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Jana Brandt

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Coordination: Bernd Hayo • Philipps-University Marburg
School of Business and Economics • Universitätsstraße 24, D-35032 Marburg
Tel: +49-6421-2823091, Fax: +49-6421-2823088, e-mail: hayo@wiwi.uni-marburg.de

Large Scale Land Investments: Impact on Child Health

Jana Brandt*

This paper investigates the impacts of large scale land investments on the health of children. I use household data of the 2005 and 2011 Demographic Health Surveys (DHS) for Ethiopia and combine them with information of large scale land investment projects provided by the Land Matrix Observatory. This data provides information about the location of the land investments and about the location of children. With this information I develop an index that indicates the level of investment intensity for each child's residential area. Taking advantage of the repeated cross sectional structure of the DHS data, I estimate the effect of an increase in the investment intensity of a child's residential area and how this effect changes over time. The results indicate that the effect is negative for children born between 2000-2005, but it rises over time by getting less negative or even positive for children born between 2006-2011. The difference-in-differences estimation with Gaussian kernel propensity score matching shows a benefit in the development status of children that are exposed to large scale land investments.

This paper investigates the impacts of the recent wave of large scale land investments on the health of Ethiopian children that are exposed to such investments. I use household data of the 2005 and 2011 Demographic Health Surveys (DHS) for Ethiopia and combine them with information of large scale land investment projects provided by the Land Matrix Observatory. This data allows to identify

*Justus Liebig University Giessen, Department of Economics and Business, Licher Straße 64, 35394 Gießen, Germany. Tel.: +49 641 99-22642. E-mail: jana.brandt@wirtschaft.uni-giessen.de.

the location of the land investments as well as the location of children born between 2000-2011. I use these information to construct an index that indicates the level of investment intensity for each child's residential area. Taking advantage of the repeated cross sectional structure of the DHS data, I estimate the effect of an increase in the investment intensity of a child's residential area and how this effect changes over time. The results indicate that the effect is negative for children born between 2000-2005, but it rises over time by getting less negative or even positive for children born between 2006-2011. The difference-in-differences estimation with Gaussian kernel propensity score matching shows a benefit in the development status of children that are exposed to large scale land investments.

JEL Classification Codes: I15, O12, Q15

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1 Introduction

Rising commodity prices, production of biofuels and the lack of secure and efficient investment opportunities in time of the financial crisis has led to a sharp increase of the demand for agricultural land. Since 2007/2008, investors from industrialized and emerging countries acquire large areas of suitable agricultural land in Sub-Sahara Africa, Latin America and East Asia (FAO (2013)). In addition to the often mentioned investments of first world countries, the group of investors contains mainly sovereign wealth funds, private investors, banks, and players of the agribusiness industry (Cotula (2013)). The effects of the recent increase of large scale agricultural investments in third world countries is controversially debated in academic literature and public media. On the one hand, the investors could help to overcome the investment gap in third world countries' and therefore foster the development of the important agricultural sector. Resulting spillovers caused, e.g., by infrastructure or educational improvements could enhance the target countries economic development. On the other hand, local people often depend on subsistence farming without having formal property rights for the used land. They could be harmed due to these projects by losing access to land and water resources as well as displacement without proper compensation (White et al. (2012)). This recent wave of investments is therefore often referred to as "land grabbing".

Overall, the actual effects of large scale land investments for local inhabitants in the target countries as well as long term macro-level impacts are not clear. This might be due to the fact that the consequences of the investment projects for target countries are difficult to measure. The time span is too short and big parts of the new investments have not started production yet. Moreover, the investment projects are very heterogeneous in terms of size, intention, and investor type. Empirical analyses of this topic are therefore quite rare and mostly stick to descriptive analyses. This paper provides a first empirical analysis of the effects of the recent large scale land investments in Ethiopia.[1] As the long term effects can not be observed, I analyse the impact of large scale land investment on child health. Child health and development status are good predictors for long term physical and cognitive development of humans and therefore influence the economic status in adult age (Behrman and Rosenzweig (2004)).

To estimate the effects of land investments on child health in Ethiopia, I develop an index that measures the level of exposure to land investments of a specific residential area. The geographic information about the location of investment projects are obtained from Land Matrix

[1] Since 1990 Ethiopian government follows a strategies of market liberalization and tries to attract investments, especially to foster development in the agricultural sector. Ethiopia therefore became one of the main target countries of land acquisitions.

Global Observatory (2015) and the information about children's residential areas are given in the Demographic Health Surveys (DHS). The investment intensity index captures the number and relative size of land investments as well as their relative distance to a specific area. The DHS data are representative household surveys that contain information about children born between 2000-2005 and 2006-2011. The use of repeated cross sectional data allows to analyse whether the impact of an area's investment intensity score on child health changes over time and to what extent these changes are due to the investment projects. First analyses show that an area's investment intensity has a significantly negative impact for children born between 2000-2005, thus before the land investment phase began. This effect diminishes for children born during the investment phase between 2006-2011. The findings obtained by difference-in-differences regressions using Gaussian kernel propensity score matching indicate a positive impact of the recent land investments for the development status of children that are exposed to this investments.

The reminder of this paper is organized as follows. Section 2 provides an overview of the related literature. Section 3 describes the used survey data and the calculation of the investment intensity index. The empirical estimation strategy is given in Section 4, followed by the presentation and discussion of the empirical findings in Section 5. Section 6 concludes.

2 Related Literature

After decades in which the agrarian sector of developing countries received no or little attention by foreign investors, the recent wave of land acquisition raised a controversial debate. The literature on this topic can be structured in four main parts. First, contributions to describe the phenomenon, like the magnitude of the investments and the involved parties.[2] Second, investigations regarding the determinants of large scale land investments.[3] Third, analyses of the consequences for the target countries and fourth, the development of policy implications that foster the potential positive outcomes of such investments.[4] This work contributes to the third group.

[2] See, e.g., Rulli et al. (2013), Cotula et al. (2014), Anseeuw et al. (2012), Von Braun and Meinzen-Dick (2009) and Cotula and Vermeulen (2009) for descriptive analysis of the magnitude, the target countries and the investors.

[3] Until now, there is only limited empirical evidence for the determinants of large scale land investments. But the findings of Arezki et al. (2015) and Osabuohien (2014) point out the relevance of the quality of institutions in the target countries. Countries with weaker institutions have a higher probability of being a target of land investments.

[4] The broad consents for governance implications is, that there is a need for more transparency and that the interests of local inhabitants must be taken into account when investment projects are planed and implemented.

The World Bank (2010) emphasizes that large scale land investments could work in favour of the target countries, by providing massive capital inflows that can promote economic development. Their argumentation is in line with the analysis of the effects of foreign direct investments in developing countries.[5] Potential benefits resulting from an increase in business activities and development of the agrarian sector are the creation of new jobs, infrastructure improvements, and raising food production due to more efficient use of land (White et al. (2012), Azadi et al. (2013), and Collier and Venables (2012)). Moreover, positive spillovers could lead to improvements in health care, education and technical progress.

A more critical view on the effects of large scale land investments claims that these projects will increase the harshness of living conditions for local people. Smallholders and local inhabitants, that depend on subsistence farming could lose access to suitable land and water resources (Rulli et al. (2013) and Mehta et al. (2012)). This process would jeopardize their food security and exacerbate poverty. Moreover, most of the investment projects lack social and environmental sustainability, because of monocultural farming, destruction of rainforest and poor working conditions (Rerkasem et al. (2009), Chamberlin et al. (2014), and Messerli et al. (2014)). I contribute to this strand of literature by analysing the effect of large scale land investments on child health.

The health and development status of children is a widely accepted indicator for income and health outcome in adult live and economic development. Many studies use children's birth weight to measure child health. Behrman and Rosenzweig (2004) and Black et al. (2007) use twin studies to estimate the effect of children's birth weight on adult health and income. Both studies find a positive relationship between birth weight and life time income. Additional to income and health status, Black et al. (2007) find that children with higher birth weights also have higher IQ-scores and are better educated. To investigate whether the relationship between birth weight and income is inherited from one generation to the next, Currie and Moretti (2007) link mother's weight with the birth weight of their children. Their findings indicate, that low income predicts lower birth weights and that this effect is persistent over time. Similar results are obtained by Palloni (2006).

Another widespread measurement for child development is the difference between a child's body height and the body height of the reference median. Such height-for-age-z-scores are,

There is less agreement about the actual steps that can lead to this goal. See Cotula (2013). Hall (2011), Vermeulen and Cotula (2010), De Schutter (2011), Nolte (2014) and Teklemariam et al. (2015) for a discussion of the policy implications.

[5] See Noorbakhsh et al. (2001), Nair-Reichert and Weinhold (2001)and Hansen and Rand (2006) for empirical analyses of the effect of FDI for developing countries.

e.g., used by Alderman et al. (2006) and Akresh et al. (2012) to examine the effect of wars on child health.[6] By using a difference-in-differences approach, they find that children are negatively affected by the war. Following this methodology, I investigate the effect of a large scale land investments on child health status.

3 Data

Analysing the effect of large scale land investments for local inhabitants requires information about the location of these investments and the development status of children that are affected by these investments. For information on child health, I use household data from the 2005 and 2011 Demographic Health Survey waves for Ethiopia. Demographic and Health Surveys collect household data about a wide range of demographic topics like health and nutrition status of children with age below five and their conditions of living. The data also includes information about the children's households, as educational levels of the parents, number of household members, and number of siblings. The surveys also give information about the geographic location of the residence area at time of data collection in form of gps coordinates. The gps coordinates correspond to the centre of a spatial cluster which can be a village in rural or a street in urban areas.[7] For the 2005 survey, 13,721 households with 14,070 females and 9,861 children born between 2000-2005 were interviewed. The data was collected in 535 spatial clusters. The 2011 survey covers 16,702 households with 16,515 females, 11,654 children born between 2006-2011, and 571 spatial clusters.

As early childhood health status is a good indicator for a person's health and cognitive development, I take the height-for-age z-score, which is the deviation of a child's height for age from the median of the reference population[8] measured in numbers of standard deviations as independent variable.[9] Children whose z-score is smaller than -3 are severely stunted, while children whose z-score is between -2 and -2.99 are moderately stunted. On average, children in Ethiopia have a z-score of -1.98 in 2005 and -1.58 in 2011.[10]

[6] For further research on the relationship between child health and human capital or economic growth, see Victora et al. (2008) and Well (2007)

[7] DHS data do not include information about a child's place of residence before the data collection. Lacking this information, I use the given gps coordinates as approximation of children's place of residence for their whole live.

[8] The measures were calculated using the CDC Standard Deviation-derived Growth Reference Curves derived from the NCHS/FELS/CDC Reference Population.

[9] The z-score is included in the DHS Data.

[10] The averages are calculated using sample weights as requested by DHS guidelines.

Information on large scale land investments are obtained from the Land Matrix. The Land Matrix is a global and independent land monitoring initiative collecting and reporting data on land investments that have been initiated since the year 2000. It covers an area of 200 hectares or more and contain information on the potential conversion of land from smallholder production, local community use or important ecosystem service provision to commercial use (Land Matrix Global Observatory (2015)). For Ethiopia, 115 land investments are reported with an overall negotiation size of almost two million hectares.[11] For the purpose of this paper, only projects that have the potential to affect children born in the period 2000-2011 are of interest. Thus, all projects with negotiations starting after 2011 are excluded. Of the remaining 77 projects, the negotiation of 33 started between 2000-2005, yet none of these projects were implemented before 2006. From 2006-2011, 44 project were negotiated and 22 were implemented.[12] It is rather unclear, which of these projects affected children in the time period of interest. Hence, I analyse the effect of four different project subgroups. The first group includes all 44 projects being negotiated between 2006-2011. The second group covers all projects that were negotiated or implemented from 2006-2011. This is with 49 cases the biggest subgroup and it includes some early projects that were negotiated before 2006. The last two groups are more narrow, as the third subgroup contains projects that were implemented between 2006-2011, independent of their negotiation year, and the fourth group consists of all projects negotiated and implemented during 2006-2011. Concerning the location of land investment projects, the Land Matrix solely gives an image of a geographical map with a location tag for every investment project. I used these images to identify the gps coordinates manually and added them to the data provided by The Land Matrix database.

To examine the effect of the recent increase in demand for agricultural land on child health, the data on child development and land investments need to be combined. To do so, I constructed an index IC_i indicating the exposure of a specific child's i residential area to land investments in order to measure to which degree a child is exposed to land investments. The index is calculated based on the four different subgroups of land investment projects.[13] The potential values of this investment intensity index range between 0 and 2, where higher values indicate that a child's residence area experienced higher levels of land investments.[14] The Index is calculated as

[11] The overall size of concluded contracts from year 2000-2015 is somewhat smaller, and about 1.8 million hectares.

[12] The information about the implementation year of the projects is quite weak. Even if the implementation status is reported the year of implementation is often missing.

[13] The distance between cluster c and investment project n is calculated as $D_{cn} = 6378.388 * acos\left[sin(latitude_c) * sin(latitude_n) + cos(latitude_c) * cos(latitude_n) * cos(longitude_n - longitude_c)\right]$.

[14] For Ethiopia the index scores range between 0.457 to 1.167, depending on the used project subgroup.

$$IC_i = \frac{1}{N} \sum_{n=1}^{N} \left[1 - \frac{D_{in}}{D^{max}} + \frac{S_n}{S^{max}} \right], \quad (1)$$

where D_{in} is the distance between child's i area of residence at time of data collection and land investment project n. D^{max} is the maximum distance between area of residence and investment project in the whole sample. N is the number of land investments of the considered subgroup. S_n is the negotiated size of investment project n and S^{max} is the maximum project size in the subgroup. IC_i is therefore increasing in relative size $\left(\frac{S_n}{S^{max}}\right)$ and decreasing in the relative distance $\left(\frac{D_{in}}{D^{max}}\right)$ of land investments. These two variables are combined to take account of the fact that bigger projects may influence child health even if they are further away as well as smaller projects that are in close distance. The score of IC_i shows to what extent child's i residential area is targeted by the recent land investment projects. This does not mean that all children living in the same residential area are equally exposed to land investments, as children were born before and during the investment period.

4 The Econometric Framework

4.1 Baseline Model: The Investment Intensity Score

In the baseline model, I analyse how changes in an area's investment intensity index affects the development status of children living in that area. Furthermore, I investigate whether this effect is the same for children born between 2000-2005, and therefore before the demand for agricultural land increased, and children born between 2006-2011. The empirical estimation strategy is given in equation (2).

$$\begin{aligned} haz_{ijet} = \alpha_j + \alpha_e + \alpha_t + \alpha_{jt} + \gamma_0 W2011_i + \beta_1 IC_i \\ + \beta_2 W2011_i * IC_i + \beta_3 X_i + \epsilon_{ijet}, \end{aligned} \quad (2)$$

where haz_{ijet} is the height-for-age z-score of child i in region j with ethnicity e that was born in year t. α_j, α_e, and α_t are region, ethnicity, and birth cohort fixed effects and α_{jt} are region specific time trends. The variable IC_i reflects the investment intensity index score for the residence area in which child i lived at time of measurement and X_i is a set of individual and household characteristics including child gender and age in years, mothers body height in centimetres, number of household members, number of children younger than five living in the household, highest educational level of the mother and her partner, age of the household head, and whether region of living is urban or rural. ϵ_{ijet} is a random, idiosyncratic error term. $W2011_i$ is a dummy variable that equals one if the child is part of the 2011 DHS wave and zero if it is part of the 2005 wave. The coefficient γ_0 therefore measures DHS wave specific fixed effects. The coefficient β_1 measures the marginal effect of changes of an area's investment intensity score for children living in that area and born between 2000-2005. The sum of β_1 and β_2 measures this effect for children that were born during the land investment phase from 2006-2011. So β_2 shows how the effect of the residential areas investment intensity has changed over time.

As it is not clear at which project stage investments start to impact local living conditions, I estimate the baseline model in equation (2) using all four different subgroups of investment projects to calculate the investment intensity index as outlined in Section 3. For further robustness checks, I excluded Tigray and Affar in the north of Ethiopia, as these regions are in the border region to Eritrea and therefore disproportionally affected by the Ethiopia Eritrea war. Moreover, changes in the impact of land investment intensity could be due to investment projects that were negotiated before 2006. According to the Land Matrix, 33 projects were negotiated before 2006, but lack clear information on the implementation status. The assumption that none of this projects were implemented between 2006-2011 might be problematic. I therefore excluded all children from the sample that lived in an area with more than one of this 33 projects in an 10 kilometre radius.

4.2 Difference-in-Differences Model: Linear and non Parametric Estimation

To complement the baseline model, I also estimate a linear and a non parametric version of the difference-in-differences model. For the non parametric version, I used kernel-weighted polynomial regression with Gaussian kernel matching. Using the difference-in-differences approach allows to investigate, which changes in the height-for-age z-scores are due to large scale land investments. For the estimation, the sample of children born between 2000-2011 is divided in a treatment and non-treatment (control) group, where treatment is living in an investment intensive area. The treatment group contains all children of both DHS waves that live in an area with an investment intensity index that is equal or bigger than a certain threshold. As the threshold level is less clear cut, I define different treatment indicators depending of varying levels of the investment intensity index. The regression equation is as follows:

$$
\begin{aligned}
haz_{ijet} = \alpha_j + \alpha_e + \alpha_t + \alpha_{jt} + \gamma_0 W_{2011} + \beta_1 InvestmentIntensiveArea_i \\
+ \beta_2 W_{2011} * InvestmentIntensiveArea_i + \beta_3 X_i + \epsilon_{ijet}.
\end{aligned} \tag{3}
$$

As in equation (2) haz_{ijet} is the height-for-age z-score of child i in region j with ethnicity e that was born in year t and α_j, α_e, α_t, and α_{jt} are fixed effects for region, ethnicity birth cohort and region specific time trends. Additionally, γ_0 measures the DHS wave fixed effect. The regression of equation (3) also includes age fixed effects. X_i covers the same individual and household characteristics like it does in the baseline model except child age and ϵ_{ijet} is a random, idiosyncratic error term. In contrast to the continues variable IC_i used in the baseline model, the variable $InvestmentIntensiveArea$ is a dummy variable that equals one for children in the treatment group and zero for children in the control group.

The coefficient γ_0 captures changes in all height-for-age z-scores from 2005 to 2011, and β_1 shows the difference in the height-for-age z-scores between children of the control and treatment group that were born between 2000-2005. For children born between 2006-2011 the effect of living in an investment intensive area is $\beta_1 + \beta_2$. When the increase in demand for land had no impact on the height-for-age z-scores, then the difference between treatment and control group is constant over time and β_2 is zero. Hence, the parameter β_2 measures the change in height-for-age z-scores due to the investment projects.

The simple linear regression of the difference-in-differences model assumes that treatment is randomized and children in the treatment and in the control group are therefore not systematically different from each other except of their treatment status. If that was the case, the results for the difference-in-differences estimator β_2 of equation (3) would show the average change in the height-for-age z-score due to the land investment projects. For non random treatment, children in the treatment and control group would differ in their probability of receiving the treatment. Matching treatment and control units based on this probability can help to overcome this sample selection problem. Moreover, for the case of exposure to land investments, the distinction between treatment and control group is not absolutely clear. To overcome this selection problem, I use kernel propensity score matching[15] for pairing treatment and non

[15]In Ethiopia the majority of large scale land investment takes place in rural areas with lower proportion of non educated people in the regions Amhara, Oromia, Benshangul-Gumaz, SNNP, and Gambela Peoples. This variables are therefore used to estimate the propensity score. I also include mother's height and a dummy variable that indicates whether the mother has any kind of education to reflect the impact of institutional quality of the different regions. See e.g. Dehejia and Wahba (2002) or Smith and Todd (2005) for discussion

treatment units to estimate the average treatment effect for the treated group.

5 Empirical Evidence on the Effect of Large Scale Land Investments

5.1 Baseline Model

5.1.1 Baseline Estimation: The Investment Intensity Score

The main estimation results from the baseline model outlined in equation (2) using different specifications of the investment intensity index are presented in Table 1. All estimations include the full set of household and child characteristics, region and birth cohort fixed effects as well as region specific time trends.[16] Column 1 shows the results for the first subgroup of investment projects that includes all projects that where negotiated between 2006-2011 into account to calculate the investment intensity index. The coefficient of IC_i shows that, for children born between 2000-2005, an increase in the investment intensity index of a child's residence area by 0.1 units reduces this child's height-for-age z-score by 0.1144 units.[17] The coefficient of $W2011_i * IC_i$ indicates that this effect changed significantly over time. For children born between 2006-2011 the impact of an increase in the investment intensity index is the sum of the coefficients of $W2011_i * IC_i$ and IC_i. Hence, an increase in the investment intensity index by 0.1 units raises the average height for z-score of children living in that area by 0.075 units.[18]

For the estimation results in column 2, the investment intensity of residential areas is measured by the investment intensity index based on all projects that were implemented or negotiated in the period 2006-2011 (second subgroup). The results are very similar to those presented in column 1, however the joint effect of IC_i and $W2011_i * IC_i$ is only significant at the 10% level. Column 3 shows the regression outcome using only projects that were implemented during 2006-2011 (third subgroup). This approach is based on the assumption that projects in planning or start up phase do not matter for the height-for-age z-score. The results point in the same direction as the specifications in column 1 and 2, but the estimates are less significant. The effect of living in an investment intensive area is significantly less negative for

of variable choice for propensity score estimation.

[16]The complete results are shown in Table 4 in the Appendix.

[17]The results are interpreted for 0.1 unit changes of the investment intensity index as it ranges just between 0-2.

[18]F-test performed on the the coefficients of IC_i and $W2011_i * IC_i$ rejects the hypotheses that the coefficients are jointly zero at the 5% level.

children born between 2006-2011 compared to children born between 2000-2005, but it is not significantly positive. The last version of the investment intensity index is calculated taking only projects into account that have been negotiated and implemented between 2006 and 2011 (fourth subgroup). With this most narrow definition of the investment intensity index, the estimated effect of rising investment intensity score on height-for-age z-score is still significantly changing over time. However, the effects are smaller compared to the results in columns 1 and 2.

Table 1: Baseline model with different specifications of the investment intensity index

haz_{ijet}	subgroup 1	subgroup 2	subgroup 3	subgroup 4
$W2011_i$	-0.735	-0.659	-0.533	-0.709
	(0.591)	(0.606)	(0.611)	(0.577)
IC_i	-1.144*	-1.261*	-1.115*	-0.956**
	(0.660)	(0.707)	(0.586)	(0.483)
$W2011_i * IC_i$	1.894**	1.782**	1.275*	1.431***
	(0.743)	(0.791)	(0.653)	(0.545)
Observations	12,797	12,797	12,797	12,797
Adjusted R^2	0.206	0.206	0.206	0.206
Region specific time trends	Yes	Yes	Yes	Yes
Birth cohort fixed effects	Yes	Yes	Yes	Yes
Region fixed effects	Yes	Yes	Yes	Yes
Household and child characteristics	Yes	Yes	Yes	Yes

Notes: Clustered standard errors in parentheses. *significant at 10%, **significant at 5%, ***significant at 1%. All estimations including child and household characteristics.

Summing up, the results in Table 1 point out that the investment intensity score of a residential area influences the development status of children living in that area. This effect changed significantly over time getting less negative or even significantly positive depending on the calculation of the investment intensity index. Section 5.1.2 presents some further robustness checks which account for the impact of the Ethiopian Eritrean War and investment projects that possibly started before the year 2006.

5.1.2 Baseline Estimation: Robustness Checks

The sample of children used to estimate the baseline model, as presented in Table 1, includes all regions of Ethiopia.[19] But this approach could lead to biased results, because it neglects the fact that children are likely to be unevenly affected by the Ethiopian Eritrea War. Changes in the effect of living in a specific area could be due to recovery from war instead of the land investment projects. I therefore excluded the border regions Tigray and Affar from the regression as they were severely exposed to the war. The results are presented in Table 5, where the columns present the estimates based on the four different specifications of the investment index corresponding to the results in Table 1 and 4.

By excluding the war regions, the coefficient of IC_i becomes insignificant for the first three subgroups of the investment intensity index.[20] Thus, a residential area's investment intensity score has no significant effect for the height-for-age z-score of children born between 2000-2005. One reason for this result is the harmonization of regions by eliminating the war regions. The coefficient β_2 is significantly positive for all specifications of the investment intensity index. Hence, the effect of the investment intensity of a residential area on the height-for-age z-scores of children living in that area is still changing over time.

Another potential issue for interpreting the baseline regression results might be the implicit assumption that children born between 2000-2006 were not exposed to land investment projects. As mentioned in section 3, no projects were implemented before the year 2006. But the negotiation of 33 projects started in the period 2000-2006. To make sure that the effects of those early investment projects are not mixed up with the effects of the investment projects of interest, I excluded all children from the sample that were exposed to negotiations for more than one project in a 10 kilometre radius of their residence area. As this approach eliminates only small number of children from the sample, the regression results, shown in Table 6, are nearly the same as in the baseline scenario. Furthermore, even if children born between 2000-2005 were affected by land investments, the effect of living in a more investment intensive area clearly changed over time by getting less negative or even positive.

[19] A list of the regions and their according population shares is given in Table 2 in the Appendix.

[20] The coefficient of IC_i is significantly negative for the last specification but the problem of multicollinearity occurs for this regression.

5.2 Difference-in-Differences Estimation

5.2.1 Difference-in-Differences Estimation: Linear Version

Results presented so far show a significant change over time in the impact of a residential areas investment intensity score on the height-for-age z-scores of children living in that area. However, this change does not measure the actual causal effect of the investment projects. To complement the results of the baseline model, this Section therefore shows how the difference between the height-for-age z-score of children living in areas affected by large scale land investments and those living in not affected areas changed due to the land investments. For the estimation of equation (3), the sample is divided in treatment and control group. All children, independent of their year of birth, that live in an area with an investment intensity score equal or above a certain threshold are part of the treatment group.

The estimation results of the simple linear difference-in-differences model without matching treated and control units are given in Table 7. All regressions include region, birth cohort, age, and DHS wave fixed effects as well as region specific time trends and child and household characteristics including child gender, mothers body height in centimetres, number of household members, number of children younger than five living in the household, highest educational level of mother and her partner, age of the household head, and whether region of living is urban or rural. The different columns of Table 7 present the estimation results of equation (3) for varying thresholds of the investment intensity index.[21] The cut off levels range from 0,63 in column 1 to 0.8 in column 10.[22]

The results obtained for the threshold $IC_i \geq 0.63$ indicate that children born between 2000-2005 who live in investment intensive areas have on average a height-for-age z-score that is about 0.296 units lower than the height-for-age z-score of children living in areas that are not investment intensive. This gap narrows due to the land investments. The coefficient of $W2011_i * InvestmentIntensiveArea_i$ in column 1 of Table 7 shows that the height-for-age z-score of children living in investment intensive areas and born between 2006-2011 is on

[21]The first specification of the investment intensity index (based on all investment projects negotiated between 2006-2011) is used in Table 7.

[22]The cut off levels for column 1 to 10 are: (1) $IC_i \geq 0.63$, (2) $IC_i \geq 0.65$, (3) $IC_i \geq 0.67$, (4) $IC_i \geq 0.69$, (5) $IC_i \geq 0.70$, (6) $IC_i \geq 0.72$, (7) $IC_i \geq 0.74$, (8) $IC_i \geq 0.76$, (9) $IC_i \geq 0.78$, (10) $IC_i \geq 0.8$. Smaller or bigger values of the cut off are not reported because the used investment intensity index takes values from 0.487-0.867 for the 2005 DHS wave and 0.457-0.866 for 2011 DHS wave. Smaller values of the cut off level would sort nearly all children to the treatment group while bigger values would sort nearly all children to the control group. This leads to insignificant results of the difference-in-differences estimation.

average about 0.301 units higher than the height-for-age z-score of children living in such areas before the investment phase sets in. Hence, the land investments had a positive impact by shrinking the gap between control and treatment group. This result holds for all cut off levels of the investment intensity index between 0.63-0.8. Only the difference between treatment and control group of children born between 2000-2005 vanishes for threshold levels over $IC_i = 0.74$.

5.2.2 Difference-in-Differences Estimation: Non Parametric Version

The linear version of the difference-in-differences estimation without matching presented in Section 5.2.1 assumes that treatment is randomized and children in treatment and control group do not systematically differ from each other except in their treatment status. As this assumption is probably violated, Table 8 presents the estimation results of the non parametric version of the difference-in-differences model outlined in equation (3) with propensity score matching using Gaussian kernel. The columns of Table 8 refer to the same threshold levels as in Table 7.

Similar to the linear difference-indifferences model, Table 8 shows a significantly positive impact of large scale land investments on children living in investment intensive areas during the land investments phase. The impact ranges from 0.246 to 0.869 depending on the threshold of the investment intensity index. Considering all children living in an area with an investment intensity index of at least 0.63 as exposed to land investment, children exposed to land investment and born between 2006-2011 have an height-for-age z-score that is about 0.869 units higher than the height-for-age z-score of similar children born between 2000-2005 in such an area. Raising the threshold of the investment intensity index, which changes the definition of who is exposed to land investment and which child is viewed as being part of the control group, does not change the direction, but the scale of the effects. By increasing the borderline between treatment and control group, the magnitude of the positive effect of land investment exposure diminishes, but remains significantly positive. For cut off levels of $IC_i > 0.72$, the significance level of the coefficient of $W2011_i * InvestmentIntensiveArea_i$ gets unstable, but even for very high levels of the investment intensity index, I do not find significant negative impacts for the exposed group of children.

5.3 Discussion of the Empirical Results

In contrast to the widespread concerns regarding the effects of the recent increase in land investment projects for target countries, the empirical results in this paper point in another direction. Land investments positively affect the development status of children exposed to these investments. These results are stable across different model specifications and estimation strategies. The results in the paper may only hold for Ethiopia and in fact could be very different for other countries, as they might be caused by country specific characteristics, like better institutions compared to other Sub-Saharan-Africa countries. Realized investment projects could be more sustainable and better governed than projects realized in other countries. Unfortunately, comprehensive and detailed information concerning the investment projects on, e.g., the participation and treatment of the local population during the implementation process, are not available.

However, for the case of Ethiopia, positive spillovers caused by the investment projects, like improvements in infrastructure, education, and health care as well as job creation and stimulation of local businesses, could be responsible for the positive impact on the height-for-age z-score of children exposed to land investments. This mechanisms would be in line with the effects of foreign direct investment.

One argument against the positive spillover mechanism could be the displacement of weak local people from highly investment intensive areas to less investment intensive areas, while stronger people stay in land investment intensive areas. Children remaining in the investment intensive areas would be better developed compared to children in less investment intensive areas just because these children are worse of just due to this displacement. On the first glance, the displacement argument seems to be supported by the decline in the average investment intensity index from 0.729 for the children included in the 2005 DHS wave to 0.721 for the children included in the 2011 DHS wave. But the average height-for-age z-score also increased. So children born between 2006-2011 live on average in less investment intensive areas than children born from 2000-2005, but they are also better developed. The displacement argument, that children do not suffer in land investment intensive areas but somewhere else, does no hold. To take the displacement argument one step further, one could say that weaker children are not replaced, but die because of the increased harshness of live conditions due to land investments. If only the fittest children survive, the average height-for-age z-score would go up. But if this was true, we would expect to find an increase of the child mortality rate. As this is not the case for Ethiopia, the survival of the fittest argument does not hold.

6 Conclusion

In this paper, I present a first empirical analysis of the impact of large scale land investments on children's health status. One of the major challenges in this context is the measurement of a child's exposure to such investments. The information about size and location of land investments provided by The Land Matrix, is combined with the information about children's place of residence given in the DHS database to calculate an investment intensity index score for every child's residential area. The results obtained in the baseline model indicate that the effect of an increase in the investment intensity score of a specific residential area on the average height-for-age z-score of children living in that area has changed over time. For children covered by the first DHS wave, the relation between height-for-age z-score and investment intensity score is negative. This effect diminishes for children born between 2005-2011 and gets even significantly positive for some model specifications.

To analyse the causal effect of land investment projects on the health of children that are exposed to these projects, the sample of children born between 2000-2011 is divided in a treatment group and a control group. Children part of the treatment group live in an area that is targeted by land investment projects. The difference-in-differences estimation with Gaussian kernel propensity score matching shows that children in the treatment group that are born between 2006-2011, and therefore were actually exposed to land investments, have a height-for-age z-score that is about 0.344-0.869 units higher than the height-for-age z-score of children in the treatment group born between 2000-2005.

Positive spillover effects originating from infrastructure, healthcare, or educational improvements could be responsible for these findings. However, the effects of large scale land investments may be very different for other countries. Ethiopia possibly has country specific characteristics that attract investment projects more beneficial for child health. The analyses presented in this paper are just a first attempt to investigate the effects of the recent increase in demand for agricultural land by using household data supplemented with geographic information about land investment projects.

As this is a first attempt to empirically analyse the effects of land investments on the development of the targeted country, there are fruitful possible directions for future research. A possibility would be to account for different production intentions like biofuels or food crops production. Different intentions of land usage are accompanied by different impacts on relative food supply, water demand and infrastructure requirements. The effects for local inhabitants are ambiguous.[23] Furthermore, the effects of different investor types and their role could be investigated.[24] Depending on future data availability, an analysis as provided in this paper could be conducted for other developing countries to control for country specifics and gain more comprehensive insights on the effects of land scale land investments.

[23] See, e.g., Vermeulen and Cotula (2010) for a discussion on the impacts of biofuels projects in Africa.

[24] See, e.g., Shepard (2012) for a discussion of the role of private equity investors and the involvement of the World Bank Group in such investments.

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7 Appendix

Table 2: Regions of Ethiopia

Region	Number	Per cent
Tigray	96,008	10
Afar	74,976	8
Amhara	121,088	13
Oromia	162,756	17
Somali	74,360	8
Benishangul-Gumuz	75,592	8
Snnp	147,136	16
Gambela	60,104	6
Harari	51,612	5
Addis Ababa	34,320	4
Dire Dawa	48,708	5
Total	946,660	100

Source: Demographic Health Surveys Ethiopia 2005 and 2011.

Table 3: Ethnicity in Ethiopia

Main Groups	Number	Percent			
Affar	65,736	7			
Alaba	94,908	10			
Amhara	94,996	10			
Oromo	126,060	13			
Mossiye	121,220	13			
Somalie	47,476	5			
Small Groups	Number	Percent		Number	Percent
agew-awi	3,520	0	qebena	29,260	3
agew hamyra	6,952	1	qechem	44	0
anyiwak	6,732	1	qewama	43,076	5
argoba	1,980	0	shekecho	1,848	0
ari	2,684	0	sheko	9,900	1
arborie	44	0	shinasha	2,068	
bacha	2,420	0	sidama	18,876	2
basketo	88	0	silte	6,644	1
bench	3,696	0	sudanese	132	0
berta	14,124	2			
bena	924	0	konso	1,188	0
dasenech	88	0	kore	2,156	0
dawuro	6,688	1	koyego	88	0
debase/gewada	88	0	karo	176	0
derashe	1,364	0	mao	968	0
dizi	6,248	1	mareko	2,420	0
donga	15,004	2	mere	88	0
gamo	13,772	1	me'enite	1,056	0
gebato	572	0	messengo	4,400	0
gedeo	6,028	1	mejenger	2,244	0
gedicho	1,276	0	mursi	176	0
gidole	7,876	1	murle	1,760	0
goffa	2,596	0	nao	88	0
gumuz	9,416	1	nuwer	18,040	2
guragie	12,012	1	nyangatom	1,320	0
guagu	44	0	oida	14,652	2
hadiya	14,432	2	surma	3,124	0
harari	2,376	0	tigrie	52,360	6
hamer	88	0	timebaro	660	0
irob	4,224	0	welaita	9,020	1
keffìcho	7,744	1	yem	2,068	0
kembata	3,784	0	other ethiopian ethinic group	528	0
konta	220	0	from different parents	44	0
komo	44	0	other foreigners	352	0
Total	940,368	100			

Source: Demographic Health Surveys Ethiopia 2005 and 2011.

Table 4: Baseline model for different specifications of the investment intensity index including full set of control variables

haz_{ijet}	subgroup 1	subgroup 2	subgroup 3	subgroup 4
W_{2011}	-0.735	-0.659	-0.533	-0.709
	(0.591)	(0.606)	(0.611)	(0.577)
IC_i	-1.144*	-1.261*	-1.115*	-0.956**
	(0.660)	(0.707)	(0.586)	(0.483)
$W_{2011} * IC_i$	1.894**	1.782**	1.275*	1.431***
	(0.743)	(0.791)	(0.653)	(0.545)
Age of child	-0.177***	-0.178***	-0.178***	-0.177***
	(0.0333)	(0.0333)	(0.0334)	(0.0333)
Child is male	-0.0882***	-0.0881***	-0.0880***	-0.0883***
	(0.0272)	(0.0272)	(0.0272)	(0.0272)
Mothers height (cm)	0.0388***	0.0388***	0.0388***	0.0388***
	(0.00250)	(0.00251)	(0.00251)	(0.00251)
Number of household members	0.00892	0.00881	0.00868	0.00888
	(0.00768)	(0.00768)	(0.00768)	(0.00768)
Number of children younger 5	0.0636***	0.0633***	0.0624***	0.0633***
	(0.0203)	(0.0203)	(0.0203)	(0.0203)
Age of household head	-0.000310	-0.000306	-0.000292	-0.000316
	(0.00139)	(0.00139)	(0.00139)	(0.00139)
Urban	0.405***	0.406***	0.407***	0.406***
	(0.0506)	(0.0506)	(0.0505)	(0.0505)
Primary education mother	0.0744**	0.0756**	0.0773**	0.0744**
	(0.0347)	(0.0347)	(0.0347)	(0.0347)
Secondary education mother	0.241***	0.241***	0.242***	0.240***
	(0.0803)	(0.0803)	(0.0803)	(0.0803)
Higher education mother	0.614***	0.615***	0.616***	0.613***
	(0.116)	(0.116)	(0.117)	(0.116)
Primary education partner	0.0669**	0.0675**	0.0680**	0.0674**
	(0.0322)	(0.0322)	(0.0322)	(0.0322)
Secondary education partner	0.293***	0.293***	0.292***	0.294***
	(0.0590)	(0.0590)	(0.0590)	(0.0590)
Higher education partner	0.144	0.144	0.144	0.145
	(0.0903)	(0.0903)	(0.0903)	(0.0903)
Observations	12,797	12,797	12,797	12,797
Adjusted R^2	0.206	0.206	0.206	0.206
Region specific time trends	Yes	Yes	Yes	Yes
Birth cohort fixed effects	Yes	Yes	Yes	Yes
Region fixed effects	Yes	Yes	Yes	Yes

Notes: Clustered standard errors in parentheses. *significant at 10%, **significant at 5%, ***significant at 1%.

Table 5: Baseline model with different specifications of the investment intensity index excluding war regions

haz_{ijet}	subgroup 1	subgroup 2	subgroup 3	subgroup 4
W_{2011}	-0.485	-0.466	-0.177	
	(0.903)	(0.949)	(0.959)	
IC_i	-1.024	-1.191	-1.141	-0.917*
	(0.743)	(0.827)	(0.700)	(0.543)
$W_{2011} * IC_i$	2.632***	2.641***	1.858**	1.935***
	(0.849)	(0.941)	(0.793)	(0.621)
Age of child	-0.182***	-0.185***	-0.187***	-0.184***
	(0.0376)	(0.0376)	(0.0376)	(0.0376)
Child is male	-0.0934***	-0.0933***	-0.0935***	-0.0938***
	(0.0304)	(0.0304)	(0.0304)	(0.0304)
Mothers height (cm)	0.0381***	0.0380***	0.0379***	0.0381***
	(0.00277)	(0.00277)	(0.00278)	(0.00278)
Number of household members	0.00494	0.00487	0.00479	0.00491
	(0.00868)	(0.00868)	(0.00868)	(0.00868)
Number of children younger 5	0.0668***	0.0670***	0.0662***	0.0666***
	(0.0228)	(0.0228)	(0.0228)	(0.0228)
Age of household head	0.000754	0.000765	0.000789	0.000755
	(0.00155)	(0.00155)	(0.00155)	(0.00155)
Urban	0.391***	0.392***	0.397***	0.394***
	(0.0561)	(0.0561)	(0.0560)	(0.0560)
Primary education mother	0.0957**	0.0969**	0.0998***	0.0959**
	(0.0385)	(0.0386)	(0.0386)	(0.0385)
Secondary education mother	0.326***	0.326***	0.326***	0.325***
	(0.0878)	(0.0878)	(0.0879)	(0.0878)
Higher education mother	0.628***	0.627***	0.628***	0.625***
	(0.127)	(0.127)	(0.127)	(0.127)
Primary education partner	0.0552	0.0568	0.0598*	0.0567
	(0.0361)	(0.0361)	(0.0361)	(0.0361)
Secondary education partner	0.266***	0.267***	0.268***	0.268***
	(0.0642)	(0.0642)	(0.0641)	(0.0642)
Higher education partner	0.139	0.141	0.143	0.142
	(0.0998)	(0.0998)	(0.0998)	(0.0998)
Observations	10,248	10,248	10,248	10,248
Adjusted R^2	0.211	0.211	0.211	0.211
Region specific time trends	Yes	Yes	Yes	Yes
Birth cohort fixed effects	Yes	Yes	Yes	Yes
Region fixed effects	Yes	Yes	Yes	Yes

Notes: Clustered standard errors in parentheses. *significant at 10%, **significant at 5%, ***significant at 1%.

Table 6: Baseline model with different specifications of the investment intensity index excluding all regions with more intensive land investment negotiation before year 2006

haz_{ijet}	subgroup 1	subgroup 2	subgroup 3	subgroup 4
W_{2011}	-0.654	-0.610	-0.534	-0.632
	(0.592)	(0.607)	(0.612)	(0.578)
IC_i	-1.069	-1.228*	-1.144*	-0.903*
	(0.661)	(0.708)	(0.586)	(0.484)
$W_{2011}IC_i$	1.790**	1.737**	1.313**	1.358**
	(0.745)	(0.792)	(0.654)	(0.546)
Age of child	-0.172***	-0.173***	-0.173***	-0.172***
	(0.0335)	(0.0335)	(0.0335)	(0.0335)
Child is male	-0.0930***	-0.0930***	-0.0930***	-0.0931***
	(0.0273)	(0.0273)	(0.0273)	(0.0273)
Mothers height (cm)	0.0387***	0.0387***	0.0387***	0.0387***
	(0.00251)	(0.00251)	(0.00251)	(0.00251)
Number of household members	0.00888	0.00879	0.00867	0.00884
	(0.00772)	(0.00772)	(0.00772)	(0.00772)
Number of children younger 5	0.0621***	0.0617***	0.0609***	0.0617***
	(0.0204)	(0.0204)	(0.0204)	(0.0204)
Age of household head	-0.000292	-0.000289	-0.000276	-0.000299
	(0.00139)	(0.00139)	(0.00139)	(0.00139)
Urban	0.403***	0.404***	0.404***	0.404***
	(0.0506)	(0.0506)	(0.0506)	(0.0506)
Primary education mother	0.0691**	0.0703**	0.0718**	0.0692**
	(0.0349)	(0.0349)	(0.0349)	(0.0349)
Secondary education mother	0.246***	0.247***	0.247***	0.246***
	(0.0803)	(0.0803)	(0.0803)	(0.0803)
Higher education mother	0.606***	0.606***	0.607***	0.604***
	(0.116)	(0.116)	(0.117)	(0.116)
Primary education partner	0.0680**	0.0686**	0.0691**	0.0684**
	(0.0323)	(0.0323)	(0.0323)	(0.0323)
Secondary education partner	0.302***	0.302***	0.301***	0.302***
	(0.0592)	(0.0591)	(0.0591)	(0.0591)
Higher education partner	0.159*	0.159*	0.158*	0.160*
	(0.0903)	(0.0903)	(0.0903)	(0.0903)
Observations	12,691	12,691	12,691	12,691
Adjusted R^2	0.207	0.207	0.207	0.207
Region specific time trends	Yes	Yes	Yes	Yes
Birth cohort fixed effects	Yes	Yes	Yes	Yes
Region fixed effects	Yes	Yes	Yes	Yes

Notes: Clustered standard errors in parentheses. *significant at 10%, **significant at 5%, ***significant at 1%.

Table 7: Difference-in-differences with treatment indicators according to varying levels of the investment intensity index (subgroup 1)

	(1) $IC_i \geq 0.63$	(2) $IC_i \geq 0.65$	(3) $IC_i \geq 0.67$	(4) $IC_i \geq 0.69$	(5) $IC_i \geq 0.70$	(6) $IC_i \geq 0.72$	(7) $IC_i \geq 0.74$	(8) $IC_i \geq 0.76$	(9) $IC_i \geq 0.78$	(10) $IC_i \geq 0.80$
W_{2011}	0.358	0.359	0.349	0.352	0.356	0.362	0.371	0.367	0.381	0.402
	(0.429)	(0.429)	(0.429)	(0.429)	(0.429)	(0.0.429)	(0.429)	(0.429)	(0.429)	(0.429)
$InvestmentIntensiveArea_i$	-0.296*	-0.533***	-0.461***	-0.366***	-0.355***	-0.171*	-0.159*	-0.0634	-0.0329	-0.0196
	(0.160)	(0.186)	(0.139)	(0.119)	(0.110)	(0.0991)	(0.0903)	(0.0823)	(0.0855)	(0.0938)
$W_{2011} * InvestmentIntensiveArea_i$	0.301*	0.540***	0.613***	0.490***	0.460***	0.290*	0.378***	0.186*	0.215**	0.266**
	(0.174)	(0.200)	(0.156)	(0.136)	(0.128)	(0.117)	(0.108)	(0.0978)	(0.0993)	(0.109)
Child is male	-0.0868***	-0.0865***	-0.0871***	-0.0871***	-0.0872***	-0.0863***	-0.0862***	-0.0862***	-0.0851***	-0.0867***
	(0.0270)	(0.0270)	(0.0270)	(0.0270)	(0.0270)	(0.0270)	(0.0270)	(0.0270)	(0.0270)	(0.0270)
Mothers height (cm)	0.0384***	0.0384***	0.0383***	0.0383***	0.0382***	0.0382***	0.0384***	0.0384***	0.0386***	0.0389***
	(0.00249)	(0.00249)	(0.00249)	(0.00249)	(0.00249)	(0.00249)	(0.00249)	(0.00250)	(0.00250)	(0.00250)
Number of household members	0.00831	0.00797	0.00827	0.00872	0.00880	0.00811	0.00827	0.00826	0.00817	0.00814
	(0.00762)	(0.00761)	(0.00761)	(0.00762)	(0.00762)	(0.0762)	(0.00762)	(0.00763)	(0.00763)	(0.00763)
Number of children younger 6	0.0551***	0.0553***	0.0553***	0.0542***	0.0552***	0.0555***	0.0570***	0.0568***	0.0578***	0.0585***
	(0.0202)	(0.0202)	(0.0202)	(0.0202)	(0.0202)	(0.0201)	(0.0202)	(0.0202)	(0.0202)	(0.0202)
Age of household head	-0.000299	-0.000356	-0.000289	-0.000285	-0.000267	0.000216	-0.000216	-0.000231	-0.000226	-0.000159
	(0.00139)	(0.00139)	(0.00139)	(0.00139)	(0.00139)	(0.00138)	(0.00139)	(0.00139)	(0.00139)	(0.00139)
Urban	0.403***	0.398***	0.395***	0.400***	0.402***	0.402***	0.403***	0.403***	0.396***	0.391***
	(0.0504)	(0.0502)	(0.0502)	(0.0502)	(0.0502)	(0.0502)	(0.0501)	(0.0502)	(0.0502)	(0.0503)
Observations	12,797	12,797	12,797	12,797	12,797	7,102	12,797	12,797	12,797	12,797
Adjusted R^2	0.213	0.214	0.214	0.214	0.214	0.214	0.214	0.213	0.214	0.214
Region specific time trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Birth cohort fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Age fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Clustered standard errors in parentheses. *significant at 10%, **significant at 5%, ***significant at 1%.

Table 8: Difference-in-differences with kernel matching, age fixed effects, and treatment indicators according to varying levels of the investment intensity index (subgrop 1)

	(1) $IC_i \geq 0.63$	(2) $IC_i \geq 0.65$	(3) $IC_i \geq 0.67$	(4) $IC_i \geq 0.69$	(5) $IC_i \geq 0.70$	(6) $IC_i \geq 0.72$	(7) $IC_i \geq 0.74$	(8) $IC_i \geq 0.76$	(9) $IC_i \geq 0.78$	(10) $IC_i \geq 0.80$
W_{2011}	-0.533	-0.444	0.457	0.341	0.224	-0.260	0.240	-0.462	0.137	-0.385
	(0.444)	(0.433)	(0.574)	(0.530)	(0.512)	(0.473)	(0.599)	(0.488)	(0.592)	(0.478)
Investment Intensive Area	-0.848***	-0.613***	-0.447***	-0.380***	-0.395***	-0.276**	-0.0702	-0.0860	0.0404	0.00816
	(0.317)	(0.228)	(0.154)	(0.128)	(0.123)	(0.114)	(0.111)	(0.0892)	(0.115)	(0.126)
$W_{2011} *$ *Investment Intensive Area*	0.869***	0.700***	0.661***	0.612***	0.638***	0.344**	0.223	0.198*	0.0181	0.246*
	(0.337)	(0.247)	(0.178)	(0.147)	(0.144)	(0.147)	(0.138)	(0.106)	(0.151)	(0.148)
Urban	0.375***	0.279**	0.315***	0.251***	0.258***	0.286***	0.318***	0.345***	0.409***	0.389***
	(0.0588)	(0.127)	(0.0884)	(0.0798)	(0.0818)	(0.0867)	(0.0836)	(0.0789)	(0.123)	(0.103)
Child is male	-0.0684	0.0422	-0.0339	-0.0430	-0.0246	0.0120	-0.0251	-0.0430	0.0135	-0.0179
	(0.0618)	(0.0627)	(0.0526)	(0.0445)	(0.0436)	(0.0543)	(0.0487)	(0.0387)	(0.0582)	(0.0565)
Mothers height (cm)	0.0348***	0.0344***	0.0360***	0.0374***	0.0374***	0.0310***	0.0353***	0.0350***	0.0261***	0.0281***
	(0.00486)	(0.00506)	(0.00428)	(0.00377)	(0.00369)	(0.00414)	(0.00401)	(0.00397)	(0.00882)	(0.00558)
Number of household members	0.0436***	0.0307**	0.0143	0.0170	0.0147	0.0313**	0.0342**	0.0198*	0.0191	0.0162
	(0.0151)	(0.0156)	(0.0136)	(0.0120)	(0.0121)	(0.0145)	(0.0138)	(0.0112)	(0.0160)	(0.0157)
Number of children younger 5	-0.0100	0.0367	0.0669*	0.0643**	0.0625**	0.0760**	0.0935***	0.0667**	0.0697*	0.0876**
	(0.0388)	(0.0368)	(0.0353)	(0.0317)	(0.0315)	(0.0363)	(0.0341)	(0.0296)	(0.0404)	(0.0407)
Age of household head	0.000603	0.00423	0.00263	0.000740	0.000470	0.00114	0.00194	0.00125	0.00253	-0.00201
	(0.00314)	(0.00309)	(0.00265)	(0.00221)	(0.00220)	(0.00297)	(0.00253)	(0.00196)	(0.00272)	(0.00303)
Observations	10,942	11,700	11,700	11,700	11,700	11,700	11,986	11,986	12,797	12,797
Adjusted R^2	0.229	0.216	0.218	0.222	0.227	0.217	0.226	0.227	0.212	0.202
Region specific time trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Birth cohort fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Age fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Clustered standard errors in parentheses. *significant at 10%, **significant at 5%, ***significant at 1%.