

The butterfly effect: A propensity score matching analysis of social transfers and their impact on child development

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Introduction

- ❑ Social transfers (STs) have significantly increased in developing nations.
- ❑ Policy intervention for eradicating poverty, improving consumption, educational attainment, and fostering human development
- ❑ Provision of STs in the households, act as a butterfly effect (Lorenz,1963).
- ❑ Early childhood development (ECD) is one of the main areas where STs have been used as they have improved child's development (Gitter et al.,2011).
- ❑ STs are intended to promote the development of human capital in both early children (aged 5 and younger) and older, school-aged children (aged 6–15) (Gitter et al.,2011).

Early childhood development

- ❑ A child's health, education, and income are shaped by their early years (Likhar et al.,2022) as these years are crucial for human capital production (Cunha & Heckman, 2008).
- ❑ The social-emotional, cognitive, and sensory-motor domains are a few factors that make up child's development from birth to age five (Zaneva et al.,2022).
- ❑ It builds the groundwork for future productivity, health, and well-being
- ❑ Due to poverty, children encounter crucial developmental delays and struggle to develop cognitively to their full potential (Grantham-McGregor et al.,2007).
- ❑ Investments
 - improved cognitive outcomes and other domains of development (Sosu & Pimenta, 2023).
 - improved wages, increased job opportunities, and greater wellness for individuals (Heckman, 2007).

Problem statement

- ❑ 3.3 million children in Pakistan endure child labor, denying them youth, health, and education (PBS, 2017).
- ❑ 54% of under-five children face stunted growth; rural boys suffer more than urban girls (UNICEF, 2017).
- ❑ Four out of ten children under five are stunted in Pakistan, while 17.7% suffer from wasting. Almost one in three children is under-weight (28.9%) (NNS, 2018).

Significance and Research gap

□ Significance

- In Punjab province, merely 27.9% of children received early stimulation, and only 59.4% were developmentally on track (UNICEF, 2022).
- Overweight prevalence in children under five nearly doubled from 5% in 2011 to 9.5% in 2018 (NNS, 2018).
- 14% of children aged 24 to 59 months faced functional difficulties: 1.8% with vision, 2.2% with hearing, 3.5% with mobility, 5.3% with memory, 10.2% with self-care, and 6.8% with communication (NNS, 2018).

□ Research gap

- This study addresses the gap by employing Propensity Score Matching (PSM) to establish causal relationships.
- Rather under-documented area of research in Pakistan.

Research objective

- The primary research objective of this study is to investigate and analyse the relationship between social transfers and early child development outcomes in the Punjab region of Pakistan using propensity score matching analysis.

Literature review

Author	Data	Methodology	Key findings
(Grantham-McGregor et al., 2007)	Data gathered from 51 countries	Comprehensive analysis of available literature	Nutrition, health, cognitive stimulation, and the quality of caregiving they receive play a crucial role in shaping a child's cognitive abilities, physical well-being, and socio-emotional development.
(Macours et al., 2012)	Data was collected from Atención a Crisis pilot program implemented between November 2005 and December 2006 in six municipalities in rural Nicaragua	Intent-to-treat regression, seemingly unrelated regressions (SUR)	Findings imply that cash transfer programs combat poverty and support early childhood development.
(Fernald et al., 2008)	Data gathered on the basis of Oportunidades program of Mexico in 1998	linear and logistic regression	Cash transfers was associated with children doing better on a scale of motor development, three scales of cognitive development, and with receptive language

Continue

Author	Data	Methodology	Key findings
Sha et al., 2018	Data gathered from China Health and Retirement Longitudinal Study (CHARLS)	Latent growth curve models	Socioeconomic factors throughout early life have long-lasting effects on cognitive well-being among individuals in the Chinese community. Moreover, the SES experienced throughout childhood has substantial ramifications for cognitive ability during adulthood.
Fernald et al., (2017)	Data gathered through parenting support program (Educación Inicial-EI) combined with Mexico's CCT program which included 1113 children from 204 communities	Cluster randomized trial	There were significant differences in cognitive outcomes between children living in communities where the parenting program was supported by the CCT.
(Sudfeld et al., 2021)	Primary data was collected from pregnant women and mother/ caregiver–infant pairs who lived in the 12 selected villages in the Ifakara Health Institute Health and Demographic Surveillance System (HDSS)	Single blind, cluster-randomized controlled experiment	CHW (community health worker) combined with CCT intervention had favorable impacts on the cognitive development of children when compared to the control group.

Data

- ❑ Multiple indicator cluster survey MICS 2018 developed by UNICEF.
- ❑ Covering all 36 districts of Punjab, including both rural and urban households
- ❑ It gathered household-level data on various dimensions, including health, development of children and women, external economic assistance, education measures, and more.
- ❑ The data covers approximately 40% of household-based indicators related to the SDGs.
- ❑ Specifically, it included data on 39,799 children under the age of five, allowing for a comprehensive analysis of early child development.

Variables

Outcome variable

- child development

Treatment variable

- Social Transfer

Covariates

- Living standard
- Region
- Recreational time
- Mother's birthorder
- Parents disability
- Mother's education
- Child's birth order
- Child's education
- Child's disability

Modelling approach

- ❑ Propensity score matching (PSM)
- ❑ Quasi-experimental design which was defined by (Rosenbaum & Rubin, 1983) where the treated unit was matched with a non-treated unit that shares similar properties for creating an artificial control group.
- ❑ PSM, unlike multivariate regression, allows for the elimination of linearity assumptions and exhibit a higher level of empirical efficacy.
- ❑ $p(x) = \frac{P(T=1)}{x} = E(T/x)$
- ❑ The pairing of children is determined by the factors that are common to both the treated and control groups.

Cont.

- ❑ We constructed different groups:
 - Households received treatment but child development is off track
 - Households received treatment but child development is on track
- ❑ Chaos theory's "Butterfly Effect"
 - Minute variations in the exposure to social transfers throughout early infancy can have significant consequences on a variety of developmental domains.
- ❑ Various matching estimators were employed to facilitate impact analysis:
 - Nearest-Neighbor Matching (NNM),
 - Radius Matching (RM),
 - Caliper Matching (CM),
 - Kernel Matching (KM)
 - Mahalanobis Distance Kernel Matching (MDKM)

Matching estimators

□ Nearest-Neighbor Matching (NNM)

- Well-known method for reducing selection bias in observational studies.
- Minimizes the absolute difference between the predicted propensity scores for the control group and the treatment group.
- The matched counterpart from the comparison group is picked based on the nearest neighbor with a propensity score that is closest to that of the treated individual

□ Caliper Matching (CM)

- If the nearest neighbor is far away, NNM may produce unsatisfactory results. This can be avoided by imposing a tolerance level (caliper) on the utmost propensity score distance.
- Avoids poor pairings, so the matching quality improves

□ Radius Matching (RM)

- Considers not only the closest neighbor within each caliper but also includes any comparable individuals found within the caliper.
- Boosts the accuracy of calculating treatment effects by properly regulating the proximity of propensity scores, hence reducing the possibility for bias.

Continue

□ Kernel Matching (KM)

- A non-parametric matching estimator that generates counterfactual outcomes by calculating the weighted averages of all control group households
- Weights are determined by the magnitude of the difference between the treated and comparison groups' propensity scores.

□ Mahalanobis Distance Kernel Matching (MDKM)

- Through kernel weighting, MDKM provides more precise treatment effect estimates by utilizing information from the entire control group
- Mahalanobis distance determines the distance between two points, which are treated and controlled. The kernel function allocates weights to matched individuals based on the Mahalanobis distance, with higher weights to children who are closer and lower weights to those who are farther away

Econometric Model

□ The simple regression model developed in this study is:

$$\begin{aligned} (\text{Early child development})_{i_{DEV, UDEV}} = & (\text{social transfers})_{ij} + \beta_0 + \beta_1(\text{recreational time}) \\ & + \beta_2(\text{mother's birthorder}) + \beta_3(\text{region}) + \beta_4(\text{mother's education}) + \beta_5(\text{caretaker's disability}) \\ & + \beta_6(\text{child's disability}) + \beta_7(\text{child's birthorder}) + \beta_8(\text{child's education}) + \beta_9(\text{Living Standard}) + e \end{aligned}$$

Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
<i>Household characteristics</i>					
<i>Living standard</i>	42408	.373	.484	0=high	1=low
<i>Region</i>	42408	.266	.442	0=rural	1=urban
<i>Parental characteristics</i>					
<i>Recreational time</i>	42408	.029	.167	0=no	1=yes
<i>Caretaker's disability</i>	42408	.02	.14	0=no	1=yes
<i>Mother education</i>	39593	.582	.493	0=no	1=yes
<i>Mother birthorder</i>	42408	.167	.373	0=later born	1=first born
<i>Child specific characteristics</i>					
<i>Child disability</i>	23808	.064	.245	0=no	1=yes
<i>Child education</i>	15996	.334	.472	0=no	1=yes
<i>Child birthorder</i>	42408	.586	.493	0=>1 child	1=1 child
<i>Outcome variable</i>					
<i>child dev</i>	7218	.317	0.465	0=not on track	1=on track

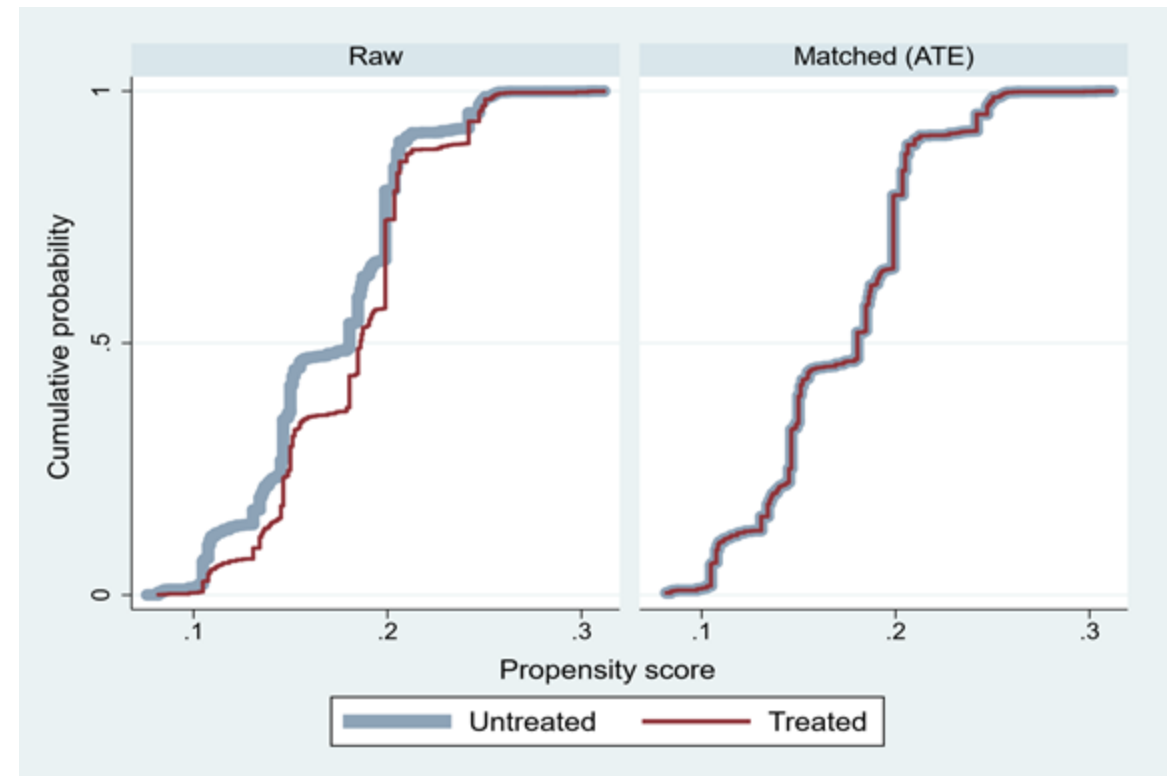
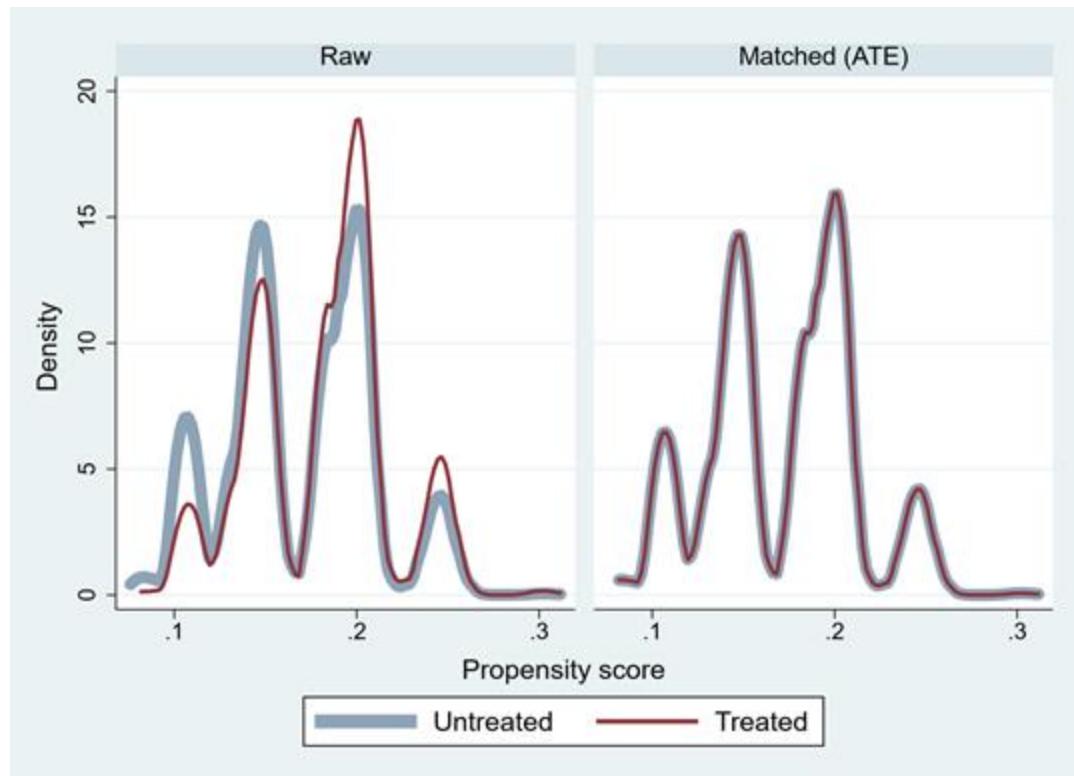
Balancing test of differences in outcome variable

<i>Complete sample</i>	<i>Untreated</i>	<i>Treated</i>
<i>N</i>	35190	7218
<i>Mean</i>	0.302	.317
<i>Difference</i>	-.014	
<i>S.E</i>	.006	
<i>t-value</i>	-2.4	

Matching summary

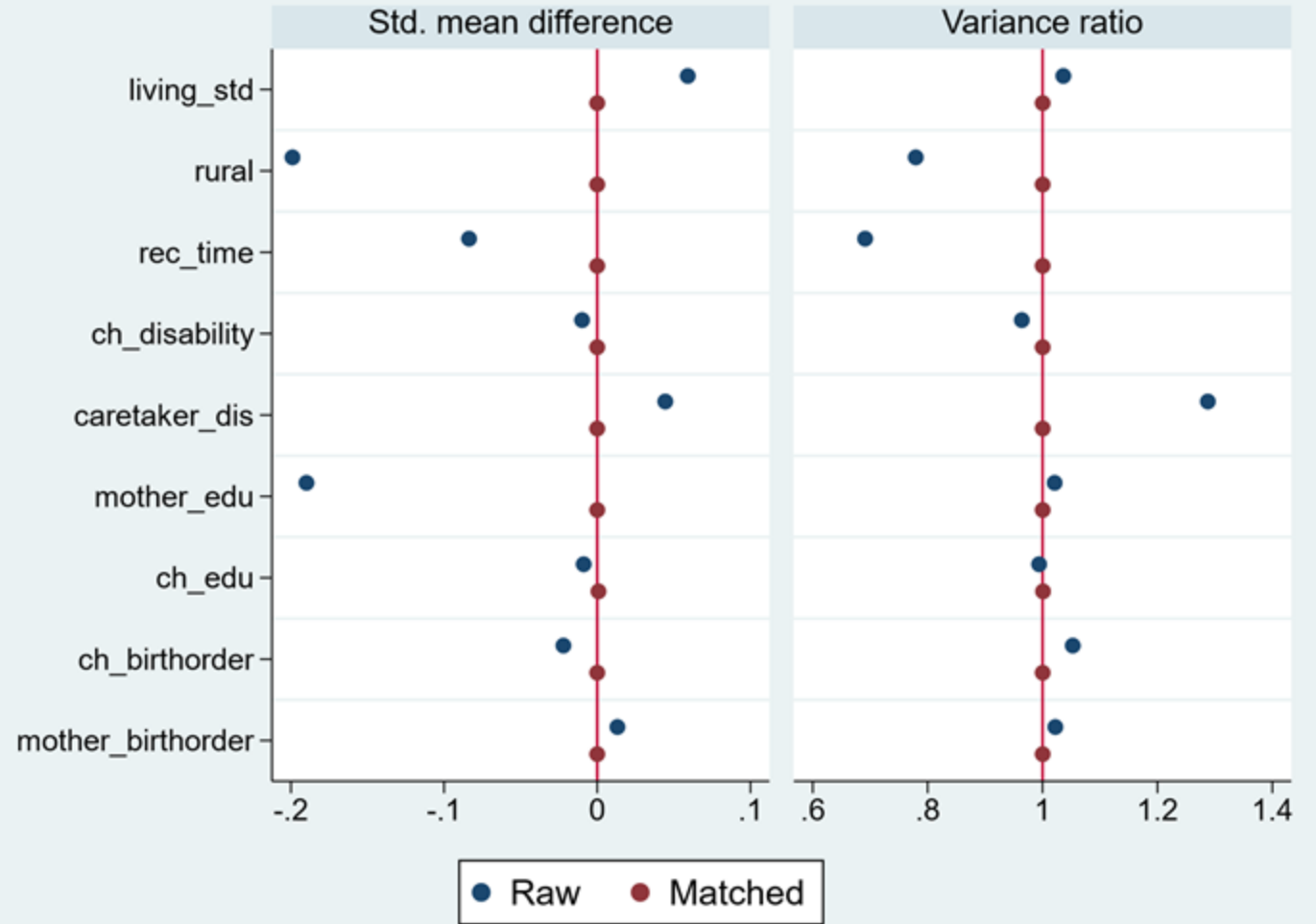
N. treated	N. control	ATT			ATE		
(1)	(2)	Coef.	S.E	t stat	Coef.	S.E	t stat
		(3)	(4)	(5)	(6)	(7)	(8)
Mahalnobis distance kernel matching method							
2693	13008	0.030	0.008	3.660	0.022	0.008	2.660
Mahalnobis-distance nearest neighbor matching method							
2693	13011	0.029	0.008	3.500	0.027	0.008	3.190
Propensity-score kernel matching method							
2693	13004	0.027	0.008	3.330	0.028	0.008	3.410
Kernel matching with bootstrap method							
2693	13004	0.027	0.009	3.150	0.028	0.009	3.220
Nearest neighbor matching method							
2693	12795	0.029	0.008	3.507	0.026	0.008	3.26
Caliper matching method							
2688	13011	0.827	0.008	3.530	0.827	0.008	2.650
Radius-caliper matching method							
2693	13011	0.827	0.008	3.460	0.827	0.008	2.650

Density balancing plots



Balancing statistics

- The plot clearly demonstrates that the balance was suboptimal before the matching process.
- However, after performing full matching, there was a noticeable improvement in balance across all covariates.
- Variance ratio near 1 signifies a suitable level of balance. Similarly, SMDs should have absolute values below 0.1 and 0.05.



Regression analysis

Variables	Coefficient	Std.Err	Z	P>z	[95% Conf.	Interval]
Low living standard	0.327	0.048	6.760	0.000	0.232	0.422
Region	-0.228	0.060	-3.780	0.000	-0.346	-0.110
Recreational time	-0.273	0.117	-1.150	0.250	-0.363	0.094
Education	-0.179	0.050	-3.590	0.000	-0.277	-0.081
Disability	0.299	0.130	2.300	0.021	0.044	0.554
Mother birthorder	0.039	0.057	0.690	0.492	-0.073	0.152
Child disability	0.039	0.094	0.410	0.680	-0.146	0.223
Child's education	0.060	0.048	1.250	0.213	-0.035	0.155
Child birthorder	-0.041	0.068	-0.600	0.548	-0.174	0.092

Logistic regression

child development	Odds Ratio	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Social transfers	1.206	.068	3.30	.001	1.079	1.347	***
Living standard	1.137	.053	2.78	.006	1.038	1.245	***
Area	1.268	.064	4.70	0	1.148	1.4	***
Recreational time	.856	.082	-1.63	.103	.709	1.032	
Child disability	.561	.042	-7.64	0	.484	.651	***
Caretaker disability	.8	.099	-1.81	.07	.628	1.019	*
Mother's education	1.196	.053	4.06	0	1.097	1.304	***
Child's education	2.149	.108	15.25	0	1.948	2.372	***
Child's birthorder	1.334	.079	4.86	0	1.188	1.499	***
Mother's birthorder	.921	.049	-1.56	.12	.831	1.022	
Constant	2.281	.143	13.17	0	2.017	2.578	***

Marginal effects

			Delta-method			
Variables	dy/dx	Std.Err.	z	P>z	[95%Conf.	Interval]
Social transfers	0.028	0.008	3.300	0.001	0.011	0.045
Living standard	0.019	0.007	2.780	0.005	0.006	0.033
Area	0.036	0.008	4.700	0.000	0.021	0.050
Recreational time	-0.023	0.014	-1.630	0.103	-0.051	0.005
Child disability	-0.086	0.011	-7.680	0.000	-0.109	-0.064
Caretaker disability	-0.033	0.018	-1.810	0.070	-0.070	0.003
Mother's education	0.027	0.007	4.070	0.000	0.014	0.040
Child's education	0.115	0.007	15.400	0.000	0.100	0.129
Child's birthorder	0.043	0.009	4.860	0.000	0.026	0.061
Mother's birthorder	-0.012	0.008	-1.560	0.120	-0.028	0.003

Conclusion

- ❑ Using a propensity score matching approach to correct for selection bias, this study has demonstrated the potential influence of social transfers on child development outcomes in Pakistan.
- ❑ Propensity score matching (PSM) method is seen more favorable in comparison to conventional regression analysis because it not only removes the assumption of linearity but also exhibits higher empirical efficacy.
- ❑ The results suggest that social transfers exert a positive and statistically substantial impact on various dimensions of child development, encompassing cognitive and socioemotional domains, as well as overall well-being.

Policy recommendation

- ❑ Parental support programs such as integrating parent education courses, parenting tools, and guidance on child-rearing methods into social transfer projects, caregivers can be empowered to enhance their ability to support the cognitive, social, and emotional development of their children.
- ❑ In order to enhance the positive impacts of social transfers on children's wellbeing, community-based support networks can be strengthened. This will result in a loving atmosphere.

Thank you!

