	0.266**				
	(0.118)				
Earning capacity		6.666**	2.300	5.458*	6.206*
		(3.356)	(1.815)	(2.925)	(3.210)
year*share of inundated areas, July 2014	-0.519**	0.213	0.403	0.406	0.0783
	(0.257)	(1.658)	(0.897)	(1.445)	(1.586)
year*Eastern Bengal	0.120**	-0.315	0.296	-0.423	-0.512
	(0.0481)	(0.479)	(0.259)	(0.417)	(0.458)
year*Central Bengal	0.238***	-0.887	-0.270	-0.858	-0.908
	(0.0449)	(0.785)	(0.425)	(0.684)	(0.751)
year*Southern Bengal	0.143***	-0.177	-0.0179	-0.195	-0.239
	(0.0490)	(0.465)	(0.252)	(0.406)	(0.445)
Higher educ.	0.0270	-1.114	-0.841	-0.596	-0.633
	(0.183)	(1.386)	(0.749)	(1.207)	(1.325)
N. children	-0.0226	0.129	0.0132	0.117	0.151
	(0.0164)	(0.141)	(0.0761)	(0.123)	(0.135)
Household income excluding own income (ln)	-0.00733	0.0459	0.0308	0.0451	0.0425
	(0.00837)	(0.0698)	(0.0378)	(0.0609)	(0.0668)
Age	-0.000352	0.0316	0.0119	-0.00116	-0.00211
	(0.00980)	(0.0501)	(0.0992)	(0.00955)	(0.00980)
Marital status married	-0.0970	0.608	-0.322	0.473	0.652
	(0.0645)	(0.613)	(0.332)	(0.534)	(0.587)
Being head of household	0.00458	0.554	1.003***	-0.111	0.0771
	(0.0520)	(0.393)	(0.213)	(0.343)	(0.376)
year*$Lambda_1$	0.307**	-0.967	-0.453	-1.244	-1.053
	(0.143)	(1.388)	(0.751)	(1.210)	(1.328)
year*$Lambda_2$	-0.190	-0.0716	-0.532	0.952	0.504
	(0.220)	(1.673)	(0.905)	(1.458)	(1.600)
Constant	0.166**	-1.206	0.0138	-0.981	-1.227
	(0.0838)	(0.883)	(0.477)	(0.769)	(0.844)
Number of observations	2,120	2,120	2,120	2,120	2,120
Number of women	1,060	1,060	1,060	1,060	1,060

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

Note: The regression is estimated for all women aged 15 or older and working without earning capacity in 2012. The indicators are the first factors extracted from factor analysis. Col. A reports the coefficients for the first stage. The outcomes are the factor for women having some role in household decision-making (col. B), the factor for women deciding alone (col. C), the factor for women deciding jointly with their husbands (col. D), and the factor for women deciding jointly either with their husbands or with someone else inside the household or with someone else outside the household (col E). Decisions concern the following aspects of household life: agricultural production, the purchase of agricultural inputs, the types of crops to be grown, taking crops to the market, raising livestock, non-farm business activities, own wage or salary employment and minor household expenditures. All the outcome factors have been standardized. All monetary values are expressed in PPP-adjusted USD in constant prices.

6 Discussion and concluding remarks

Combining household panel survey data with high-precision satellite data, we evaluated the response of women's employment to dramatic flooding that hit Bangladesh between August and September 2014. Although floods are quite common during the monsoon season in South Asian countries, shifting from droughts to floods might severely harm the productive capacity of rural households and lead to seasonal poverty. It is therefore extremely relevant to understand the effects of these natural phenomena on household behaviour. The economic literature has shown that to adapt to these repeated natural shocks, households have developed risk-coping strategies over time, including changing the labour force status of household members. In such circumstances, women's earnings opportunities have fundamental implications for household well-being, and we have shown that income uncertainty improves women's employment outcomes. This is consistent with what was found in Attanasio et al. (2005), who investigated women's reactions to idiosyncratic earnings risk within the family.

The results of our difference-in-differences analysis have suggested that after the shock, women's probabilities of employment and of entering employment conditional on non-employment at baseline have increased by approximately 13 and 17 percentage points, respectively. After correcting for selection bias due to initial employment statuses, we also observed a significant increase in average monthly income. Following these improvements in employment outcomes, and consistent with our theoretical model, women's probabilities of engaging in paid work or of gaining earning capacity have also increased.

However, cultural and gender norms in traditional Bangladeshi society do not necessarily mean that women earning an income have command over the money they earn. Therefore, in addition to analysing the effect of natural shocks on employment outcomes, our results also contribute to disentangling the effects of acquiring earning capacity on women's bargaining power. Since women's employment outcomes are potentially endogenous explanatory factors for women's bargaining power, we applied the analysis of employment outcomes as the first stage of the bargaining power model, thus using the intensity of flooding as an instrument. We then employed the Women's Empowerment in Agriculture Index to test the hypothesis that only working for an independent income contributes to increasing women's autonomy. We found that increased earning capacity has contributed to increasing women's bargaining power in the household. Compared to other indicators for female

autonomy found in the literature, the WEAI has shown to be more comprehensive and adequate for capturing the multifaceted aspects of empowerment in women's lives. Thus, our causal analysis supports the previous cross-sectional evidence of Anderson and Eswaran (2009), who have shown that, in Bangladesh, wage labour has a more significant effect than unearned income on women's autonomy.

Following our theoretical model for interpreting these results, we have inferred that net seller households have increased their demand for farm labour after the flood shock to support their productive activities and compensate for the economic losses suffered. Women in net buyer households have met this demand, as shown by the increase in their employment off of their household farm to cope with the shock. Our findings show that our earning capacity indicator has exerted a positive influence on women's empowerment. However, the indicator for shifting from unpaid to paid work derived from the standard information on their employment status has not allowed us to identify a significant effect on empowerment.

We believe that among the strengths of our analysis is the use of georeferenced data—employed as treatment variables, exclusion restrictions, instruments and control variables—which have allowed us to increase our confidence in the robustness of the results. In addition, our results have shown to hold using additional indicators of women's bargaining power that have allowed us to disentangle the different impacts of women's employment on joint and sole decision-making. This robustness check has shown that acquired earning capacity leads women to be more involved in household decision-making, especially when decisions are made jointly with their husbands. Given the cultural and socioeconomic background in Bangladesh, this may be considered an important achievement. Finally, our results have shown to be robust to tests for parallel trends.

Our analysis is not without limitations. As already outlined, we were unable to conduct a natural parallel trend test because of the lack of another panel wave of the BIHS before the shock. The alternative test we performed employing nighttime light data as an outcome relies on the assumption that these data are a valid proxy for local economic growth and that the observed parallel trends in local development also imply similar trends in women's employment. Moreover, we do not extend the investigation to the impact of the shock on men's employment. While we acknowledge that an analysis including men's employment would also be relevant, especially when investigating empowerment, in

rural Bangladesh, the large majority of men are employed at baseline (approximately 91 percent of men over 15 years old), and we have not detected sufficient variability in our outcomes of interest between the two waves of the survey. Most likely, for men, it would be more relevant to investigate different questions.

From a policy point of view, it is well known that in rural areas, women working on household farms do not own the land and do not have any decision-making power related to the economic activities performed in most cases. However, natural shocks and the consequent larger participation of women in the labour market may alter this equilibrium. Our evidence has shown that women engaging in independent wage-earning activities have higher decision-making power: this might be exerted in decisions regarding household expenditure, the allocation of time and productive activities on the farm. However, only women with employable skills are likely to be employed in the labour market. If women acquire the skills to work autonomously in the market, this would guarantee them a higher level of autonomy. Therefore, based on our findings, policies that encourage female labour force participation in the market—such as the training programmes designed by the Bangladesh Rural Advancement Committee (BRAC) and the Grameen Bank to advance women's skills and reduce their economic dependency—should be further developed. In addition, many studies have demonstrated that increasing female autonomy and control over household financial resources has beneficial repercussions for the whole household, such as improving food security and the health status of its members (Dyson & Moore, 1983; Caldwell, 1986; Mason, 1987), as well as children's school attendance (Luz & Agadjanian, 2015).

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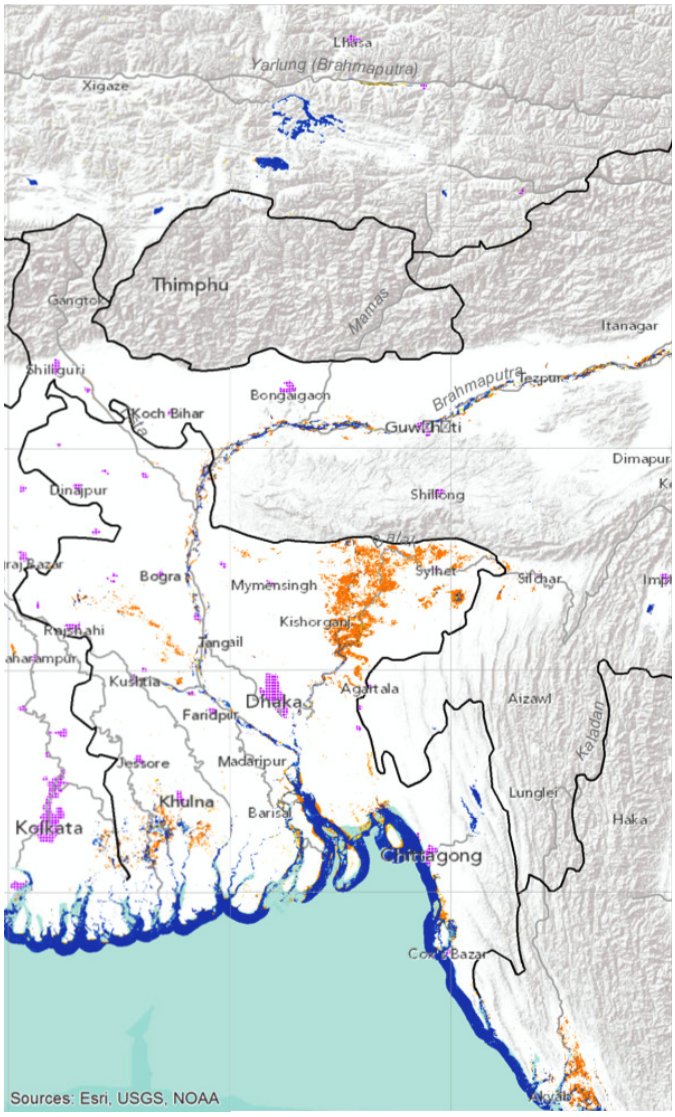
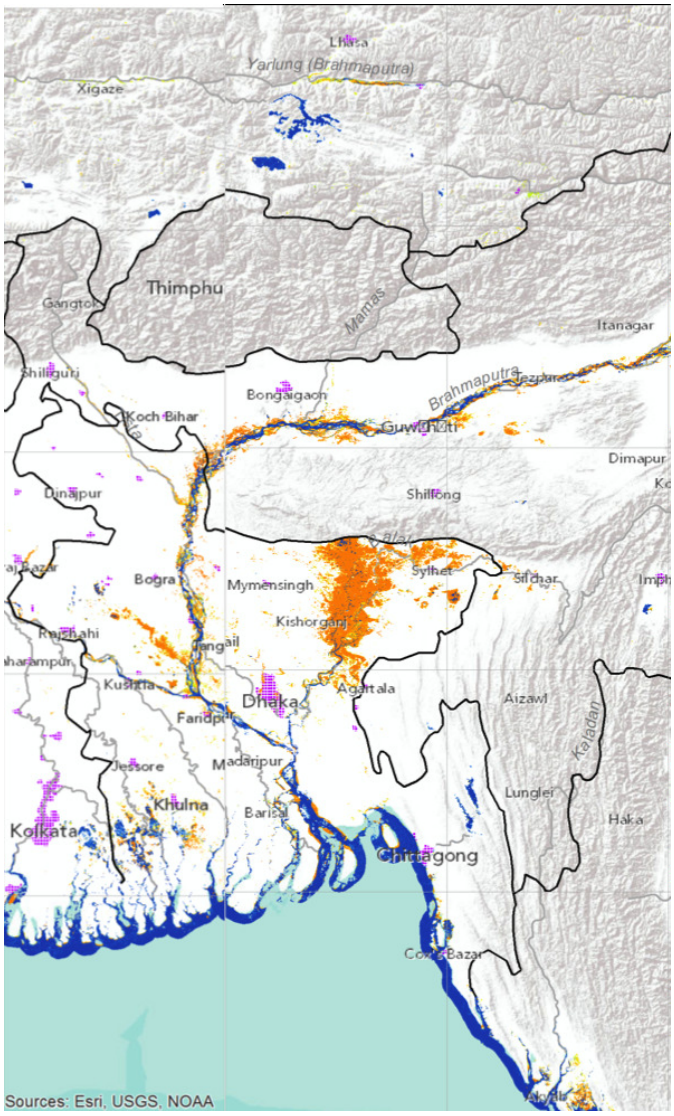
Appendix

A.1 Figures

Figure A1. NASA MODIS images, flood mapping



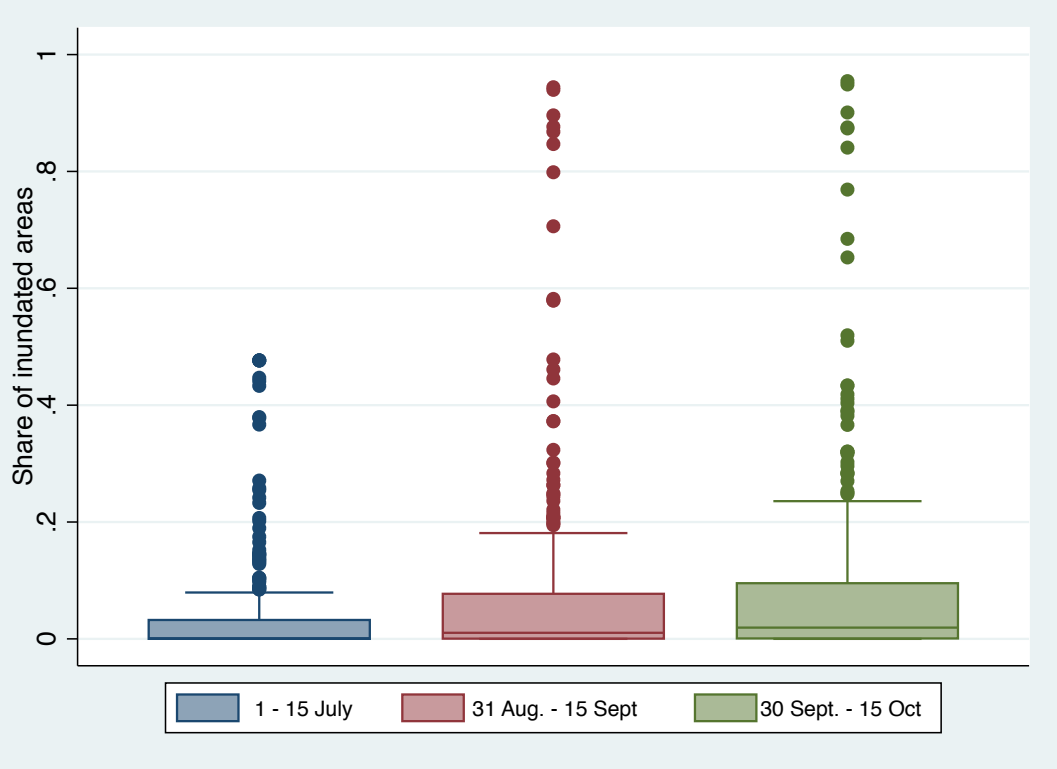
(a) July 2014



(b) September 2014

Note: NASA satellite image for non-flooding period, July 2014, compared to the period of interest, August 31st-September15th 2014.This figure is drawn from Giannelli and Canessa (forthcoming), Appendix, figure A1.

Figure A2. Share of inundated areas in a radius of 5km around each village



Note: The graph illustrates the box plot for inundated areas in a radius of 5 kilometers for each sampled village, before, during and after the flood.

A.2 Attrition analysis

4.4 percent attrition registered between the two years at the household level and 22 percent among individuals are potentially worrisome in case of correlation with our treatment variable. In this case the same households might not have been tracked in the second year as displaced after the flood or might have chosen to leave to avoid the dramatic consequences of the shock. Since this potential correlation would lead to biased estimates, we have performed an attrition analysis, regressing the indicator for attrition - a dummy equal to one in case of households or individuals not tracked in the second year - on our flood shock variable. Table A1 shows the results from a *probit* regression estimated both at household and individual level on all the observations of the sample for the two years. The main explanatory variable is the treatment measure, i.e. the share of inundated areas in a radius of 5 kilometres around each village, while regression controls comprehend household characteristics and location fixed effect.

The estimated coefficients do not significantly differ from 0, thus ruling out the possibility of sample selectivity bias.

Table A1. Impact of the flood shock on attrition among households and individuals, 2012-2015

Outcomes	Main explanatory variable: share of inundated areas, 5km
	Household level
Attrition indicator	0.216
	(0.179)
Number of households	6,503
	Individual level
Attrition indicator	-0.0413
	(0.0530)
Number of individuals	29,131

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

Note: The table contains the results of *probit* regressions estimated at household and individual levels, where the outcome is the dummy equal to 1 for household or individual not tracked in the second year and the coefficient is that of the treatment variable. Regression controls include household characteristics and location fixed effect.

A.3 Other tables

Table A2. Domains and proportions of the Women's Empowerment in Agriculture Index

DOMAIN	Indicator	Weight	Proportion of *adequate* women in 2012	Proportion of *adequate* women in 2015
Production	Input in production decisions	1/10	0.46	0.59
	Autonomy in production	1/10	0.57	0.80
Resources	Ownership of assets	1/15	0.71	0.99
	Purchase, sale or transfers of assets	1/15	0.77	0.80
	Access to and decisions about credit	1/15	0.47	0.53
Income	Control over use of income	1/5	0.59	0.68
Leadership	Group member	1/10	0.27	0.66
	Speaking in public	1/10	0.32	0.58
Time	Workload	1/10	0.75	0.72
	Leisure	1/10	0.70	0.75
Number of women			4,083	4,083

Note: The table reports the five domains, the ten indicators and their weights used to construct the WEAI. The proportions of *adequate* women found for each indicator are similar to those reported for the rural sector by Alkire et al. (2013), pp. 24-37, in the pilot study for Bangladesh.

Table A3. Probability of employment at baseline, Probit estimates

	Probability of employment in 2012	
Age	-0.000564	
	(0.000994)	
Higher educ.	-0.517***	
	(0.0592)	
N. children	-0.0121	
	(0.0122)	
Household income excluding own income	0.0580***	
	(0.00989)	
Being head of household	0.411***	
	(0.0606)	
Marital status married	0.0274	
	(0.0651)	
Night-time lights 2011	-0.00596***	
	(0.00135)	
Rainfall in 2011	-0.000497***	
	(0.000139)	
Constant	0.440***	
	(0.119)	
Number of women	7,808	7,808

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

Table A4. Impact of the flood shock on unpaid work and lack of earning capacity, FE estimates

	(A) Unpaid work	(B) No earning capacity
Year 2015	0.126***	-0.193***
	(0.0271)	(0.0587)
Treatment (DiD)	0.0475	-0.213
	(0.0377)	(0.158)
year*share of inundated areas, July 2014	-0.188**	0.355**
	(0.0795)	(0.157)
year*Eastern Bengal	-0.0134	0.157***
	(0.0130)	(0.0217)
year*Central Bengal	-0.0221*	0.0490***
	(0.0115)	(0.0177)
year*Southern Bengal	-0.0211*	0.0574***
	(0.0124)	(0.0181)
Higher educ.	0.0530	-0.0402
	(0.0657)	(0.0997)
N. children	0.00573	-0.000213
	(0.00508)	(0.00766)
Household income excluding own income (ln)	0.00551**	0.00369
	(0.00258)	(0.00396)
Age	0.000504	-0.00288
	(0.00190)	(0.00286)
Marital status married	-0.0114	-0.0318
	(0.0182)	(0.0266)
Being head of household	-0.0439***	-0.00788
	(0.0164)	(0.0249)
year*$Lambda_1$	-0.245***	-0.577***
	(0.0536)	(0.114)
year*$Lambda_2$	0.256***	0.784***
	(0.0653)	(0.146)
Constant	-0.0395	0.123
	(0.0739)	(0.112)
Number of observations	7,284	5,650
Number of women	3,642	2,825

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

Note: The regression has been run on all women aged 15 or older working paid in 2012 (col. A) and working with earning capacity in 2012 (col. B). All monetary values are expressed in PPP-adjusted USD in constant prices.

Table A5. Robustness checks with placebo test using night-lights data for 2012-2013

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Placebo test for 2012-2013			*Treatment effect test for 2012-2015*		
Outcomes	OLS	FE	Outcomes	OLS	FE
Night lights intensity	-0.0103	-0.0103	Night lights intensity	-0.0737*	-0.0652**
	(0.0474)	(0.00950)		(0.0428)	(0.0259)
Number of observations		318	Number of observations		318
Standard errors in parentheses			Standard errors in parentheses		
*** p<0.01, ** p<0.05, * p<0.1			*** p<0.01, ** p<0.05, * p<0.1		

Note: The two columns contain the difference-in-difference coefficient of the OLS and fixed effects regressions for the night light outcome at village level. This table is drawn from Giannelli and Canessa (forthcoming), Section 4.3, Table 3.