Tradeoffs between fertility and child development attributes: evidence from coral bleaching in Indonesia

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ONLINE APPENDIX

A. Map of treatment and control areas

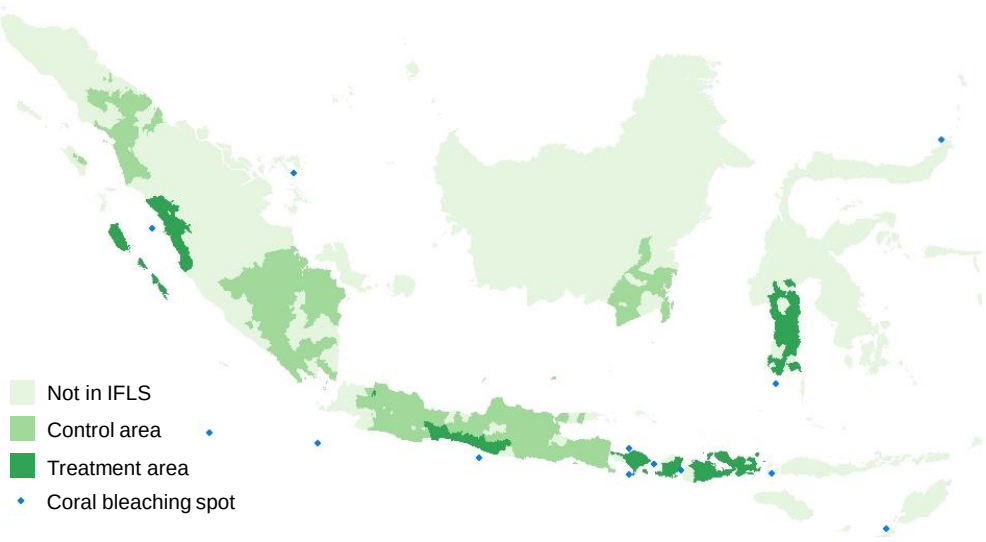

Figure A1. IFLS provinces and treatment area.

B. Robustness checks

Three checks were performed to ensure that the results in this paper are robust: 1) testing for placebo treatment effects, 2) controlling for the 2004 Indian Ocean tsunami, and 3) using an alternative measure of coral bleaching. The first two tests help affirm that all results are driven by coral bleaching and not some other shocks while the third test shows that measurement errors in coral bleaching exposures are not a major concern.

B.1 Placebo treatment

Table A1. Placebo treatment tests

	(1) Wasting	(2) Stunting	(3) Enroll	(4) Fail	(5) Wasting	(6) Stunting	(7) Enroll	(8) Fail
Bleach*Post	-0.0186	-0.000245	0.00415	0.0235	-0.00794	-0.0489	-0.00168	-0.0111
	(0.0121)	(0.0307)	(0.0233)	(0.0243)	(0.0313)	(0.0585)	(0.0387)	(0.0561)
Bleach	0.0294*	0.0189	-0.00125	-0.0212				
	(0.0148)	(0.0541)	(0.0146)	(0.0165)				
Post	0.00185	-0.0260	-0.0390**	-0.0673**	-0.0184	-0.0317	-0.0448	-0.0539
	(0.00599)	(0.0158)	(0.00924)	(0.0144)	(0.0209)	(0.0337)	(0.0379)	(0.0531)
Constant	0.112	2.183***	0.813***	0.0742**	-0.258	1.612	0.356***	-0.102
	(0.0646)	(0.158)	(0.0198)	(0.0351)	(0.726)	(1.229)	(0.0535)	(0.140)
HH FE	No	No	No	No	Yes	Yes	Yes	Yes
N	5,584	4,830	7,581	7,224	5,584	4,830	7,581	7,224

Remarks: Province clustered standard errors are in parentheses. *, **, and *** denote statistical significance at the 0.1, 0.05, and 0.01 levels, respectively. All samples come from non-fishery households. For models 1-2 and 5-6, the sample is all children who were 0-5 years old in the 1997 and 2000 waves. For models 3-4 and 7-8, the sample is all children who were 7-12 years old in the 1997 and 2007 waves. The dependent variables are dummy indicators for severe wasting, severe stunting, current school enrollment status, and whether a child has ever failed a grade in school. All models include household head's gender, age, and education as control covariates. Models 1-2 and 5-6 also control for mother's height and race. Age (in years) and province fixed effects are included in all models. Models 5-8 also contain household fixed effects.

In this placebo treatment test, non-fishery households in coral bleaching areas are compared against non-fishery households in unaffected areas to show that treatment effects are driven by coral bleaching and not by some inherent differences between the two areas. Table A1 exhibits results from this test. All coefficients on $Post * Bleach$ are not statistically significant suggesting that being in areas with coral bleaching alone (an indirect exposure to coral bleaching) does not affect any anthropometric and schooling outcomes.

B.2 Effects of the 2004 Indian Ocean Tsunami

The 2004 Indian Ocean Tsunami was one of the deadliest natural disasters in recent history, which could have potentially affected the children in our sample in a number of ways. Al-

though the area hardest hit by the tsunami in Indonesia was Aceh, which is not part of the main IFLS surveys, a few households in the IFLS self-reported themselves as affected. For this reason, the self-reported exposure to the tsunami is incorporated into the models that utilize the 2007 data to ensure that the main results are not driven by the tsunami. Tables A2 to A3 exhibit these new results and show that they are very similar to the main ones.

One reason that the 2004 tsunami has minimal impacts in our sample is that very few households in our sample were affected. Among the over 10,000 households in the IFLS, only 52 households, mostly in Central Java,[1] reported that they were affected by the 2004 tsunami. In our women sample, only 0.47% were affected by the tsunami in 2007.

B.3 An alternative measure of coral bleaching

Another identification concern is measurement errors in the measures of coral bleaching. The binary treatment variable used in the previous sections is based on reported bleaching spots and is subject to underreporting. For example, some reefs might not have been observed or reported. In this subsection, we use SST anomaly days constructed from comprehensive satellite maps as an alternative measure of coral bleaching exposure and show that similar results can be obtained.

The SST anomaly measure of coral bleaching in this subsection is based on a popular mass coral bleaching model (Hoegh-Guldberg, 1999) which suggests that coral bleaching would start to occur when the SST is higher than 1°C above the normal summer average for at least 3-4 weeks. NOAA has been employing this SST anomaly measure to forecast

[1]Central Java was also affected by the 1998 coral bleaching, but very few households in the IFLS in this province engaged in fisheries. Consequently, the correlation between the 1998 coral bleaching and the 2004 tsunami exposures in this dataset is very low making it difficult to detect their joint effects, even when the effects might actually exist in the real world.

Table A2. Effects of coral bleaching on fertility after controlling for the 2004 tsunami

	(1) Live births	(2) Live births	(3) Live births	(4) Live births
Bleach*Fish*Post2000	0.134**	0.146**	0.127	0.167*
	(0.0513)	(0.0597)	(0.0738)	(0.0834)
Bleach*Fish*Post2007	0.0523	0.0724	0.0828	0.0847
	(0.0886)	(0.103)	(0.140)	(0.141)
Bleach*Fish	-0.0192	-0.0118		
	(0.0297)	(0.0291)		
Fish*Post2000	-0.0907**	-0.0914**	-0.0728	-0.103*
	(0.0341)	(0.0398)	(0.0569)	(0.0560)
Fish*Post2007	-0.00411	-0.00864	0.00563	-0.0156
	(0.0317)	(0.0301)	(0.0470)	(0.0507)
Bleach*Post2000	-0.0432***	-0.0349***	-0.0203	-0.0163
	(0.0106)	(0.0103)	(0.0143)	(0.0148)
Bleach*Post2007	0.00290	-0.000450	0.0113	0.00626
	(0.0208)	(0.0236)	(0.0289)	(0.0272)
Tsunami	-0.0116	-0.0405	-0.00388	-0.0556**
	(0.0495)	(0.0518)	(0.0237)	(0.0264)
Constant	1.461***	1.049***	0.874***	1.068***
	(0.0866)	(0.0829)	(0.169)	(0.182)
HHH characteristics	No	Yes	No	Yes
HH FE	No	No	Yes	Yes
Ever married only	Yes	Yes	Yes	Yes
N	26,531	23,640	26,531	23,640

Remarks: Province-clustered standard errors are in parentheses. *, **, and *** denote statistical significance at the 0.1, 0.05, and 0.01 levels, respectively. The sample is women who were 15–49 years old in 1993, 1997, 2000, and 2007 waves of data. The dependent variable is the number of children born within 19 months of the earliest interview date. All models include the woman's age, education, and marital status. Columns 2 and 4 also include household head's sex, education, and age. Wave and province fixed effects are included in all models. Columns 3 and 4 also contain household fixed effects.

Table A3. Effects of coral bleaching on schooling outcomes in 2007 after controlling for the 2004 tsunami

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Enroll	Ever Enrolled	Fail	Fail	Enroll	Ever Enrolled	Fail
Bleach*Fish*Post	0.234**	0.104***	0.164*	0.159**	0.251	0.0755	0.0896
	(0.0867)	(0.0357)	(0.0778)	(0.0801)	(0.150)	(0.0646)	(0.251)
Fish*Post	-0.0662***	-0.0832***	-0.0320	-0.0299	-0.0387	-0.0353	-0.109
	(0.0183)	(0.0268)	(0.0421)	(0.0423)	(0.0520)	(0.0574)	(0.179)
Bleach*Fish	-0.147	-0.0282	0.0140	0.00950			
	(0.0849)	(0.0252)	(0.0552)	(0.0565)			
Bleach*Post	-0.00511	-0.00226	0.0186	0.0179	-0.0154	-0.000663	-0.0157
	(0.0216)	(0.0171)	(0.0211)	(0.0213)	(0.0419)	(0.0287)	(0.0535)
Bleach	0.00274	-0.00619	-0.0209	-0.0191			
	(0.0151)	(0.00867)	(0.0162)	(0.0166)			
Fish	-0.0380	-0.0192	-0.0398	-0.0283			
	(0.0257)	(0.0196)	(0.0297)	(0.0333)			
Post	-0.0367***	-0.0425***	-0.0666***	-0.0602***	-0.0413	-0.0454*	-0.0557
	(0.00913)	(0.00624)	(0.0140)	(0.0139)	(0.0369)	(0.0218)	(0.0524)
Tsunami	0.0399***	0.0367***	-0.0561***	-0.0652***	0.0408	0.0144	-0.0119
	(0.0135)	(0.0120)	(0.0107)	(0.0113)	(0.0463)	(0.0402)	(0.0674)
Constant	0.824***	0.818***	0.0500	0.0800**	0.367***	0.750***	-0.104
	(0.0196)	(0.0183)	(0.0346)	(0.0396)	(0.0558)	(0.0591)	(0.138)
Method	OLS	OLS	OLS	Heckman	FE	FE	FE
HH FE	No	No	No	No	Yes	Yes	Yes
N	7,581	7,581	7,224	7,358	7,581	7,581	7,224

Remarks*: Province clustered standard errors are in parentheses. *, **, and *** denote statistical significance at t*he 0.1, 0.05, and 0.01 levels, respectively. The sample is children who were 7-12 years old in the 1997 and 2007 waves. The dependent variables are dummy variables equal to 1 if a child is currently enrolled in school, if a child has ever enrolled in school, and if a child has ever failed a grade in school. All models include child's sex, and household head's sex, age, and education. Age (in years) and province fixed effects are included in all models. Models 5-7 also contain household fixed effects.

coral bleaching since the 1990s. Precisely, the SST variable in this paper is the number of days a coastal area was exposed to SST higher than the 1°C threshold in the first half of 1998. This variable is calculated from NOAA's hotspot maps which are available every 1-7 days depending on geographical locations.

The SST days treatment variable does not suffer from under-reporting as it was constructed from comprehensive satellite maps. However, the SST anomaly days is not perfectly correlated with the actual bleaching events. Even though SST is the most important trigger for coral bleaching, other factors, such as light, also affect the bleaching process.

Tables A4–A6 demonstrate results using the SST anomaly variable. These results are very similar to the results from the main specifications albeit lower statistical powers. This implies that measurement errors in coral bleaching measures are not a major identification threat. In addition, Chaijaroen (2019) also used both measures of coral bleaching to estimate the effects on income and consumption and found that the estimates from the two measures were similar.

Table A4. Effects of coral bleaching on fertility using SST anomalies

	(1)	(2)	(3)	(4)
	Newborns	Newborns	Newborns	Newborns
SST*Fish*Post1	0.00112*	0.00115	0.00108	0.00104
	(0.000596)	(0.000711)	(0.000770)	(0.000945)
SST*Fish*Post2	0.000387	0.000666	0.000511	0.000488
	(0.000693)	(0.000645)	(0.000812)	(0.000932)
SST*Fish	-0.000147	-0.000127	0.00121	0.00244**
	(0.000333)	(0.000339)	(0.00115)	(0.000999)
Fish*Post1	-0.0339	-0.0246	-0.0204	-0.0181
	(0.0317)	(0.0363)	(0.0361)	(0.0449)
Fish*Post2	-0.0226	-0.0175	-0.00166	0.00117
	(0.0297)	(0.0247)	(0.0331)	(0.0288)
SST*Post1	-0.000427**	-0.000350	-0.000333	-0.000236
	(0.000191)	(0.000208)	(0.000270)	(0.000262)
SST*Post2	-0.000120	-0.000129	-0.000112	-0.000177
	(0.000263)	(0.000265)	(0.000267)	(0.000254)
SST	-0.000225	-0.000267*	-0.000402	-0.00116
	(0.000138)	(0.000149)	(0.000413)	(0.000727)
Constant	1.743***	1.776***	1.851***	1.824***
	(0.0931)	(0.0946)	(0.135)	(0.156)
HHH characteristics	No	Yes	No	Yes
Woman FE	No	No	Yes	Yes
N	24,079	21,012	24,079	21,012

Remarks: Province-clustered standard errors are in parentheses. *, **, and *** denote statistical significance at the 0.1, 0.05, and 0.01 levels, respectively. The sample is women who were 17–51 years old in 1993, 1997, 2000, and 2007 waves of data. The dependent variables are the number of children born within 19 months of the earliest interview date. All models include the woman's age, education, and marital status. Columns 2 and 4 also include household head's sex, education, and age. Wave and province fixed effects are included in all models. Columns 3 and 4 also contain family fixed effects.

Table A5. Regression results on anthropometric outcomes in 2000 using SST anomalies

	(1) WHZ	(2) HAZ	(3) Wasting	(4) Stunting	(5) WHZ	(6) HAZ	(7) Wasting	(8) Stunting
SST*Fish*Post	0.00783	-0.00771	0.000494	0.000739	0.00763	-0.000708	0.00100	0.00279
	(0.00659)	(0.00650)	(0.000385)	(0.000754)	(0.00932)	(0.0105)	(0.000780)	(0.00189)
Fish*Post	-0.0539	-0.166	-0.0413	0.0274	0.0341	-0.219	-0.0386	-0.0428
	(0.332)	(0.260)	(0.0253)	(0.0393)	(0.664)	(0.690)	(0.0542)	(0.119)
SST*Fish	-0.00554	0.0124*	-0.000387	-0.00246**	-0.0116	0.0228	-0.000860	-0.00785**
	(0.00533)	(0.00684)	(0.000374)	(0.000957)	(0.00778)	(0.0185)	(0.000963)	(0.00278)
SST*Post	0.000577	0.000543	-0.000337**	-0.000390	-0.00134	0.00359	-0.000206	-0.000760
	(0.00201)	(0.00308)	(0.000134)	(0.000394)	(0.00237)	(0.00637)	(0.000348)	(0.000730)
SST	-0.00172	-0.00141	0.000298*	0.000723	0.00358	-0.00654	0.000256	0.00251*
	(0.00132)	(0.00198)	(0.000142)	(0.000479)	(0.00323)	(0.00860)	(0.000818)	(0.00141)
Fish	0.191	-0.128	0.00942	-0.00367	-0.756	0.723	0.0228	-0.0355
	(0.316)	(0.247)	(0.0238)	(0.0557)	(0.667)	(1.800)	(0.0465)	(0.209)
Post	-0.0763	0.119	0.00151	-0.0187	-0.0186	0.119	-0.0107	-0.0308
	(0.0778)	(0.104)	(0.00648)	(0.0155)	(0.150)	(0.204)	(0.0218)	(0.0294)
Constant	-0.821	-11.78***	0.103	2.196***	0.139	-13.89***	-0.197	1.961***
	(0.807)	(0.949)	(0.0602)	(0.161)	(3.655)	(2.157)	(0.366)	(0.541)
HH FE	No	No	No	No	Yes	Yes	Yes	Yes
N	5,781	4,994	5,781	4,994	5,781	4,994	5,781	4,994

Remarks: Province clustered standard errors are in parentheses. *, **, and *** denote statistical significance at the 0.1, 0.05, and 0.01 levels, respectively. The sample is children who were 0-5 years old in the 1997 and 2000 waves. The dependent variables are standardized weight-for-height (WHZ) and height-for-age (HAZ), and dummy indicators for severe malnutrition based standardized weight-for-height and height-for-age ($Z < -3$, wasting and stunting, respectively). All models include race, household head's gender, age, and education, as well as mother's education and height as control covariates. Age and province fixed effects are also included in all models. Models 5-8 also contain household fixed effects.

Table A6. Effects of coral bleaching on schooling outcomes in 2007 using SST anomalies

	(1)	(2)	(3)	(4)	(5)	(6)
	Enroll	Ever Enrolled	Fail	Enroll	Ever Enrolled	Fail
SST*Fish*Post	0.000895	0.000808*	0.00208**	0.00178	0.00113	0.00169
	(0.000931)	(0.000450)	(0.000782)	(0.00148)	(0.000782)	(0.00351)
Fish*Post	-0.0119	-0.0691**	-0.0375	-0.0119	-0.0450	-0.139
	(0.0577)	(0.0300)	(0.0414)	(0.0917)	(0.0526)	(0.207)
SST*Fish	0.000186	0.000167	0.0000372			
	(0.000904)	(0.000358)	(0.000636)			
SST*Post	-0.000145	-0.000179*	0.000491*	0.000115	0.000209	-0.0000363
	(0.000169)	(0.0000974)	(0.000257)	(0.000515)	(0.000381)	(0.000728)
SST	0.000151	0.0000736	-0.000600***			
	(0.000189)	(0.000121)	(0.000179)			
Fish	-0.0910*	-0.0334	-0.0328			
	(0.0486)	(0.0207)	(0.0307)			
Post	-0.0351***	-0.0395***	-0.0710***	-0.0490	-0.0510*	-0.0531
	(0.00849)	(0.00581)	(0.0131)	(0.0393)	(0.0249)	(0.0536)
Constant	0.812***	0.807***	0.0741**	0.356***	0.745***	-0.1000
	(0.0203)	(0.0191)	(0.0347)	(0.0536)	(0.0592)	(0.137)
HH FE	No	No	No	Yes	Yes	Yes
N	7,581	7,581	7,224	7,581	7,581	7,224

Remarks: Province clustered standard errors are in parentheses. *, **, and *** denote statistical significance at the 0.1, 0.05, and 0.01 levels, respectively. The sample is children who were 7-12 years old in the 1997 and 2007 waves. The dependent variables are a dummy variable equal to 1 if a child is currently enrolled in school, a dummy variable equal to 1 if a child has ever enrolled in school, and a dummy variable equal to 1 if a child has ever failed a grade in school. All models include child's sex, and household head's gender, age, and education. Age (in years) and province fixed effects are included in all models. Models 4-6 also contain household fixed effects.

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