Land Reform and Child Health in the Kyrgyz Republic[±]

Katrina Kosec
International Food Policy Research Institute (IFPRI)

Olga N. Shemyakina[±±]
Georgia Institute of Technology
School of Economics

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Abstract

Can the establishment of private property rights to land improve child health and nutrition outcomes? We exploit a natural experiment in the Kyrgyz Republic following the collapse of socialism, whereby the government rapidly liquidated state and collective farms containing 75 percent of agricultural land and distributed it to individuals, providing 99-year transferable use rights. We use household surveys collected before, during, and after the privatization reform and spatial variation in its timing to identify its health and nutrition impacts. We find that young children aged 0-5 exposed to land privatization for longer periods of time accumulated significantly greater gains in height and weight, both critical measures of long-term health and nutrition. Health improvements appear to be driven by increases in consumption of home-produced food—suggesting that increased private control over household production may translate into increased consumption and thus health dividends for young children. We find minimal impacts on urban-dwelling children affected only indirectly by the reform.

Keywords: human capital, health, nutrition, land reform, Central Asia, Kyrgyz Republic
JEL classifications: I1, J1, O1

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The authors may be contacted at: Katrina Kosec, Senior Research Fellow, IFPRI, 1201 I Street, NW Washington, DC 20005, USA, k.kosec@cgiar.org, (202) 862-4663; and Olga Shemyakina, Associate Professor, School of Economics, Georgia Institute of Technology, Atlanta, GA, 30332, USA, olga.shemyakina@econ.gatech.edu, (323) 229-3180.

1. Introduction

A growing literature establishes the benefits of strengthening property rights to agricultural land for child welfare. Landholders invest more in their land (Do and Iyer 2008; Holden *et al.* 2009; Fenske 2011; Deininger *et al.* 2011) and homes (Field 2005; Galiani and Schargrodsky 2010; Meeks 2018) due to decreased risk of expropriation and increased access to credit, thus raising incomes and wealth and fueling investments in children. This literature, however, has delivered mixed results, with poor and marginalized households least likely to benefit from such land reforms (Deininger and Binswanger 1999; Meren and Haller 2008; Deininger and Feder 2009; Ali et al. 2014). It has also generally focused on *existing* landholders with previously more tenuous claims to property. Far less is known about how granting private land ownership to landless individuals—who may have previously worked as wage laborers on the land—affects child health and nutrition. However, a sizeable portion of land in low-income countries is publicly owned or controlled (RRI 2015), and providing land to the landless is viewed by many as a key means to reduce poverty and support rural livelihoods (Lipton 2009; McKay 2018).

The child health and nutrition impacts of providing privately owned land to landless individuals may differ from the impacts of strengthening property rights protections for existing landholders due to fundamental differences between existing landholders and the landless. First, the landless are among the most vulnerable of poor individuals and may have lower baseline wealth and access to credit, hampering their ability to make timely investments following land reform. Second, their capacity to manage land may be relatively low compared to households that already have land, due either to less experience with the characteristics of the particular parcels they will farm (once allocated land) or less experience in handling the various, diverse aspects of land management more generally (e.g., they may have previously specialized in one narrow aspect of farming as a wage laborer). Even if tenure claims are insecure, individuals that already have land would generally have relatively high-quality information about land management. Finally, the previously landless may have enjoyed a share of production (e.g., a share of crops in payment for labor), but would not have exercised control over what was grown or produced, while existing landholders, even with insecure tenure, could make such decisions. The reduced ability to effectively invest in land combined with a lower knowledge base related to land management may disrupt the causal chain between land reform raising income and

investment and eventually yielding child health and nutrition benefits. Further, newly granted land confers "freedom to farm"—e.g., to exercise decisions over what to produce, what inputs to use, and how to market—that existing landholders generally already had to some degree.[1]

What are the child health and nutrition impacts of granting private land ownership to previously landless households? This study provides some of the first causal evidence on the implications of a rapid change from government to private management and ownership of land on child health and nutrition. This is a distinct research question from the effects of a gradual change in institutions or in the degree of tenure security of households with existing claims to land. One existing study we are aware of is Keswell and Carter (2014), showing that land transfers in South Africa improved household consumption. However, this study does not further consider health impacts, and findings from an upper-middle income country may not translate to low-income countries with lower levels of capital to invest in land.

To answer this question, we utilize a natural experiment in the Kyrgyz Republic following the collapse of the Soviet Union to identify the effects of land de-collectivization, hereafter referred to as land privatization, on child health and nutrition outcomes. Starting in the early 1990s and peaking during 1994–1995, the Government of the Kyrgyz Republic undertook the rapid and near total privatization of previously government owned and managed land. It liquidated 262 state farms and 190 collective farms containing 75 percent of agricultural land (excluding pastureland) and distributed it to rural households, providing 99-year transferable use rights. While some households previously had small kitchen gardens, households were otherwise landless; this quickly changed, with the average household acquiring 1.17 hectares of land due to the reform.

We exploit spatial variation in the timing of land privatization using repeated cross-sections of Living Standards Measurement Study (LSMS) data from the Kyrgyz Republic from 1993, 1996, 1997, and 1998. Specifically, we compare children of the same age (in months) with different exposures to land privatization due to the timing of its roll-out. The Kyrgyz Republic is the only Central Asian country with high-quality data form the early stages of transition (Anderson and Pomfret 2003), uniquely allowing for such an impact evaluation. The 1993 LSMS survey, in particular, is incredibly valuable as it fully predates the country's conversion into a

[1] Existing landholders with weak tenure may lack incentives to grow certain crops (e.g., fruit trees that yield little fruit in the short term), but this is distinct from having no say over what is grown or how.

market economy (Anderson and Pomfret 2003). As we have four rounds of data and spatial variation in the timing of privatization, we can include not only age in months fixed effects but also region (i.e., oblast) and survey year fixed effects. Our analysis examines the health status of children 0 – 5 years old (i.e., 0 – 60 months old). As children are especially vulnerable before age two (Shrimpton *et al.* 2001; Carter and Maluccio 2003), we additionally always separately consider children aged 0-24 and 25-60 months. We further test for different impacts on girls and boys. Our primary health outcomes are the three most commonly used anthropometric indices: the height-for-age z-score (a measure of stunting and long-term health and nutritional experience), weight-for-height z-score (a measure of wasting), and weight-for-age z-score (another measure of long-term health and nutritional experience) (WHO 1997). We additionally consider the impacts of exposure to land privatization on land access itself, and on household food (home produced and purchased) and non-food consumption.

We find that young children exposed to land privatization for longer periods of time accumulated significantly greater gains in height and weight, both critical measures of long-term health and nutrition. Height-for-age and weight-for-age z-scores of children aged 0 – 5 are increasing in months of exposure to land privatization. This effect is driven by children 0 – 24 months old; impacts on 25 – 60 month olds are smaller in magnitude and statistically insignificant. We find no overall impacts on weight-for-height z-scores, a measure of wasting, though we do find some reductions for children 25 – 60 months old. We find no evidence of significant gender differences in the effects of land privatization. Thus, the benefits of accessing land are shared broadly by very young children. We also present evidence consistent with the reform having an effect before it became official policy; the effect of months of exposure to land privatization on child anthropometrics is larger in magnitude, and still statistically significant, when we perturb the timing of privatization backward by one year. In contrast, perturbing it forward one year yields smaller, though still statistically significant, impacts.

If land privatization affected child health, we would expect households' access to land to increase in response. This is indeed the case. And access increased most among those with below-median expenditures. Improvements in child health and nutrition due to land privatization appear to be driven predominately by increased consumption of food produced at home rather than increased consumption of purchased food or increases in non-food expenditures that may support health improvements in other ways (e.g., increased expenditure on medical care). We

cannot reject that food purchases and non-food expenditures were unchanged by the reform. This is consistent with a higher marginal utility of consumption of food compared to non-food items immediately preceding land privatization due to food shortages; with market frictions impeding the sale of agricultural commodities grown on newly privatized land; or—quite likely—both.

We also consider whether urban-dwelling children experienced similar health and nutrition gains. Urban households were ineligible to receive land from the government and thus only indirectly affected (e.g., through market interactions with rural households). Indeed, we find minimal impacts on urban children, confirming that the granting of plots to rural households and not broader policy changes exhibiting similar spatial and temporal patterns, explain our results.

We contribute to a large empirical literature on the welfare impacts of land reform. Existing literature establishes that individuals' incentives to invest in land are predicated on their ability to recoup on investments—which generally requires strong protection of property rights (Demsetz 1967; Alchian and Demsetz 1973; Besley 1995). Compared to government or communal land ownership, secure, private land ownership should in theory stimulate investment. These might include more land devoted to long-term crops (Do and Iyer 2008; Holden *et al.* 2009; Fenske 2011), more engagement in non-farm activities (Do and Iyer 2008), construction and repair of soil conservation structures (Holden *et al.* 2009; Deininger *et al.* 2011), or more use of land fallowing (Fenske 2011). The effects of strong property rights on investment may also extend to investments in the housing environment that have been linked to child health (Field 2005; Galiani and Schargrodsky 2010; Meeks 2018); for example, in electricity, improved water, sanitation, garbage disposal, and air ventilation. Secure land tenure can also increase access to credit to invest (Feder *et al.* 1988; De Soto 2000) and allows for gains from trade (through land sales and rental) (Besley 1995). Formal, private property rights can also reduce child labor and increase market work for adults, potentially benefitting child health (Field 2007). Finally, those farming communal land may or may not retain much production; if the share is small, they may benefit little from accessing communal land. There is accordingly a growing number of reforms bringing about land tenure recognition in low-income countries (Lawry *et al.* 2017).

Despite the potential for strengthened protection of private property rights—such as through land titling—to stimulate investments in land and improve smallholder welfare, the empirical evidence is mixed (Sitko *et al.* 2014). In practice, land titling programs have often failed to achieve objectives including boosting investment in land and housing, access to formal

credit, and local revenues (Payne *et al.* 2009). The poor and marginalized are often least likely to benefit from them (Deininger and Binswanger 1999; Meren and Haller 2008; Deininger and Feder 2009; Ali *et al.* 2014). In large part, the poor fail to secure land rights due to information asymmetries between richer and poorer households which disproportionately spur land acquisition by the relatively rich (Jansen and Roquas, 1998; Benjaminsen and Sjaastad, 2002; Peters, 2004). Land titling programs may also nullify important benefits of customary tenure systems, including their role as a social safety net (Lavigne-Delville, 2002; Meinzen-Dick and Mwangi, 2009; Yaro 2010). It is thus not clear whether the establishment of private property rights will necessarily be net beneficial for land investment and household incomes, compared to communal or government land ownership. Further, that investing in land following land reforms may require wealth and expertise which vulnerable household lack calls into question whether findings from studies considering the impacts of strengthening property rights would generalize to settings in which highly vulnerable, previously landless households newly acquire land.

Much of the empirical evidence on how private property rights affect child health and nutrition has focused on the degree of formality of rights (e.g., by exploiting randomized or quasi-randomized land titling programs) rather than the presence or absence of access to privately-owned land. The evidence is furthermore mixed. While some studies suggest that increasing the degree of formality of existing tenure rights through land titling increases children's weights in Argentina (Galiani and Schargrodsky 2004) and Peru (Vogl 2007), it does not affect child height in either country, and increases the incidence of overweight and obesity (Vogl 2007).[2] Also, these studies consider urban land formalization in capital cities of a high-income (Argentina) and an upper-middle income (Peru) economy,[3] and it is unclear whether their findings apply to rural, low-income country contexts where children face severe health and nutrition deficiencies.[4] Our study extends this literature by considering a low-income country and explicitly considering the effects of newly acquiring land. Our findings have implications for the health impacts of allocating land to individuals, and further shed light on likely mechanisms.

[2] Land titling does, however, lower the rate of teenage pregnancy (Galiani and Schargrodsky 2004).
[3] That optimal property rights systems may depend on income levels is suggested, for example, by Kremer *et al.* (2011) in the context of investments in health.
[4] Several studies show that offering formal land rights to women can empower them and improve investments in children and child health (Quisumbing et al. 1996; Allendorf 2007; Menon et al. 2014; Burroway 2015)—providing evidence on the *combined* effects of secure land access and women's empowerment for child health outcomes.

We also contribute to a large literature on the impacts of parental wealth on child health and nutrition. In a useful review, Currie (2009) presents a strong body of evidence that parental socioeconomic status affects child health. Well-identified, recent studies corroborate these findings; for example, Chen et al. (2017) exploit an income shock created by rural tax reform in China in the early 2000s and find that an increase in family income significantly raises children's height-for-age z-scores. And in the Kyrgyz Republic, Kosec and Song (2019) identify significant gains from household income increases in terms of young children's anthropometric outcomes. The adverse health effects of lower income further accumulate over children's lives (Case et al. 2002). Child health gains are meaningful; for example, they predict better cognitive and non-cognitive development outcomes (Cunha et al. 2006; Paxson and Schady 2007; Fletcher and Wolfe 2016; Akee et al. 2018). If socio-economic status has diminishing impacts on child health, one might expect health benefits to be confined to low-income country contexts. However, Hoynes et al. (2015) find that tax credits in the U.S. increase birth weights, and Cesarini et al. (2016) find that lottery winnings in Sweden increase children's health care utilization and reduce obesity risk.[5] Policy recommendations for reducing health disparities across socio-economic groups often focus on increasing access to health insurance and healthcare (Conti et al. 2010) or modifying taxation policies (Hoynes et al. 2015). Our study contributes evidence that granting poor households land may similarly improve child health.

The remainder of the paper is organized as follows: Section 2 presents our conceptual framework related to the likely effect of privatizing land access on child health outcomes. Section 3 provides background information on the collapse of socialism, land privatization, and child health in the Kyrgyz Republic. Section 4 describes the empirical strategy, data, and outcomes of interest. Section 5 characterizes our main empirical results. Finally, Section 6 concludes and discusses implications for future research.

2. Conceptual Framework

Young children—especially those under age five—are especially sensitive to investments made in their health, including receipt of a sufficient and sufficiently diverse diet. Access to major productive resources such as land when they are young may thus play a critical role in

[5] In contrast, Kuehnle (2014) finds that family income is not a major determinant of child health in the UK.

determining their health outcomes through consumption and other channels. Government efforts to establish private property rights for the rural poor may be one means of providing them with greater access to land, or access to more productive land. Access to land tends to reduce out-migration and increases the likelihood of working in agriculture, especially in settings where land rental markets are underdeveloped (Kosec *et al.* 2018). While there is a direct relationship between farm size and productivity in many developed countries, there is generally an inverse relationship in labor-abundant low-income countries, suggesting the value of individuals producing food on many small plots—such as occurred following land privatization in Kyrgyzstan (Lipton 2009).[6] Also, if individuals farming on communal land do not retain a sizeable share of production, or if their share is small, they may benefit little from accessing communal land. Thus, secure access to privately-held land may lead individuals to work in agriculture and to produce and thus consume more—benefiting child welfare. Where food markets are imperfect, land can also serve as a source of cheaper food relative to the market, reducing poverty and undernutrition (Burgess 2001). And if private land access allows for greater diversity of agricultural production, this increased diversity may in some cases translate into higher-quality and more diverse diets, thus benefiting health (Arimond and Ruel 2004; Jones *et al.* 2014; Dillon *et al.* 2015; Sibhatu *et al.* 2015).

At the same time, there are potential costs of private as opposed to government or communal ownership of land. For households, these include physically demarcating and delineating plots, and the time involved in seeking titles or otherwise defending one's claim to land. For governments, they include establishing and maintaining land ownership records, enforcing land rights, and resolving disputes (Feder and Feeney 1991; DeMeza and Gould 1992; Deininger and Feder 2001). Beyond any productivity differences, potential advantages of collective farms include economies of scale in risk management, input purchasing, and marketing, as well as increased access to information and credit (Putterman 1985; Carter 1987; Deininger 1995; Mathijs and Swinnen 1998; Pryor 2014). These features may translate into greater productivity and thus, potentially, child welfare. A number of scholars have also

[6] This pattern comes from smaller farms' advantage in managing labor (e.g., in seeking and screening workers, allocating tasks, training, and supervising), while large farms have an advantage in managing capital (e.g., hiring or buying a tractor). This difference may manifest as small farms having a higher percentage of land area cultivated (Kay 1998), a higher cropping intensity on cultivated land (Agrawal 2000), or higher-value cropping patterns (e.g., using land for labor-intensive staples, vegetables, trees, and grazing) (Boyce 1987; van den Brink *et al.* 2006).

challenged the value of private property rights, showing that many groups can successfully collectively govern common pool resources (Boyd *et al.* 2018). Thus, there is theoretical ambiguity about the ultimate impacts of establishing private property rights to land on child health and nutrition outcomes. Our paper seeks to fill this gap.

3. Background

The Soviet era in the Republic of Kyrgyzstan spanned from 1917 to 1991; its economy was centrally planned, and followed development strategies handed down by Moscow (Anderson and Pomfret 2003). The country declared its independence from the Soviet Union in August 1991, and in May 1993, the newly named "Kyrgyz Republic" joined the Commonwealth of Independent States. The Kyrgyz Republic is a land-locked, low-income country in Central Asia. Its population in 1993 was approximately 4.5 million, and reached 4.8 million by 1998. It is comprised of seven regions, or *oblasts*, in addition to the independent cities of Bishkek (the capital) and Osh.[7] In 1990, the Kyrgyz Republic had a GDP per capita of $1096, which plummeted to $535 by 1995 (both values in constant, 2010 USD). This was largely due to the triple economic shock of transition from central planning, dissolution of the Soviet Union, and hyperinflation (Anderson and Pomfret 2003). Consumption levels dropped significantly—though not by as much as GDP estimates would suggest, in part due to rapid growth of the private sector and emergence of a shadow economy supplying 25-50% of household consumption (Roberts 1997; Anderson and Pomfret 2003). Real GDP per capita grew by 15 percent between 1995 and 1998 (the end of our study period) (World Bank 2017). Despite these economic shocks, however, the Kyrgyz Republic by 1999 had the most liberalized economy and the best institutional quality in Central Asia, according to a European Bank for Reconstruction and Development index (Anderson and Pomfret 2003). Further, the country's Gini coefficient, a measure of inequality, declined by 14 percent between 1993 and 1998 (from 53.7 to 46.4) (World Bank 2017).

Our study focuses on children in rural parts of the Kyrgyz Republic who were aged 0-5 during household surveys which took place over 1993–1998, and thus born in the decade between 1988 and 1998. They form a micro-generation of children who experienced the collapse and short-term aftermath of a long period of Soviet rule. Livelihoods in the rural Kyrgyz

[7] In addition to Osh being a large city, there is also an oblast named Osh. Given our focus on rural areas, it is this oblast, rather than the independent city of Osh, to which we refer in Table 1 and analyze throughout.

Republic evolved rapidly during the mid-1990s. In the Soviet era, land was collectively owned and managed. The law formally allowed two forms of collective ownership in agriculture: *sovkhozes* were state owned enterprises that employed workers similarly to a Western corporation, and *kolkhozes* were collectively owned and managed enterprises that members entered into voluntarily, and which then shared profits with their members. Reportedly, there were no real differences between the two (Bloch, 2002). This institutional arrangement changed rapidly in the 1990s, as we describe below.

Agriculture is critical to the economy of the Kyrgyz Republic. Throughout 1988–1998, between 62 and 64 percent of the country's population lived in rural areas. Rural areas held the greatest concentration of poverty—with the lowest levels being in the capital city of Bishkek, and the highest being in the southern region of the country—and the country was further characterized by low labor mobility. In 1993, a full 56 percent of the rural population lived below the poverty line (Anderson and Pomfret 2003). Agriculture's share in GDP reached peak of 46 percent in 1996, but has declined since (World Bank 2017). Corresponding to these trends, the share of male employment in agriculture in 1988 was 34 percent, and rose steadily to 49 percent by 1998. In 1998, 8.6 percent of children aged 7-14 were employed—94.5 percent of them in agriculture. These values are large, especially for a country where only 7 percent of land is arable (World Bank 2017). They suggest low productivity in agriculture and few alternate employment opportunities during this time. All Central Asian countries experienced negative growth in gross agricultural production in the early 1990s, including the Kyrgyz Republic (Bloch 2002). However, by 1998, among all Central Asian countries, only the Kyrgyz Republic had exceeded its Soviet-era (1989-1991) agricultural production; by contrast, Kazakhstan and Tajikistan each achieved slightly under half of their Soviet-era levels (Bloch 2002).

Along with five other Central Asian countries that similarly gained their independence with the breakup of the Soviet Union in 1991, the Kyrgyz Republic initiated a process of transition to a market economy in the agricultural sector that included land reform policies aimed at making agriculture an engine for economic growth (Bloch 2002; FAO 2015). However, of the five, the Kyrgyz Republic was the most aggressive in its approach to restructuring agricultural enterprises, privatizing land, and promoting private farming (Bloch and Rasmussen 1998). Other countries pursued more gradual approaches. In Kazakhstan, the reform was the slowest paced, as farmers who received land were supposed to give it back to a cooperative and farm in the same

way as *kolkhozes* or *sovhozes* used to operate. Privatization in the Kyrgyz Republic in contrast placed few requirements on farmers. Acquiring land from the government was not conditional on farmers continuing to sell their crops to the government boards at set prices (as was done in Tajikistan and Turkmenistan); farmers were not restricted in producing products based on government orders (as in Tajikistan and Turkmenistan); farmers did not face penalties for not using or improving their land within a certain time (as in Turkmenistan); and farmers more broadly could use the inputs they wanted and market their agricultural products as they desired. Further, trade policies in the Kyrgyz Republic during this period were liberal, with low formal trade barriers (Anderson and Pomfret 2003).

In the post-Soviet Kyrgyz Republic, land reform involved taking land that was in collective ownership and distributing parcels of land or farm shares to former members of *kolkhozes* and *sovkhozes*. This process stands in contrast to many other land reforms that involve redistributing land from wealthy landowners and giving it to individuals (i.e., movement from one form of private ownership to another). The reform proceeded swiftly but unevenly across the country. Starting in the early 1990s and peaking during 1994–1995, the government rapidly liquidated 262 state farms and 190 collective farms containing 75 percent of the country's agricultural land (excluding pastureland) and distributed it to individuals. In effect, this process initiated the privatization of land, and we therefore refer to it as the Kyrgyz Republic's land privatization. All farm residents were eligible to receive land distributions, and farm workers were eligible to receive farm equipment (World Bank 1998). The amount provided to each farmer was based on their employment status, farming experience, and proximity to the farm (USAID 2011). Also, only residents who lived in the area for at least two years were eligible to receive land. Individuals received 99-year transferable use rights for land shares ranging from 0.1 to 1 hectares. In 1998, a constitutional amendment allowed for private land ownership, and all land use certificates were transformed into land ownership certificates (USAID 2011). Private access to land provided a source of income generation as well as home consumption. In contrast, urban citizens received no land—a point we return to as it provides a useful placebo analysis on the health impacts of land reform. Indeed, Anderson and Pomfret (2003) describe how "non-essential items such as furniture or sheets or towels were being sold by urban dwellers who had no plot of land to fall back on for food."

In sum, the reform vastly improved rural individuals' "freedom to farm"—that is, their ability to decide what to plant and when, which inputs to apply, and to whom to sell their production and at what price. Households could also make their own decisions regarding the optimal mix of agriculture and livestock rearing. This change was in marked contrast to rural agriculture during the Soviet era, in which individuals supplied labor to collective farms and were compensated monetarily and in kind for their labor, but largely removed from all decisions about how to farm. The government did impose some market restraints on land sales; for example, land plots were indivisible even if a buyer and seller could agree on the sale of part of the plot. This feature may have contributed to the primary land market being rentals of land plots—which typically occurred through informal (unregistered) rental arrangements (USAID 2005).

Land privatization in the Kyrgyz Republic did not proceed all at once across the full country given the obvious logistical challenges of a simultaneous reform. The initial land reform started in the early 1990s but was quickly put on hold due to concerns about unfairness in land distribution across different ethnicities and unsustainably high input prices for farmers (World Bank 1993). Between 1990-1991 and 1996-1997, the number of private farms rose from zero to 38,218 while the number of collective farms declined from 518 to 22 (World Bank 1998, p. 12).[8] In some places, large farms reportedly split quickly into very small one-household farms, whereas in other places, reform stalled for years (Mogilevskii 2016).

To learn about the pattern of privatization over time and space, we included a question on the community questionnaire of the 2016 Life in Kyrgyzstan Survey (LIK) asking, "In the 1990s, a large-scale land reform occurred in the Kyrgyz Republic that allocated land plots to households. When did the land reform first allocate plots of land in your community (month and year)?" The survey covered between 4 and 27 rural communities in each oblast. We took the median date (month and year) in each oblast and assigned this as the date of the reform; these dates are shown in Table 1. The dates of privatization range from September 1992 to January 1996 – a period of three years and five months. Existing sources provide little explanation for the exact spatial pattern in the timing of land reform that transpired. Given the likelihood that the timing of reform was due to unobserved, region-specific factors, we include region fixed effects in all analyses.

[8] The relevant legislation and pattern of land reform are described in more detail in World Bank (1998).

Table 1: Date of Land Reform

Oblast	Date of reform.
Batken[9]	Jan-96
Chui	Dec-94
Issyk-Kul	Feb-95
Jalal-Abad	Mar-94
Naryn	Sep-92
Osh	May-94
Talas	Mar-94

Notes: The date of reform is calculated by the authors from the Life in Kyrgyzstan survey conducted in 2016. The date is a median date reported by Life in Kyrgyzstan survey participants.

Clearly, land privatization did not take place immediately in the month and year in which individuals recognize that land reform occurred in their oblast. It is possible that restrictions relaxed and individuals began to farm plots as if they were individual plots prior to the reform being perceived as officially permitting private land management. It is also possible that even after reform occurred, it took some time for individuals to access individual plots—either due to administrative delays or individuals' own slowness in petitioning government for land. Lacking further information on what aspects of reform specifically had been initiated at the time land privatization occurred, we carry out analysis (Appendix Table A6) that perturbs the data of privatization—either one year forward, or one year backward—to observe whether the effects are larger or smaller when allowing for either anticipatory or lagged effects of reform.

Following the early 1990s land reforms and accompanying tenure security, crop production by 19 percent between 1992 and 1998 (World Bank 2017),[10] suggesting improvements in productive capacity. However, the number of tractors per 100 square kilometers of arable land was effectively unchanged over the same period, rising only from 189.4 to 189.8, providing little evidence of greater mechanization. Cereal yields (kilograms per hectare) in particular declined slightly by about 10 percent during 1992 – 1998. Further, livestock production—a significant share of agricultural production value in the Kyrgyz Republic—

[9] Note that Batken oblast is not on the list of oblasts that were included for sampling for the LSMS surveys used in this paper (1994, 1996, 1997 and 1998) (World Bank 1996, 2002).

[10] The crop production index increased from 64.7 to 76.97, the food production index increased from 78.1 to 85.1, and the livestock production declined from 108.6 to 92.6 over 1992 to 1998 (2004 – 2006 = 100).

decreased by 15 percent during 1992 – 1998, suggesting that increases in crop agriculture did not necessarily extend to livestock (World Bank 2017). These trends reflect the fact that the vast majority of agricultural production became concentrated in small, individual farms (FAO 2015); new farmers may have lacked the resources to farm as efficiently as was done previously on large, collective farms (Jones 2004).

4. Empirical Strategy

A. Data

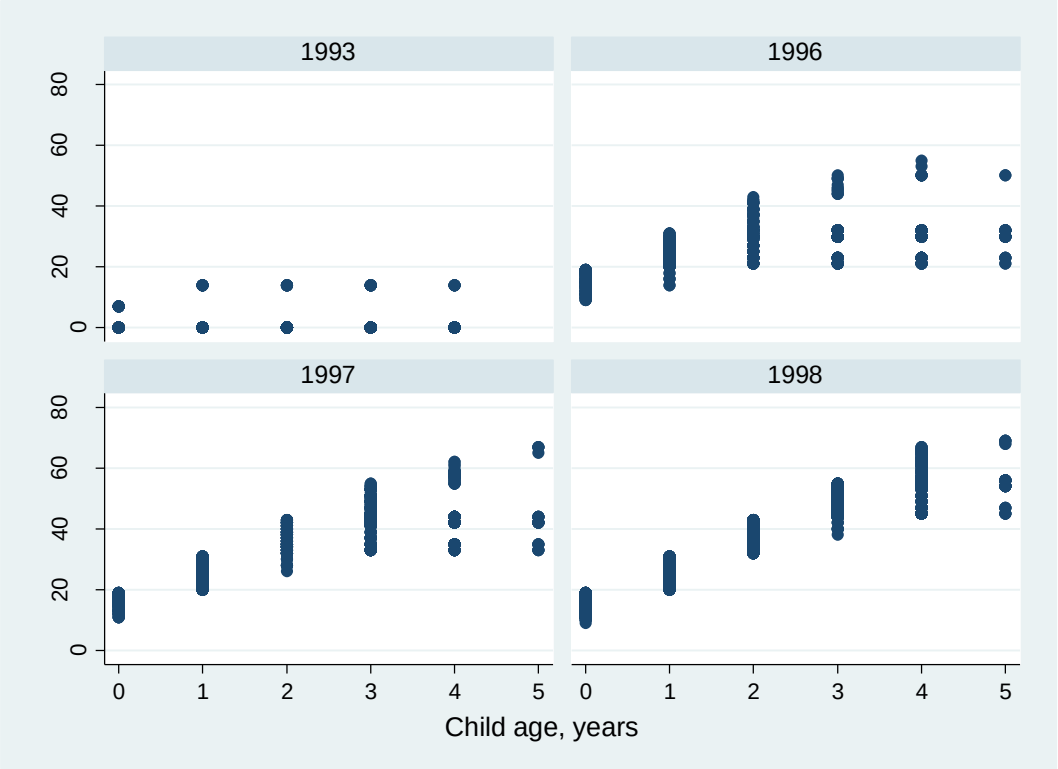
Our main data source consists of four repeated cross-sections of Living Standards Measurement Study (LSMS) data for the Kyrgyz Republic: 1993, 1996, 1997, and 1998. Each survey was nationally representative and carried out during the months of October – November.[11] These data are optimally suited to answer our research questions for several reasons. First, roughly the same sampling methodology, geographical coverage, and questions about our outcomes of interest and relevant control variables were asked in all four rounds, allowing us to compare otherwise similar households and children at different points in time. Second, the data are generally of high quality; they were collected by the National Statistical Committee (NATSTATCOM) with technical assistance from the World Bank, and are well documented, translated into English, and publicly downloadable from the World Bank's website (World Bank 1993). Finally, these data importantly span the critical period during which land privatization occurred (i.e., between September 1992 and January 1996). The differences in the timing of land privatization illustrated in Table 1 mean that privatization had not yet occurred all over the country at the time of the 1993 survey (except for Naryn oblast), but had been in place for varying amounts of time when the 1996, 1997, and 1998 surveys took place. This feature allows us to employ both oblast and year fixed effects, as we explain in more detail below.

Figure 1 depicts visually how young children's (age 0—5) exposure to land privatization varies across our four rounds of repeated cross sections according to child age in years. While in 1993, few children were exposed and exposure was not highly correlated with age, exposure

[11] The 1996 survey was split between two time periods—one in early 1996 and one in late 1996. We use the data collected during October – November 1996 in our analysis.

grew significantly by 1996, as did variation in the length of exposure even within a given year of age. By 1998, exposure was close to being predominately a function of child age, as land privatization had occurred everywhere by January 1996. Appendix Figure A1 displays these patterns in further detail, showing how they vary across oblasts that comprise our sample; here, we see not only the temporal but also the spatial variation in exposure more clearly.

Figure 1: Exposure to land privatization by child age in years, over the four survey years



Notes: Overall exposure includes exposure to land reform between 0 and 60 months of age and exposure in utero.
Source: World Bank LSMS (1993, 1996, 1997, and 1998).

We focus on children living in rural areas, where agriculture is important to livelihoods and households were eligible to receive land from the reform (those living in urban areas were ineligible). Our analysis examines the health and nutritional status of children aged 0 – 5 years old in addition to separately considering children aged 0-24 months and 25-60 months. We have data on these children's gender, height, whether they were measured laying down or standing, weight, and age in years for all four years. For 1996, 1997, and 1998, we further know both the year and month of birth. Date of visit is not consistently available, but given the fairly short

window of enumeration for each survey (i.e., during October – November), we assume a November 1st date of visit (the midpoint) and compute age in months accordingly. For 1997 and 1998, we further know the exact day of birth. In all years, we use all of information available to us about timing of birth to compute children's ages and anthropometric measurements.[12] As such, measurement error in our anthropometric measurements is decreasing over time. Appendix Table A1 clarifies the data we have in each year and the calculations we accordingly make to compute children's ages as precisely as possible.

Our child age data are imperfect, and we acknowledge them as a caveat for our empirics. However, we know of no other surveys carried out during the Kyrgyz Republic's historic land privatization, making these the best data available to us. We argue that the noise in our estimates of child age in months constitutes random measurement error and should thus not bias our estimates of the effects of privatization on child health and nutrition. If anything, we would expect this random measurement error to make it harder to pick up statistically significant effects. Importantly, we also show the robustness of our main results to omitting 1993—the year for which our knowledge of the timing of birth is the least precise—and thus using only 1996, 1997, and 1998 data (results reported in Appendix Table A2). While these regressions do not include any children that were completely unexposed to privatization—since the last oblast to privatize did so in January 1996—we can compare children of the same age in months with different exposures due to both the timing of privatization (and the spatial variation in it) and the year of survey data considered (1996, 1997, or 1998).

All of our econometric specifications control for child age (dummies age in months) and gender. Our baseline econometric specifications further control for several characteristics of the household head: their age, gender, marital status, and ethnicity (Kyrgyz, Russian, Uzbek, or "other"). Table 2 summarizes these control variables for our child-level sample, for each survey round and for all rounds pooled together. In the pooled sample of all 0 – 5 year olds, 48 percent of children are female and 80 percent live in male-headed households. The average birth year is 1994. Average exposure to privatization since birth is 19.74 months; the corresponding figures

[12] For 1993, we do so by assuming that May (i.e., 6 months before the survey date of November) is the month of birth. A simple examine illustrates why: assume a child is 3 years old at the time of the November 1993 survey. We know that her age in months must be between 36 and 47 (if it were 35, she would be 2 years old, and if it were 48, she would be 4 years old). We thus assume that she is 42 months old in November 1993 (since (36+47)/2 = 42 when rounded to the nearest integer), implying that she turned 3 in May 1993 (her birth month).

for 1993, 1996, 1997, and 1998 individually are 0.12, 15.63, 24.44, and 30.08 months, respectively.

Table 3 summarizes variables at the household-level. Across all survey years, the average rural household has 5.57 members. About 88 percent of households report having access to land (pooling all years)—though we note the caveat that the survey question did not specify that the land was privately-held, and it could have been understood by some to include communal land or land in the form of small kitchen gardens (i.e., small areas typically adjacent to private houses). Indeed, a full 71 percent of households already indicated having land access as of 1993, a period pre-dating privatization for most of the sample. However, a follow-up question which asked about the size (in hectares) of the plot(s) of land to which the household had access casts doubt on the interpretation of the access question as including communal land. Across all rounds, the average amount of land to which individuals had access was 1.26 hectares; during 1996-1998, this amount was an even higher at 1.47 hectares.[13] However, it was only 0.30 hectares at the time of the 1993 survey—likely reflecting access to small kitchen gardens, rather than to larger plots of land that were actually communally controlled. Further, the share of rural households claiming that they had access to land grew to above 88 percent by 1996, where it remained for the next two years—suggesting that many households claiming no access to land in 1993 obtained it over the next 3-5 years.

Food expenditures constitute a full 65 percent of total household expenditure, indicating the level of poverty of our rural households. A large share of food consumption—about 41 percent—also comes from home production, indicating the importance of land for households' diets. Thus, individual land access should in theory heavily affect young children's health in this very poor context.

[13] This value is the weighted (by sample size in each year) average of hectares accessed on average in 1996, 1997, and 1998.

Table 2 – Summary Statistics in a Sample of 0-5 year olds

	All Surveys		1993 survey		1996 survey		1997 survey		1998 survey	
Variables	Obs	Mean	Obs	Mean	Obs	Mean	Obs	Mean	Obs	Mean
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Height-for-age Z-score	3,335	-1.36	652	-0.34	632	-1.34	919	-1.80	1,132	-1.60
Weight-for-age Z-score	3,823	0.03	712	0.60	725	0.06	1,065	-0.23	1,321	-0.09
Weight-for-length(height) Z-score	3,072	0.83	663	0.71	573	1.12	840	0.76	996	0.81
Months in utero during reform	4,136	4.69	824	0.02	777	3.63	1,146	5.65	1,389	7.26
Months exposed to reform during life (btw 0 and 60 months)	4,136	23.95	824	0.74	777	23.37	1,146	29.71	1,389	33.28
Months exposed overall (including in utero period	4,136	28.63	824	0.76	777	26.99	1,146	35.36	1,389	40.54
Age in months	4,136	32.74	824	30.96	777	32.20	1,146	32.77	1,389	34.06
Child is female	4,136	0.48	824	0.48	777	0.49	1,146	0.47	1,389	0.49
Birth year	4,136	1994.04	824	1990.92	777	1993.69	1,146	1994.66	1,389	1995.56
HH head age	4,113	46.30	824	43.84	771	44.93	1,136	47.81	1,382	47.28
HH head is female	4,117	0.20	824	0.35	772	0.15	1,139	0.16	1,382	0.16
HH head is married	4,117	0.81	824	0.85	772	0.82	1,139	0.80	1,382	0.80
HH head - Kyrgyz	4,118	0.83	824	0.74	777	0.79	1,137	0.94	1,380	0.83
HH head - Russian	4,118	0.03	824	0.03	777	0.04	1,137	0.02	1,380	0.03
HH head - Uzbek	4,118	0.07	824	0.12	777	0.10	1,137	0.01	1,380	0.09
HH head other ethnic group	4,118	0.06	824	0.11	777	0.08	1,137	0.04	1,380	0.05
HH has land	4,114	0.90	822	0.73	777	0.90	1,143	0.99	1,372	0.92
Hectares of land in HH possession	4,109	1.47	817	0.18	777	3.54	1,143	1.37	1,372	1.16
Born before 1995 & HH has land	4,114	0.48	822	0.73	777	0.60	1,143	0.47	1,372	0.26

Source: World Bank LSMS (1993, 1996, 1997 and 1998).
Notes: All children in the sample are age 60 months or younger. Rural sample. Note that the birth month for 1993 is missing due to the design of the survey. For 1993, we assume that all children are born in May of the respective year of their birth. Since the survey was conducted in November 1991, this assumption leads to the assignment of age in months for each child that is based on May birth. Thus, a child born in 1993 will be assigned an age of 6 months. "Other" ethnic group includes all ethnic groups in the Kyrgyz Republic other than Kyrgyz, Russian, and Uzbek.

Table 3: Household-level summary statistics

	All Surveys		1993 survey		1996 survey		1997 survey		1998 survey	
Variable	Obs	Mean	Obs	Mean	Obs	Mean	Obs	Mean	Obs	Mean
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Household expenditure (som), 30 days, deflated, 1995=100										
Food expenditure	6132	577.06	1,108	1437.43	1,203	398.67	1,759	482.27	2,062	299.68
Food: home produced & consumed crops & animal products	6034	1029.04	1,108	2589.90	1,199	350.13	1,681	311.35	2,046	1171.28
Total food consumption	6034	1607.38	1,108	4027.33	1,199	749.25	1,681	789.10	2,046	1472.05
Expenditure on non-food	6132	551.38	1,108	774.88	1,203	509.73	1,759	539.75	2,062	465.52
Total food & non-food expenditure	6034	2159.57	1,108	4802.21	1,199	1259.58	1,681	1327.53	2,046	1939.49
Share of home produced food in total food	5992	0.41	1,070	0.53	1,197	0.30	1,680	0.42	2,045	0.40
Share of food expenditure in total consumption	6012	0.65	1,086	0.88	1,199	0.59	1,681	0.63	2,046	0.59
Months HH was exposed to land reform	6231	36.86	1,108	0.88	1,203	29.40	1,760	42.91	2,160	54.53
Household size	6034	5.57	1,108	5.71	1,199	5.06	1,681	5.71	2,046	5.67
HH head is male	6034	0.80	1,108	0.87	1,199	0.77	1,681	0.79	2,046	0.77
HH head is Kyrgyz	6034	0.76	1,108	0.66	1,199	0.69	1,681	0.86	2,046	0.76
HH head is Russian	6034	0.11	1,108	0.13	1,199	0.14	1,681	0.07	2,046	0.11
HH head is Uzbek	6034	0.05	1,108	0.09	1,199	0.08	1,681	0.01	2,046	0.05
HH head- other ethnic group	6034	0.08	1,108	0.12	1,199	0.09	1,681	0.06	2,046	0.07

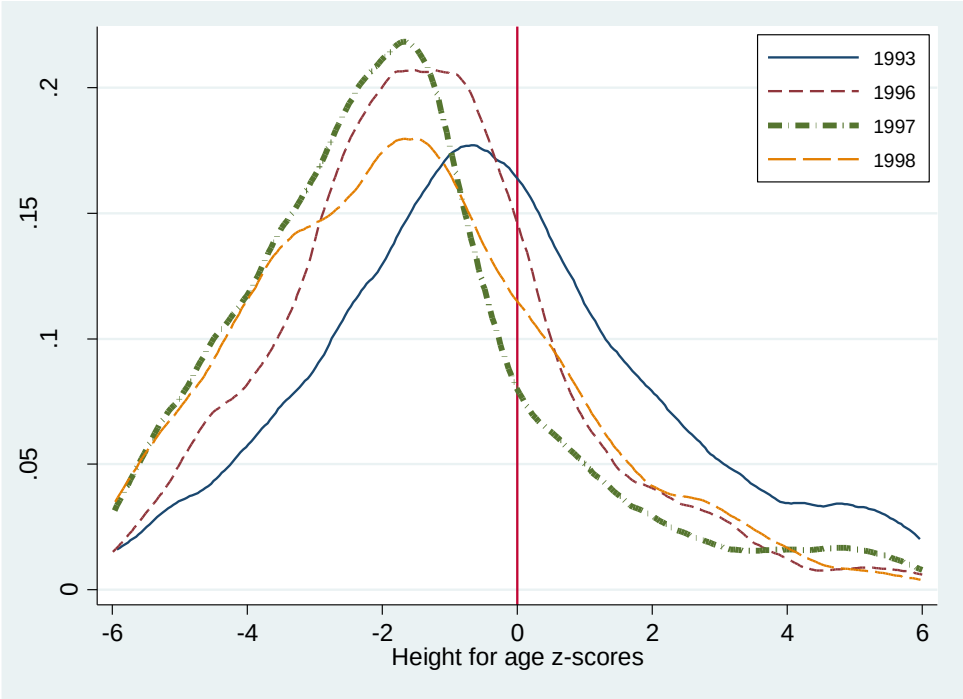
Source: World Bank LSMS (1993, 1996, 1997 and 1998).

Notes: The date of land reform (to calculate months a household was "exposed" to reform) is based on 2016 Life in Kyrgyzstan survey (which provided the month and year). "other ethnic status" is a reference category. Sample: households in rural areas. All expenditure values for 1996/1997/1998 were calculated using methods outlined in World Bank (2002). The home production and consumption values for 1993 survey were calculated by the World Bank staff (World Bank 1996). All expenditure values are in Kyrgyz som, deflated using World Bank GDP deflator data for the Kyrgyz Republic, with base year 1995. https://data.worldbank.org/indicator/NY.GDP.DEFL.ZS (Accessed: July 28, 2018).

B. Outcomes

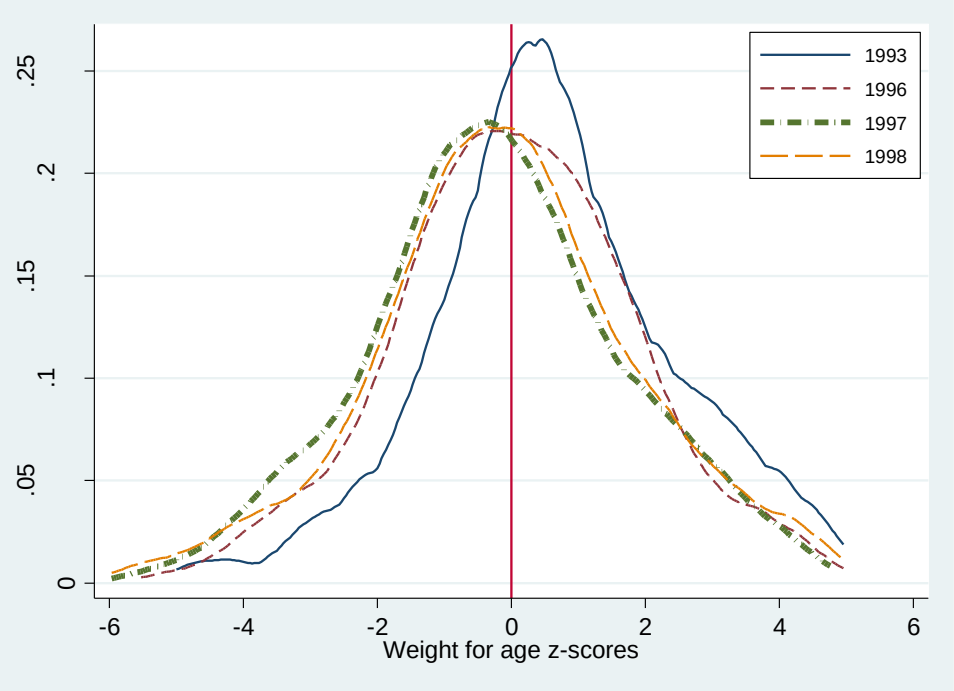
Our primary health outcomes are the three most commonly used anthropometric indices for children: height-for-age z-scores (a measure of stunting and of long-term health and nutritional status), weight-for-height z-scores (a measure of wasting), and weight-for-age z-scores (another measure of long-term health and nutritional experience) (WHO 1997). We compute these using the 2006 WHO child growth standards and the Stata program zscore06 (Leroy 2011). Table 2 summarizes these outcome variables, while Figures 2 – 4 show kernel density plots of each of the three measures for each survey year, separately. What is most clear is that height-for-age z-scores (HAZ) and weight-for-age z-scores (WAZ) worsened between 1993 (prior to land privatization for all oblasts except Naryn) and subsequent years. That is, they reflect a general pattern of deterioration in young children's anthropometrics during the time period of land reform. This pattern reflects the costs of the transition period more broadly, rather than land reform specifically, and our econometric strategy—which we turn to next—explicitly aims to disentangle of the effects of the two by accounting for year trends and exploiting spatial variation in exposure.

Figure 2: Height for age z-scores (HAZ)



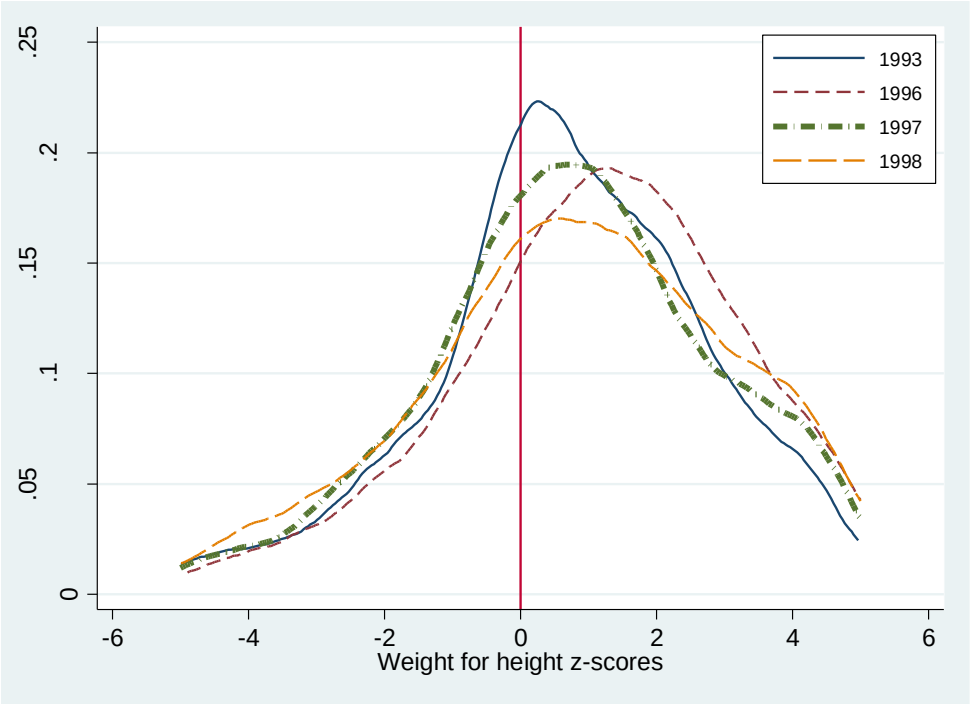
Notes: As for Figure 1. Source: as for Figure 1.

Figure 3: Weight for age z-scores (WAZ)



Notes: As for Figure 1. Source: as for Figure 1.

Figure 4: Weight for height z-scores (WHZ)



Notes: As for Figure 1. Source: as for Figure 1.

C. Empirical specification

To estimate the effects of land privatization on child health and nutrition outcomes, we examine the effect of a variable indicating the number of months of a child's life (inclusive of the nine month in utero period) that they were exposed to a regime of privatized land. For all children interviewed in 1993—with the exception of children in Naryn oblast, where privatization occurred in late 1992—exposure is zero months. For children of a given age (in months) that were interviewed in 1996, 1997, and 1998, the extent of their exposure is determined by the oblast – survey year in which they were observed. As older children will, on average, be mechanically exposed for more months, we importantly include fixed effects for child age in months in all specifications (60 dummies in total, for the child being age 0 months (reference) through age 60 months). These capture all factors related to a child's age that should affect both health and nutrition outcomes in addition to months of exposure. Our main empirical specification, which we estimate using ordinary least squares (OLS), is as follows:

$$Y_{iahjt} = \beta_0 + \beta_1 P_{iahjt} + \beta_2 X_{hjt} + \delta_a + \alpha_j + \gamma_t + \varepsilon_{iahjt} \quad (1)$$

where Y_{ihjt} is a health and nutrition outcome variable for child *i* whose age in months is *a* from household *h* living in oblast *j* in year *t*. P_{iahjt} is a variable capturing the number of months of a child's life that they have been exposed to land privatization; its range is from 0 to the child's age in months plus nine (i.e. from no exposure at all to exposure for the child's entire life plus the full in utero period). δ_a are child age in months fixed effects, α_j are oblast fixed effects, and γ_t are survey year fixed effects. X_{hjt} are household head controls including age, gender, a dummy for being married, and ethnicity (Russian, Kyrgyz, Uzbek, and "other" as the base group). *t* is either 1993, 1996, 1997, or 1998, according to the survey round. To account for correlation within birth year cohorts, we cluster standard errors at the birth year level. This specification is similar to that used by Hidrobo (2014) to study the effects of Ecuador's 1999 economic crisis on child health.

Effectively, our econometric specification means that we compare children of the same age (in months) with differential exposures to land privatization due to the timing of its roll-out. The fact that we have four rounds of data, both before and after the reform, in addition to spatial variation in the timing of privatization allows us to include not only age in months fixed effects

but also region (oblast) and survey year fixed effects, to account for both time-invariant features of each oblast as well as political and economic changes associated with the transition that affected the entire country.

5. Results

5.1 Overall effects on child anthropometrics

Table 4 presents OLS results from estimation of equation (1), where our outcomes are our three measures of child health and nutrition: the child's height-for-age z-score (columns 1 – 3, a measure of stunting and of long-term health and nutritional experience), weight-for-height z-score (columns 4 – 6, a measure of wasting), and weight-for-age z-score (columns 7 – 9, another measure of long-term health and nutritional experience) (WHO 1997). We find that greater exposure to land privatization leads children to be both taller and heavier, increasing both measures of the child's long-term health and nutritional experience. It does not, however, affect the prevalence of wasting (low weight-for-height z-scores)—at least for the full sample of children aged 0 – 5.

Increases in height appear to be predominately driven by young children under the age of two; effects on children aged 25 – 60 months are more than an order of magnitude smaller and statistically insignificant. The findings suggest that there are long-term positive effects of land privatization for young children's health, and that children under age two are the most affected. Considering HAZ, we estimate that for each additional month of exposure to land privatization during the life of a child aged 0 – 5 (inclusive of the in utero period), their HAZ is 0.029 standard deviations lower (column 1). For comparison, Minoiu and Shemyakina (2014) estimate that in utero or early childhood exposure to the 2002 – 2007 civil conflict in Côte d'Ivoire led HAZs of children in conflict zones to be 0.414 S.D. lower than those of children born during the same period who lived outside conflict regions. These values suggest large long-term health and nutrition improvements owing to land privatization; an additional 14 months of exposure is equivalent to avoiding exposure to a conflict zone.

Table 4: Effect of exposure to land privatization on child anthropometrics

	Panel A: height for age z-scores			Panel B: weight for age z-scores			Panel C: weight for height z-scores		
	All	0-24m	25-60m	All	0-24m	25-60m	All	0-24m	25-60m
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Months exposed overall (including in utero period)	0.029***	0.111*	0.006	0.026***	0.070**	0.002	0.011	-0.01	0.019*
	(0.007)	(0.046)	(0.011)	(0.008)	(0.023)	(0.007)	(0.008)	(0.028)	(0.010)
Child is female	0.190*	0.490*	0.062	0.042	0.199*	0.004	-0.073	-0.011	-0.077
	(0.094)	(0.210)	(0.059)	(0.075)	(0.082)	(0.086)	(0.060)	(0.131)	(0.065)
Survey 1993	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
Survey 1996	-1.766***	-3.801***	-0.965**	-1.351***	-2.575***	-0.501*	-0.125	0.148	-0.284
	(0.166)	(0.789)	(0.398)	(0.228)	(0.583)	(0.231)	(0.277)	(0.875)	(0.316)
Survey 1997	-2.263***	-4.374***	-1.148**	-1.794***	-3.215***	-0.602*	-0.626	-0.095	-0.989**
	(0.222)	(0.836)	(0.464)	(0.273)	(0.599)	(0.277)	(0.349)	(0.869)	(0.378)
Survey 1998	-2.206***	-4.399***	-0.936	-1.741***	-3.138***	-0.397	-0.608	-0.053	-1.028*
	(0.261)	(0.864)	(0.546)	(0.331)	(0.603)	(0.319)	(0.354)	(0.878)	(0.444)
N	3315	1025	2290	3799	1200	2599	3050	994	2056
R squared	0.12	0.21	0.08	0.07	0.11	0.05	0.04	0.04	0.04

Source: World Bank LSMS (1993, 1996, 1997 and 1998). The date of land reform (to calculate months a child was "exposed" to reform) is based on 2016 Life in Kyrgyzstan survey (which provided the month and year).

Notes: These are OLS regressions. “All”, “0-24m” and “25-60m” - the sub-sample includes children aged 0-60, “0-24” and “25-60” months old, respectively, at the time of the survey. The regressions are estimated for the sample of children who live in rural areas. “Months exposed overall (including in utero period)” is the number of months a child was alive during the land reform plus months exposed to land reform in utero. All regressions include survey year fixed effects, oblast fixed effects, child age in months fixed effects, and controls for household head: age, gender, a dummy for being married; and ethnicity (Russian, Kyrgyz, Uzbek, with "other" being a reference group.) Standard errors are clustered at the year of child birth level and appear in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

The effects are even larger among younger children. For children aged 0 – 24 months, the effect is a 0.111 standard deviations decrease in their HAZ (column 2). In contrast, for children aged 25 – 60 months, there is not a statistically significant effect of land privatization exposure on HAZs, and furthermore, the point estimate itself is appreciably smaller, at 0.006 (column 3). This effect is consistent with children being especially vulnerable to investments in their health earlier in their lives.

Next considering children's WAZs as our outcome, we find that an additional month of exposure to land privatization lowers the WAZ of 0 – 5 year olds by 0.026 standard deviations (column 4), and it lowers the WAZ of 0 – 24 month olds by an even more sizeable 0.07 standard deviations (column 5). Similar to the case of the HAZ, exposure to land privatization does not appear to affect the WAZs of 25 – 60 month olds; the coefficient is a mere 0.002, and the effect is furthermore statistically insignificant (column 6).

Only for 25 – 60 month olds (and not 0 – 5 year olds overall, nor for the subset of 0 – 24 month olds) does exposure to land privatization appears to affect WHZs (columns 7 – 9). Furthermore, the effect size is also more modest than the statistically significant effects estimated for the case of the HAZ and WAZ, at only 0.019 standard deviations (column 9). Overall, we take this finding as evidence that exposure to land privatization has positive impacts on the long-term health and nutrition of 0 – 5 year olds, predominately driven by effects on 0 – 24 month olds, and possibly some effects on decline in malnutrition among children aged 24 – 60 months old.

Similar results hold when we drop 1993 and use only data from the three latter surveys, as shown in Appendix Table A2. Among 0 – 5 year olds, while the coefficient on months of exposure in the HAZ and WAZ regressions grows slightly smaller in magnitude and statistical significance, our broad conclusions remain: increased exposure to land privatization is associated with overall gains in long-term health and nutrition, driven predominately by 0 – 24 month olds. This finding is of significance given that the precision of our information on exact child age is smallest for this earliest survey wave. While our power is decreased by dropping one of the four survey waves, our main conclusions hold.

The results are also not particularly sensitive to the control set used. In Appendix Table A3, we drop our household head controls and obtain nearly identical point estimates to those found in Table 4—differing only in the third decimal point and only for some specifications. Also, all of the coefficients that were statistically significant at conventional levels in Table 4 remain so here as well. In Appendix Table A4, we further check robustness of the results to controlling for household land access (a dummy) as well as the number of hectares of land in the household's possession. Once again, the point estimates on months of exposure and their levels of statistical significance are preserved for both the HAZ (columns 1 – 3) and WAZ (columns 4 – 6) outcomes, and for all sub-samples (ages 0-5, 0-24 months, and 25-60 months). That the results are not particularly sensitive to observable controls also increases our confidence that they are not simply explained by un-observables in the error term that affect both privatization exposure and health and nutrition outcomes. They may also suggest that increasing access to land is not the main channel explaining child health improvements—though we caveat this analysis by noting that access to land is likely endogenous to these same child health outcomes.

Results are also robust to transforming the independent variable of interest. In Appendix Table A5, we log exposure to land reform, in months, to allow a non-linear relationship in which each additional month may not have a constant effect on child health. This specification is non-ideal given that many children have zero months of exposure; in these cases, we impute exposure as 0.001 months. We see that greater exposure to land privatization continues to predict statistically significantly better HAZ and WAZ outcomes in children aged 0—5, with point estimates in both cases larger for very young children (0—24 months old) compared to older children.

We next consider whether the results are sensitive to our assumptions about the speed with which land privatization's impacts were realized by perturbing the timing of privatization, in Appendix Table A6. Taking health outcomes of children aged 0 – 5 as our outcome, Panel A perturbs the timing of land privatization one year forward in time, which assumes a delayed effect of the reform (i.e., a lagged response). Panel B, in contrast, moves it one year backward in time, which assumes that there are anticipatory effects of the reform. This set-up might be the case if individuals knew that the reform was coming and were able to seize land plots and manage them privately before it was widely recognized that land had been privatized. There are strong reasons to think anticipatory effects would hold given that an initial wave of land reform

started in late 1991 – early 1992 and was then tabled in March of 1992 due to concerns about unfairness in land distribution and high input prices for farmers (World Bank 1993).[14]

Whether we perturb the timing of land privatization forward or backward by one year, a greater number of months of exposure to land privatization leads to statistically significantly higher HAZ and WAZ values among 0—5 year olds. While length of exposure to land privatization is in both cases positively correlated with WHZ values, this relationship is only statistically significant when allowing for anticipatory effects (i.e., moving the date of reform backward by one year). Panel A, column 1 considers the HAZ; the point estimate on months of exposure for the 0 – 5 sample is slightly smaller than its Table 4 counterpart. In contrast, in Panel B, the comparable point estimate (also column 1) becomes larger than its Table 4 counterpart. For the other two outcomes as well, WAZ and WHZ, the anticipatory effects of the reform are stronger than the lagged ones, in both magnitude and statistical significance. We conclude that whether the reform took time to have an effect or started having an effect even before it became official policy, there is a strong evidence that it benefited long-term child health and nutrition. Further, that estimates are larger and more statistically significant when we allow anticipatory effects may suggest that reform indeed began to change land management before it was officially recognized as doing so.

5.2 Heterogeneous effects on child anthropometrics by gender and poverty

We next examined if the effects in Table 4 varied by gender (Table 5). On the one hand, there may be difference in resilience to shocks in general across genders. Additionally, households may respond to a shock like land privatization with compensatory behavior that may tend to affect boy and girl children in different ways; for example, if land privatization softened households' budget constraints and increased food consumption, girls might benefit most if boys had been prioritized previously. However, we find no evidence that the effects of our exposure variable varies by gender. For both our HAZ and WAZ outcomes, the interaction effect between

[14] This scenario is highly plausible given that the initial wave of reform started in late 1991 – early 1992 and was tabled in March of 1992 due to concerns about unfairness in land distribution and high input prices for farmers (World Bank 1993).

exposure and a dummy for being female is small in magnitude and furthermore statistically insignificant.

Table 5: Effect of exposure to land privatization on child anthropometrics, by gender

	Panel A: height for age z-scores			Panel B: weight for age z-scores		
	All	0-24m	25-60m	All	0-24m	25-60m
	(1)	(2)	(3)	(4)	(5)	(6)
Months exposed overall (including in	0.030***	0.112**	0.003	0.026**	0.072**	0.000
utero period)	(0.007)	(0.042)	(0.010)	(0.008)	(0.023)	(0.009)
Child is female	0.236	0.507**	-0.062	0.044	0.283	-0.079
	(0.201)	(0.187)	(0.154)	(0.145)	(0.281)	(0.226)
Exposed * Female	-0.002	-0.001	0.004	0.000	-0.004	0.003
	(0.004)	(0.012)	(0.003)	(0.004)	(0.012)	(0.005)
Survey 1993	ref.	ref.	ref.	ref.	ref.	ref.
Survey 1996	-1.768***	-3.800***	-0.953**	-1.351***	-2.571***	-0.486*
	(0.165)	(0.801)	(0.373)	(0.230)	(0.586)	(0.229)
Survey 1997	-2.265***	-4.373***	-1.111**	-1.794***	-3.211***	-0.568*
	(0.222)	(0.849)	(0.409)	(0.275)	(0.601)	(0.285)
Survey 1998	-2.208***	-4.398***	-0.875	-1.741***	-3.134***	-0.378
	(0.260)	(0.876)	(0.474)	(0.333)	(0.606)	(0.321)
Age in months FE	Yes	Yes	Yes	Yes	Yes	Yes
Oblast FE	Yes	Yes	Yes	Yes	Yes	Yes
HH Head controls	Yes	Yes	Yes	Yes	Yes	Yes
N	3315	1025	2234	3799	1200	2534
R squared	0.12	0.21	0.08	0.07	0.11	0.05

Source: World Bank LSMS (1993, 1996, 1997 and 1998) and Life In Kyrgyzstan Study (2016).
Notes: These are OLS regressions using the sample of children aged 0-60 months old at the time of the survey. "All", "0-24m" and "25-60m" refer to children aged 0-60, 0-24, and 25-60 months old, respectively, at the time of the survey. The regressions are estimated for the sub-sample of children living in rural areas. "Months exposed overall (including in utero period)" or "Exposed" is the number of months a child was alive (including the in utero period) while land privatization was in place. The date of land reform (to calculate months of exposure) is based on the 2016 Life in Kyrgyzstan Study (which provided the month and year). Standard errors are clustered at the year of child birth level and appear in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

Next, we considered whether relatively poor or relatively less-poor households tended to benefit most by considering whether an interaction term between the household having median or below household expenditure and months of exposure to land privatization is statistically significant (Table 6). It is important to note that the Kyrgyz Republic was a low-income country in the 1990s (and indeed up until 2014) and child HAZ and WAZ were actively declining. With 75 percent of the population living in rural areas and with two-thirds of rural residents being below poverty line (World Bank 1998), above-median households should not be thought of as

rich; they are simply households capable of productively using a small plot of land such that the land access could actually benefit child health. As Table 6 shows, young children aged 0—5 similarly benefited from exposure to land privatization, whether they lived in above- or below-median expenditure households. However, among more vulnerable 0—24 month olds, it is in fact the less-poor households that tended to see greater gains from land privatization for their very young children, in the form of higher HAZ and WAZ scores. This finding supports a story in which access to land which land privatization conferred could only help very young children whose parents had a sufficiently high level of income for rural Kyrgyzstan—possibly as this minimum amount of income permitted households to purchase the inputs necessary to make efficient use of their new land, or possibly because it permitted households to make other investments in their children that were complementary to those that greater access to land afforded them. Another possibility is that better quality land went to higher-income and thus more influential individuals, allowing them to earn more from this (more productive) land. While we lack data on land quality, sub-section 5.2 helps us better understand the mechanisms likely driving child health improvements by considering how land privatization affected land access, and additionally how these effects varied according to household income (specifically, whether it was above median or not).

Table 6: Effect of exposure to land privatization on child anthropometrics, by household having expenditure at median or below

	Panel A: height for age z-scores			Panel B: weight for age z-scores			Panel C: weight for height z-scores		
	All	0-24m	25-60m	All	0-24m	25-60m	All	0-24m	25-60m
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Months exposed overall (including in utero period)	0.034***	0.123**	0.011	0.029***	0.081**	0.005	0.011	-0.015	0.020*
	(0.007)	(0.048)	(0.012)	(0.008)	(0.025)	(0.007)	(0.007)	(0.028)	(0.010)
Child is female	0.190*	0.503*	0.065	0.043	0.205*	0.007	-0.073	-0.005	-0.076
	(0.095)	(0.210)	(0.056)	(0.075)	(0.084)	(0.085)	(0.060)	(0.134)	(0.065)
Survey 1993	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
Survey 1996	-1.760***	-3.720***	-0.953**	-1.351***	-2.537***	-0.497*	-0.125	0.116	-0.284
	(0.165)	(0.804)	(0.392)	(0.227)	(0.589)	(0.233)	(0.277)	(0.880)	(0.315)
Survey 1997	-2.253***	-4.313***	-1.137**	-1.793***	-3.179***	-0.600*	-0.626	-0.125	-0.990**
	(0.222)	(0.847)	(0.457)	(0.273)	(0.603)	(0.280)	(0.348)	(0.873)	(0.375)
Survey 1998	-2.201***	-4.297***	-0.932	-1.742***	-3.100***	-0.397	-0.608	-0.079	-1.030*
	(0.259)	(0.881)	(0.539)	(0.332)	(0.610)	(0.320)	(0.351)	(0.880)	(0.445)
Exposed*Below or equal to median expenditure (=1)	-0.01	-0.039***	-0.01	-0.006	-0.029**	-0.006	0.001	0.014	-0.002
	(0.005)	(0.010)	(0.006)	(0.004)	(0.011)	(0.004)	(0.003)	(0.011)	(0.004)
Indicator for Total Expenditure below or equal to median expenditure (deflated)	0.148	0.314	0.321	0.156	0.398	0.233	-0.021	-0.339	0.091
	(0.195)	(0.201)	(0.242)	(0.106)	(0.222)	(0.144)	(0.141)	(0.240)	(0.112)
N	3315	1025	2290	3799	1200	2599	3050	994	2056
R squared	0.12	0.22	0.08	0.07	0.12	0.05	0.04	0.04	0.05

Source: World Bank LSMS (1993, 1996, 1997 and 1998). The date of land reform (to calculate months a child was "exposed" to reform) is based on 2016 Life in Kyrgyzstan survey (which provided the month and year).

Notes: These are OLS regressions. “All”, “0-24m” and “25-60m” - the sub-sample includes children aged 0-60, “0-24” and “25-60” months old, respectively, at the time of the survey. The regressions are estimated for the sample of children who live in rural areas. “Months exposed overall (including in utero period)”or “Exposed” is the number of months a child was alive during the land reform plus months exposed to land reform in utero. All regressions include survey year fixed effects, oblast fixed effects, child age in months fixed effects, and controls for household head: age, gender, a dummy for being married; and ethnicity (Russian, Kyrgyz, Uzbek, with "other" being a reference group.) Standard errors are clustered at the year of child birth level and appear in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

5.3 Mechanisms

To explore the mechanisms driving our results, we next estimated household-level regressions of consumption-related outcomes as well as land access related outcomes on months of exposure to land privatization. In these regressions, months of exposure is an average level of exposure that varies at the oblast – year level (and is thus common for all households surveyed in the same oblast in the same year). The consumption outcomes include monthly food purchases, monthly value of food produced and consumed at home, total food expenditures (the sum of the previous two amounts), total monthly non-food expenditures, and total overall expenditures (the sum of the previous two amounts). The land access outcomes include a dummy for land access and the number of hectares of land the household has. The results for both sets of outcomes appear in Table 7.

We see that land reform increased households' total consumption, but not due to increased purchases of food in the market. Instead, food produced at home and consumed increased substantially. For each month of additional exposure to land privatization, households increased their consumption of home produced food, crops and animal products, by about 155.1 soms per month (measured in constant, 1995 soms). This is a sizeable increase that explains similarly sizeable child health improvements. In contrast, we find no statistically significant increases in non-food expenditures.

Exposure to land reform also increased access to land on both the extensive and the intensive margins, with an additional month of exposure leading to a 1.5 percentage point increase in the likelihood of reporting having access to land, and a 0.1 hectare increase in the amount of land accessed. This observation points towards the source of consumption gains from home production: individuals are more likely to have land to farm, and they have more of it, expanding their production possibilities.

Table 7: Effect of exposure to land privatization on land access and monthly food production and expenditures

	Panel A: Land access variables		Panel B: household monthly expenditure				
	HH has land	Hectares of land HH has access to	Food purchases	Food home produced & consumed	Total value of food consumption (3)+(4)	Nonfood expenditures	Total food and non-food expenditure: (5)+(6)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Average months exposed	0.015***	0.100***	10.9	155.1***	166.0***	-22.7	143.4***
	(0.003)	(0.034)	(14.9)	(33.2)	(36.3)	(20.1)	(42.6)
HH size	0.016***	0.142***	67.2***	108.4***	175.5***	47.0**	222.5***
	(0.002)	(0.035)	(14.1)	(23.4)	(27.8)	(21.2)	(35.1)
Constant	0.689***	-0.991	1,104.3***	3,184.9***	4,289.2***	722.7*	5,011.9***
	(0.032)	(0.612)	(108.9)	(433.2)	(442.4)	(426.1)	(617.2)
N obs	6,000	5,991	6,024	6,024	6,024	6,024	6,024
R-squared	0.111	0.028	0.156	0.055	0.087	0.007	0.077

Source: World Bank LSMS (1993, 1996, 1997, and 1998) and Life in Kyrgyzstan Study (2016).

Notes: These are household-level OLS regressions estimated using all rural households. “Average months exposed” is an average level of exposure that varies at the oblast – year level (and is thus common for all households surveyed in the same oblast in the same year). Expenditure on food and total expenditure numbers are in Kyrgyz som and deflated using World Bank GDP deflator data for Kyrgyzstan, with base year 1995. (https://data.worldbank.org/indicator/NY.GDP.DEFL.ZS, last accessed: July 28, 2018). Non-food expenditure includes: expenditure on frequent non-food purchases; infrequent non-food purchases; consumption of durable goods, and expenditure on utilities. All expenditures are converted on the 30 day basis using method outlined in World Bank (2002). The date of land reform is based on the 2016 Life in Kyrgyzstan Study (which provided the month and year). All regressions include survey year fixed effects, oblast fixed effects, child age in months fixed effects, and controls for household head: age, gender, a dummy for being married; and ethnicity (Russian, Kyrgyz, Uzbek, with "other" being a reference group.) Robust standard errors clustered at the oblast level appear in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

We next considered how the effects of land privatization on access to land (on both the extensive and intensive margins) vary with the household's socio-economic status, as measured by the household having total expenditure below the median. These results appear in Table 8; from column 1, we find some limited evidence that households with below-median total expenditures were statistically significantly more likely to acquire land through exposure to land privatization than were their less-poor counterparts, but the difference is economically very small: for less-poor households, an additional month of exposure to land privatization increases their probability of having access to private land by 1.4 percentage points, while the effect for the poorest half of households is 1.6 percentage points. While these are statistically different, the difference is small. Further, we find no evidence that exposure to land privatization differentially affects the poor and the less-poor in terms of total hectares of land that they access. Overall, we find no evidence that households with higher expenditures were better able to access land during the privatization reform, suggesting that greater health gains among the less poor may be due to superior inputs to make land productive rather than their greater ability to access land in the first place.

Table 8: Heterogeneous effects of exposure to land privatization on land access by household socio-economic status

VARIABLES	HH has land, indicator	Hectares of land HH has access to
	(1)	(2)
Average months exposed	0.014***	0.100***
	(0.003)	(0.032)
HH Size	0.012***	0.107***
	(0.002)	(0.034)
Exposed * Below or equal to median expenditure (=1)	0.002***	0.002
	(0.000)	(0.006)
Indicator for Total Expenditure below or equal to median expenditure (deflated)	-0.172***	-0.684**
	(0.021)	(0.302)
Constant	0.800***	-0.418
	(0.033)	(0.670)
Observations	6,000	5,991
R-squared	0.132	0.030

Source: World Bank LSMS (1993, 1996, 1997, and 1998) and Life in Kyrgyzstan Study (2016).
Notes: These are household-level OLS regressions estimated using all rural households. "Average months exposed" is an average level of exposure that varies at the oblast – year level (and is thus common for all households surveyed in the same oblast in the same year). Expenditure on food and total expenditure numbers are in Kyrgyz som and deflated using World Bank GDP deflator data for Kyrgyzstan, with base year 1995.

(https://data.worldbank.org/indicator/NY.GDP.DEFL.ZS, last accessed: July 28, 2018). Non-food expenditure includes: expenditure on frequent non-food purchases; infrequent non-food purchases; consumption of durable goods, and expenditure on utilities. All expenditures are converted on the 30 day basis using method outlined in World Bank (2002). The date of land reform is based on the 2016 Life in Kyrgyzstan Study (which provided the month and year). All regressions include survey year fixed effects, oblast fixed effects, child age in months fixed effects, and controls for household head: age, gender, a dummy for being married; and ethnicity (Russian, Kyrgyz, Uzbek, with "other" being a reference group.) Robust standard errors clustered at the household level appear in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

5.4 Placebo analysis

We next carry out a placebo analysis that considers the impact of exposure to land privatization on urban children. Urban households were not directly exposed to land privatization in the way rural households were given that they were ineligible to receive plots of land from the government. As such, urban-dwelling children were removed from all analysis up to this point. They could very well be exposed to changes in prices and other general equilibrium effects in their oblasts generated by privatization of land. However, we would expect these effects to be relatively modest.

As Table 9 shows, we indeed find that the main effects of privatization on child anthropometrics identified in Table 4 are substantially weakened when we consider urban children. As columns 1 – 3 demonstrate, we no longer find any statistically significant effects of exposure to land privatization on HAZ values—either for 0 – 5 year olds overall, or for our two sub-groups (0 – 24 month olds, or 25 – 60 month olds). If anything, our exposure variable now has a negative effect on HAZ – though it is very far from being statistically significant, and the point estimates are furthermore very small (always under 0.008). While we identify some effects of exposure to land privatization on WAZ values of 0 – 5 year olds overall, the coefficient is just over a third the size it was in our main results from Table 4, and it's statistical significance is diminished as well (while significant at the 0.01 level in Table 4, it is only significant at the 0.10 level here). Furthermore, we find no impacts on the WAZ values of 0 – 24 month holds or 25 – 60 month olds individually, and the coefficient for 0 – 24 month olds is in fact negative (though far from statistically significant at conventional levels). This observation is in contrast to a rather large coefficient on months of exposure of 0.07 (significant at the 0.05 level) in our main (Table 4) WAZ results for 0 – 24 month olds. We find some evidence that WHZ values increase in urban children aged 0 – 5 overall, but these effects are not apparent among 0 – 24 month olds or among 25 – 60 month olds individually.

Appendix Table A7 considers whether our results for rural versus urban children are statistically significantly different by taking all children—rural children from our main analysis (Table 4) as well as urban children from Table 9—and interacting all independent variables including months of exposure with an urban dummy. We find that the effect of months of exposure on HAZ and on WAZ values is indeed statistically significantly lower for urban children. For the HAZ, the coefficient on months of exposure is 0.029 and the coefficient on months of exposure interacted with an urban dummy is -0.031, showing that the effect of exposure is coming fully from rural children, and the effect is effectively zero for urban children. For WAZ values, there is some evidence of statistically significantly smaller but still positive impacts on urban children. For WHZ values, neither months of exposure nor its interaction with an urban dummy is statistically significant.

Overall, we conclude that the improvements in child anthropometrics are concentrated in rural areas, as we would expect given the nature of the reform—which predominately benefited rural households by granting them (and not urban households) access to privately-held land. While there is at least some evidence of urban children benefiting through higher WAZ values, the fact that these benefits are substantially muted compared to effects in rural areas provides evidence that they are not simply due to contemporaneous economic and policy changes that equally impacted rural and urban areas. Rather, they appear to be due to the unique features of the land privatization reform itself, which impacted rural areas predominately but may have affected urban children to a lesser degree through general equilibrium effects or other spillover benefits.

Table 9: Effect of exposure to land privatization on child anthropometrics, placebo with urban dwelling children

	Panel A: height for age z-scores			Panel B: weight for age z-scores			Panel C: weight for height z-scores		
	All	0-24m	25-60m	All	0-24m	25-60m	All	0-24m	25-60m
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Months exposed overall (including in utero period)	-0.002	-0.006	-0.008	0.010*	-0.026	0.005	0.022**	-0.015	0.02
	(0.007)	(0.032)	(0.008)	(0.005)	(0.023)	(0.006)	(0.007)	(0.021)	(0.011)
Child is female	0.379**	0.562*	0.239	0.055	0.099	0.054	-0.108	-0.209	-0.073
	(0.162)	(0.235)	(0.206)	(0.097)	(0.299)	(0.107)	(0.088)	(0.322)	(0.119)
Survey 1993	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
Survey 1996	-0.763	-3.341***	-0.051	-0.764**	-0.261	-0.719*	-0.115	1.565**	-0.482
	(0.559)	(0.731)	(0.435)	(0.318)	(0.866)	(0.333)	(0.343)	(0.482)	(0.406)
Survey 1997	-1.024*	-3.602***	-0.267	-0.956**	-0.797	-0.741*	-0.132	1.077**	-0.319
	(0.543)	(0.722)	(0.385)	(0.310)	(0.707)	(0.334)	(0.344)	(0.399)	(0.486)
Survey 1998	-0.839	-3.289**	-0.124	-0.871**	-0.706	-0.61	-0.097	1.690***	-0.529
	(0.587)	(0.927)	(0.376)	(0.358)	(0.838)	(0.383)	(0.340)	(0.379)	(0.431)
Age in months FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Oblast FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
HH Head FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	988	340	648	1120	379	741	916	305	611
R squared	0.14	0.23	0.12	0.14	0.20	0.08	0.10	0.19	0.08

Source: World Bank LSMS (1993, 1996, 1997 and 1998). The date of land reform (to calculate months a child was "exposed" to reform) is based on 2016 Life in Kyrgyzstan survey (which provided the month and year).

Notes: These are OLS regressions. “All”, “0-24m” and “25-60m” - the sub-sample includes children aged 0-60, “0-24” and “25-60” months old, respectively, at the time of the survey. The regressions are estimated for the sample of children who live in rural areas. “Months exposed overall (including in utero period)” is the number of months a child was alive during the land reform plus months exposed to land reform in utero. All regressions include survey year fixed effects, oblast fixed effects, child age in months fixed effects, and controls for household head: age, gender, a dummy for being married; and ethnicity (Russian, Kyrgyz, Uzbek, with "other" being a reference group.) Standard errors are clustered at the year of child birth level and appear in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

6. Conclusion

This paper considers the question of whether private property rights to land can improve child health and nutrition outcomes. We exploit a natural experiment in the Kyrgyz Republic following the collapse of socialism, whereby the government rapidly liquidated state and collective farms containing 75 percent of agricultural land and distributed it to individuals, providing 99-year transferable use rights. We use household surveys collected before, during, and after the reform (repeated cross-sections) and spatial variation in the timing of privatization to identify its health and nutrition impacts. We find that young children aged 0-5 exposed to land privatization for longer periods of time accumulated significantly greater gains in height and weight, both critical measures of long-term health and nutrition. Health improvements appear to be driven by increases in consumption of home-produced food—suggesting that increased private control over personal production may translate into increased consumption and thus health dividends for the youngest and thus most vulnerable children.

While households in the Kyrgyz Republic accessed land prior to privatization, they did so predominately through small kitchen gardens and working on communal land which they neither owned nor managed. Our findings point to the important health value of actually having private control over a more sizeable amount of land (1.47 hectares on average during the 1996-1998 surveys, compared to 0.30 hectares on average during the 1993 survey). It is interesting that food purchases and non-food expenditures are not increasing with exposure to land privatization while food consumption is. It suggests either that households' food consumption was inframarginal prior to land privatization and/or that market frictions in the 1990s resulted in households predominately consuming rather than trading the increased home production that land privatization afforded them. Either way, this resulted in health benefits, in the form of higher HAZ and WAZ scores, that accrued mostly to both boys and girls aged 0-2.

Future research is needed to better understand the mechanisms delivering these results. For example, did productivity rise on the plots of land that were privatized, or is it simply the case that households (as opposed to the collective) were better able to retain and use what was produced? What did a switch from collective to private farming do to parental labor supply and time use, and how did this translate into changes in investments in children (e.g., more vs. less time spent with children, or monitoring and investing in their health)? Did access to a greater

array of inputs, ability to decide what to plant or which livestock to rear, or freedom to market agricultural products as desired help in contributing to increased food consumption and child health gains? Interrogating these and other mechanisms will require more data on how individuals farmed in the Kyrgyz Republic before and after land privatizations.

More work is also needed to study whether these impacts hold up in modern-day contexts. Agricultural technology as well as information technology have changed drastically over the last two decades, changing rural service delivery and rural livelihoods (Kosec and Wantchekon 2020). Land markets and markets for goods and services have also changed. Understanding whether and how these changes magnify or blunt the effects of privately accessing land on child health is important for extrapolating from this work to made modern day policy recommendations.

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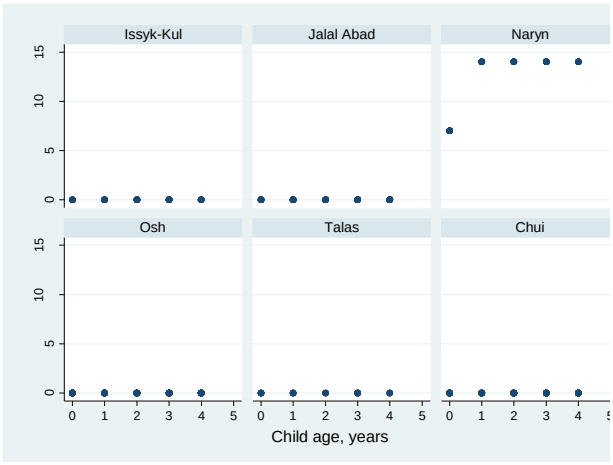
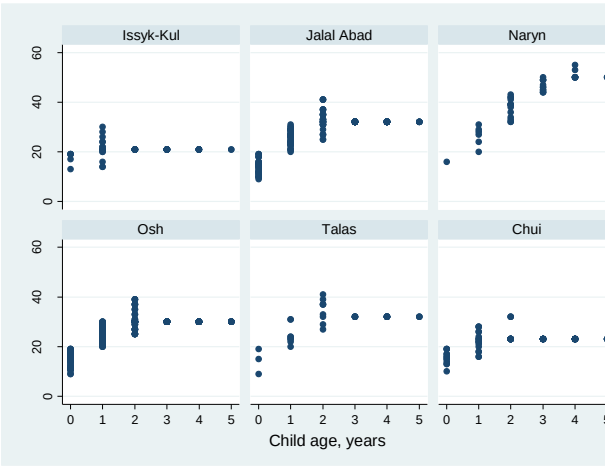
Appendix

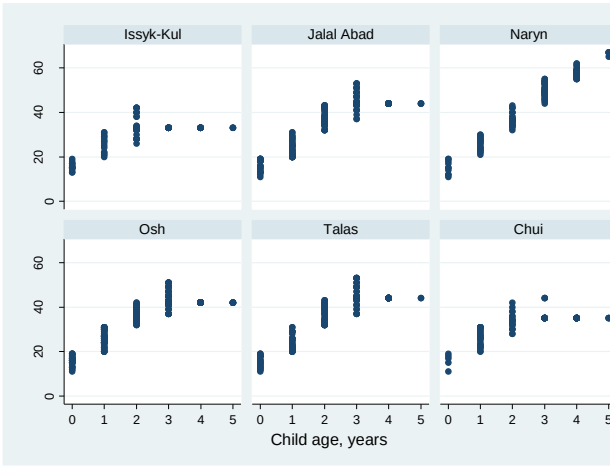
Figure A1: Exposure to land privatization by child age in years and oblast, over the four survey years



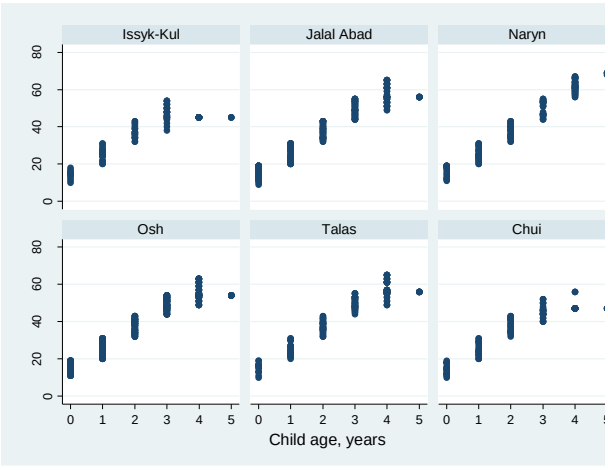
a) 1993



b) 1996



c) 1997



d) 1998

Source: World Bank LSMS (1993, 1996, 1997, and 1998).
Note: Overall exposure includes in utero period.

Table A1: Calculation of child's age in months

Survey year	Month survey conducted	Date of survey administration assumed for child age calculation	Child age in years availability	Year of birth avail.	Month of birth avail.	Day of birth avail.	Age in months calculation
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1993	Oct-Nov	1-Nov-93	YES	based on age in years	NO	NO	Assume that May (i.e., 6 months before the survey date of November) is the month of birth for all children (given a year) and calculate age in months
1996	Oct-Nov	1-Nov-96	YES	YES	YES	NO	survey date - birth date
1997	Oct-Nov	1-Nov-97	YES	YES	YES	YES	survey date - birth date
1998	Oct-Nov	1-Nov-98	YES	YES	YES	YES	survey date - birth date

Source: World Bank LSMS (1993, 1996, 1997, and 1998).

Table A2: Effect of exposure to land privatization on child anthropometrics, robustness to not including the 1993 data

	Panel A: height for age z-scores			Panel B: weight for age z-scores			Panel C: weight for height z-scores		
	All	0-24m	25-60m	All	0-24m	25-60m	All	0-24m	25-60m
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Months exposed overall	0.016	-0.043	0.000	0.014*	-0.027**	-0.003	0.010	0.018	0.022
(including in utero period)	(0.009)	(0.031)	(0.012)	(0.007)	(0.008)	(0.008)	(0.007)	(0.022)	(0.013)
Child is female	0.241*	0.547	0.116	0.073	0.226**	0.044	-0.078	-0.036	-0.091
	(0.118)	(0.265)	(0.058)	(0.081)	(0.061)	(0.092)	(0.069)	(0.178)	(0.056)
Survey 1997	-0.409**	-0.463**	-0.106	-0.369***	-0.537***	-0.061	-0.512***	-0.294*	-0.784**
	(0.121)	(0.120)	(0.152)	(0.091)	(0.110)	(0.105)	(0.121)	(0.128)	(0.195)
Survey 1998	-0.269	-0.467*	0.189	-0.251**	-0.465***	0.168	-0.497***	-0.278*	-0.837**
	(0.165)	(0.187)	(0.218)	(0.106)	(0.077)	(0.133)	(0.109)	(0.112)	(0.273)
Age in months FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Oblast FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
HH Head controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	2663	825	1782	3087	984	2038	2387	750	1584
R squared	0.06	0.10	0.06	0.05	0.06	0.06	0.05	0.05	0.06

Notes: These are OLS regressions using the sample of children aged 0-60 months old at the time of the survey. "All", "0-24m" and "25-60m" refer to children aged 0-60, 0-24, and 25-60 months old, respectively, at the time of the survey. The regressions are estimated for the sub-sample of children living in rural areas. "Months exposed overall (including in utero period)" is the number of months a child was alive while land privatization was in place. The date of land reform (to calculate months of exposure) is based on the 2016 Life in Kyrgyzstan Study (which provided the month and year). Standard errors are clustered at the year of child birth level and appear in parentheses. * p<0.10, ** p<0.05, *** p<0.01.
Source: World Bank LSMS (1996, 1997 and 1998) and Life In Kyrgyzstan Study (2016).

Table A3: Effect of exposure to land privatization on child anthropometrics, robustness to omitting household head controls

	Panel A: height for age z-scores			Panel B: weight for age z-scores			Panel C: weight for height z-scores		
	All	0-24m	25-60m	All	0-24m	25-60m	All	0-24m	25-60m
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Months exposed overall (including in utero period)	0.029***	0.115*	0.008	0.026***	0.068**	0.002	0.01	-0.014	0.017*
	(0.006)	(0.049)	(0.011)	(0.007)	(0.025)	(0.007)	(0.008)	(0.030)	(0.009)
Child is female	0.188*	0.488*	0.061	0.04	0.181*	0.001	-0.069	-0.017	-0.074
	(0.096)	(0.225)	(0.049)	(0.077)	(0.081)	(0.086)	(0.058)	(0.126)	(0.064)
Survey 1993	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
Survey 1996	-1.778***	-3.870***	-1.015**	-1.317***	-2.453***	-0.478*	-0.022	0.277	-0.161
	(0.138)	(0.878)	(0.412)	(0.226)	(0.628)	(0.217)	(0.263)	(0.908)	(0.296)
Survey 1997	-2.286***	-4.510***	-1.213**	-1.741***	-3.100***	-0.549*	-0.496	0.034	-0.822*
	(0.187)	(0.933)	(0.482)	(0.276)	(0.637)	(0.265)	(0.333)	(0.912)	(0.371)
Survey 1998	-2.228***	-4.517***	-1.013	-1.700***	-3.016***	-0.363	-0.465	0.121	-0.857*
	(0.223)	(0.935)	(0.550)	(0.334)	(0.674)	(0.298)	(0.344)	(0.922)	(0.424)
Age in months FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Oblast FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	3335	1031	2304	3823	1208	2615	3072	1001	2071
R squared	0.12	0.21	0.07	0.06	0.11	0.05	0.04	0.04	0.04

Notes: These are OLS regressions using the sample of children aged 0-60 months old at the time of the survey. "All", "0-24m" and "25-60m" refer to children aged 0-60, 0-24, and 25-60 months old, respectively, at the time of the survey. The regressions are estimated for the sub-sample of children living in rural areas. "Months exposed overall (including in utero period)" is the number of months a child was alive while land privatization was in place. The date of land reform (to calculate months of exposure) is based on the 2016 Life in Kyrgyzstan Study (which provided the month and year). Standard errors are clustered at the year of child birth level and appear in parentheses. * p<0.10, ** p<0.05, *** p<0.01.
Source: World Bank LSMS (1993, 1996, 1997 and 1998) and Life In Kyrgyzstan Study (2016).

Table A4: Effect of exposure to land privatization on child anthropometrics, controlling for the availability of land

	Panel A: height for age z-scores			Panel B: weight for age z-scores		
	All	0-24m	25-60m	All	0-24m	25-60m
	(1)	(2)	(3)	(4)	(5)	(6)
Months exposed overall (including	0.030***	0.114*	0.006	0.026***	0.072**	0.002
in utero period)	(0.007)	(0.050)	(0.011)	(0.008)	(0.025)	(0.008)
Child is female	0.179*	0.461*	0.058	0.042	0.195*	0.008
	(0.095)	(0.202)	(0.062)	(0.069)	(0.085)	(0.081)
Survey 1993	ref.	ref.	ref.	ref.	ref.	ref.
Survey 1996	-1.757***	-3.856***	-0.916**	-1.319***	-2.637***	-0.432
	(0.180)	(0.853)	(0.385)	(0.231)	(0.584)	(0.231)
Survey 1997	-2.184***	-4.354***	-1.014*	-1.707***	-3.241***	-0.466
	(0.240)	(0.909)	(0.440)	(0.279)	(0.618)	(0.277)
Survey 1998	-2.158***	-4.428***	-0.817	-1.678***	-3.157***	-0.294
	(0.282)	(0.936)	(0.533)	(0.338)	(0.616)	(0.329)
HH has land	-0.487***	-0.712***	-0.394**	-0.313**	-0.213	-0.359**
	(0.112)	(0.158)	(0.153)	(0.110)	(0.210)	(0.125)
Hectares of land in HH posession	0.013***	0.008	0.016***	0.012***	0.007	0.016***
	(0.002)	(0.006)	(0.002)	(0.003)	(0.006)	(0.002)
Age in months FE	Yes	Yes	Yes	Yes	Yes	Yes
Oblast FE	Yes	Yes	Yes	Yes	Yes	Yes
HH Head controls	Yes	Yes	Yes	Yes	Yes	Yes
N	3295	1019	2276	3774	1194	2580
R squared	0.13	0.22	0.08	0.07	0.11	0.06

Notes: These are OLS regressions using the sample of children aged 0-60 months old at the time of the survey. "All", "0-24m" and "25-60m" refer to children aged 0-60, 0-24, and 25-60 months old, respectively, at the time of the survey. The regressions are estimated for the sub-sample of children living in rural areas. "Months exposed overall (including in utero period)" is the number of months a child was alive while land privatization was in place. The date of land reform (to calculate months of exposure) is based on the 2016 Life in Kyrgyzstan Study (which provided the month and year). "Hectares of land in HH possession" is the amount of land that the respondent indicates that the household can access. Households with "zero" amount of land reported are included in the analysis. Standard errors are clustered at the year of child birth level and appear in parentheses. * p<0.10, ** p<0.05, *** p<0.01.
Source: World Bank LSMS (1993, 1996, 1997 and 1998) and Life In Kyrgyzstan Study (2016).

Table A5: Effect of exposure to land privatization on child anthropometrics, using logged value of exposure to reform

	Panel A: height for age z-scores			Panel B: weight for age z-scores		
	All	0-24m	25-60m	All	0-24m	25-60m
	(1)	(2)	(3)	(4)	(5)	(6)
Log [months exposed overall (including in utero period)] (replace 0 values with 0.001)	0.135**	0.172	0.071**	0.075**	0.053	0.052
	(0.058)	(0.126)	(0.025)	(0.025)	(0.047)	(0.032)
Child is female	0.196*	0.491*	0.063	0.044	0.197*	0.003
	(0.094)	(0.207)	(0.058)	(0.074)	(0.086)	(0.084)
Survey 1993	ref.	ref.	ref.	ref.	ref.	ref.
Survey 1996	-2.273***	-3.122**	-1.477***	-1.357***	-1.604***	-0.962**
	(0.602)	(0.886)	(0.301)	(0.259)	(0.201)	(0.328)
Survey 1997	-2.570***	-3.587***	-1.607***	-1.624***	-2.178***	-1.058**
	(0.563)	(0.898)	(0.253)	(0.290)	(0.243)	(0.331)
Survey 1998	-2.378***	-3.601***	-1.361***	-1.450***	-2.101***	-0.850**
	(0.579)	(0.899)	(0.269)	(0.292)	(0.200)	(0.318)
N	3315	1025	2290	3799	1200	2599
R squared	0.12	0.21	0.08	0.06	0.11	0.05

Notes: These are OLS regressions using the sample of children aged 0-60 months old at the time of the survey. "All", "0-24m" and "25-60m" refer to children aged 0-60, 0-24, and 25-60 months old, respectively, at the time of the survey. The regressions are estimated for the sub-sample of children living in rural areas. "Months exposed overall (including in utero period)" is the number of months a child was alive while land privatization was in place. The date of land reform (to calculate months of exposure) is based on the 2016 Life in Kyrgyzstan Study (which provided the month and year). Standard errors are clustered at the year of child birth level and appear in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

Source: World Bank LSMS (1993, 1996, 1997, and 1998) and Life In Kyrgyzstan Study (2016).

Table A6: Effect of exposure to land privatization on child anthropometrics, with modifications to reform date (+/- one year)

	Panel A: One year forward (move effect of reform by one year later or a delayed response)								
	Height for age z-scores			Weight for age z-scores			Weight for height z-scores		
	All	0-24m	25-60m	All	0-24m	25-60m	All	0-24m	25-60m
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Months exposed overall	0.018*	0.032	-0.006	0.022***	0.060***	-0.011	0.009	0.034	0.006
(including in utero period)	(0.009)	(0.043)	(0.017)	(0.006)	(0.015)	(0.009)	(0.009)	(0.025)	(0.013)
Child is female	0.194*	0.467*	0.066	0.046	0.195*	0.012	-0.071	-0.008	-0.067
	(0.094)	(0.219)	(0.063)	(0.075)	(0.082)	(0.087)	(0.060)	(0.128)	(0.064)
Survey 1993	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
Survey 1996	-1.289***	-2.078**	-0.696*	-1.033***	-2.165***	-0.251	0.013	-0.622	0.195
	(0.142)	(0.662)	(0.303)	(0.177)	(0.515)	(0.148)	(0.188)	(0.683)	(0.291)
Survey 1997	-1.749***	-2.705**	-0.725	-1.500***	-3.029***	-0.183	-0.498	-1.056	-0.409
	(0.249)	(0.874)	(0.474)	(0.224)	(0.598)	(0.241)	(0.299)	(0.752)	(0.446)
Survey 1998	-1.673***	-2.767**	-0.391	-1.478***	-3.005***	0.131	-0.494	-1.04	-0.362
	(0.302)	(0.897)	(0.607)	(0.284)	(0.621)	(0.336)	(0.324)	(0.785)	(0.569)
N	3315	1025	2234	3799	1200	2534	3050	994	2003
R squared	0.12	0.20	0.08	0.06	0.11	0.05	0.04	0.04	0.04
	Panel B: One year backwards (move effect of reform by one year earlier or an anticipatory effect)								
	All	0-24m	25-60m	All	0-24m	25-60m	All	0-24m	25-60m
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Months exposed overall	0.045***	0.087***	0.033***	0.038***	0.083***	0.025***	0.012*	0.025	0.020**
(including in utero period)	(0.006)	(0.017)	(0.008)	(0.005)	(0.020)	(0.005)	(0.006)	(0.019)	(0.006)
Child is female	0.189*	0.475*	0.059	0.045	0.194*	0.007	-0.073	-0.011	-0.072
	(0.095)	(0.210)	(0.064)	(0.072)	(0.083)	(0.085)	(0.059)	(0.130)	(0.062)
Survey 1993	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
Survey 1996	-2.226***	-2.610***	-1.926***	-1.720***	-2.218***	-1.329***	-0.142	-0.376	-0.399
	(0.197)	(0.234)	(0.190)	(0.204)	(0.322)	(0.204)	(0.266)	(0.540)	(0.337)
Survey 1997	-2.707***	-3.073***	-2.259***	-2.142***	-2.779***	-1.577***	-0.608*	-0.629	-1.070***
	(0.219)	(0.223)	(0.233)	(0.201)	(0.305)	(0.218)	(0.274)	(0.500)	(0.268)
Survey 1998	-2.592***	-3.108***	-2.074***	-2.033***	-2.710***	-1.442***	-0.557*	-0.585	-1.011**
	(0.247)	(0.290)	(0.269)	(0.239)	(0.360)	(0.233)	(0.265)	(0.489)	(0.316)
N	3315	1025	2234	3799	1200	2534	3050	994	2003
R squared	0.13	0.21	0.08	0.07	0.12	0.05	0.04	0.04	0.05

Notes: These are OLS regressions using the sample of children aged 0-60 months old at the time of the survey. “All”, “0-24m” and “25-60m” refer to children aged 0-60, 0-24, and 25-60 months old, respectively, at the time of the survey. The regressions are estimated for the sub-sample of children living in rural areas. “Months exposed overall (including in utero period)” is the number of months a child was alive while land privatization was in place. The date of land reform (to calculate months of exposure) is based on the 2016 Life in Kyrgyzstan Study (which provided the month and year). In Panel A the assumed date of exposure is moved one year forward to allow for lagged response. In Panel B, the assumed date of reform is moved one year earlier to allow for anticipatory effects. All regressions include controls for household head age, gender, marital status, and ethnicity (Russian, Kyrgyz, Uzbek, with “other” being a reference group), child age in months fixed effects and oblast of residence fixed effects. Standard errors are clustered at the year of child birth level and appear in parentheses. * $p<0.10$, ** $p<0.05$, *** $p<0.01$.
Source: World Bank LSMS (1993, 1996, 1997 and 1998) and Life In Kyrgyzstan Study (2016).

Table A7: Effect of exposure to land privatization on child health, by urban residence status

	Panel A: height for age z-scores			Panel B: weight for age z-scores			Panel C: weight for height z-scores		
	All	0-24m	25-60m	All	0-24m	25-60m	All	0-24m	25-60m
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Months exposed overall	0.029***	0.111*	0.006	0.026***	0.070**	0.002	0.011	-0.01	0.019*
(including in utero period)	(0.007)	(0.047)	(0.011)	(0.008)	(0.024)	(0.008)	(0.008)	(0.029)	(0.010)
Overall exposed*Urban	-0.031***	-0.117	-0.014	-0.016*	-0.096**	0.004	0.01	-0.005	0.001
	(0.007)	(0.061)	(0.013)	(0.008)	(0.030)	(0.006)	(0.009)	(0.030)	(0.013)
Survey 1993	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
Survey 1996	-1.766***	-3.801***	-0.965**	-1.351***	-2.575***	-0.501*	-0.125	0.148	-0.284
	(0.167)	(0.798)	(0.400)	(0.229)	(0.588)	(0.233)	(0.279)	(0.886)	(0.318)
Survey 1997	-2.263***	-4.374***	-1.148**	-1.794***	-3.215***	-0.602*	-0.626	-0.095	-0.989**
	(0.224)	(0.845)	(0.467)	(0.275)	(0.605)	(0.278)	(0.352)	(0.880)	(0.380)
Survey 1998	-2.206***	-4.399***	-0.936	-1.741***	-3.138***	-0.397	-0.608	-0.053	-1.028*
	(0.263)	(0.874)	(0.549)	(0.333)	(0.609)	(0.321)	(0.357)	(0.889)	(0.447)
Survey 1996*Urban	1.003*	0.46	0.914	0.587**	2.313**	-0.218	0.01	1.417	-0.198
	(0.543)	(1.149)	(0.665)	(0.230)	(0.862)	(0.345)	(0.306)	(0.806)	(0.466)
Survey 1997*Urban	1.239**	0.773	0.882	0.838***	2.418***	-0.138	0.494	1.172	0.67
	(0.458)	(1.135)	(0.604)	(0.229)	(0.608)	(0.361)	(0.366)	(0.844)	(0.513)
Survey 1998*Urban	1.367**	1.111	0.811	0.871***	2.433**	-0.213	0.511	1.743*	0.499
	(0.478)	(1.253)	(0.617)	(0.254)	(0.683)	(0.316)	(0.404)	(0.871)	(0.607)
HH Head FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
HH Head FE * Urban	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Age in months FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Age in months FE * Urban	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Oblast FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Oblast*Urban FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	4303	1365	2938	4919	1579	3340	3966	1299	2667
R squared	0.13	0.22	0.09	0.08	0.14	0.06	0.05	0.07	0.06
F-test	0.755	12.257	4.394	0.643	1.153	2.596	3.143	2.449	2.559
p-value	0.659	0.004	0.035	0.740	0.434	0.116	0.052	0.150	0.119

Notes: These are OLS regressions using the sample of children aged 0-60 months old at the time of the survey. “All”, “0-24m” and “25-60m” refer to children aged 0-60, 0-24, and 25-60 months old, respectively, at the time of the survey. The regressions are estimated for the sub-sample of children living in rural areas. “Months exposed overall (including in utero period)” is the number of months a child was alive while land privatization was in place. The date of land reform (to calculate months of exposure) is based on the 2016 Life in Kyrgyzstan Study (which provided the month and year). All regressions include controls for household head age, gender, marital status, and ethnicity (Russian, Kyrgyz, Uzbek, with “other” being a reference group), a dummy for urban residence, child being female and an interaction term between “female” and “urban” indicators. Standard errors are clustered at the year of child birth level and appear in parentheses. * $p<0.10$, ** $p<0.05$, *** $p<0.01$. “F-test” is the F-test result for testing for joint significance of coefficients estimated on interactions terms with “urban” indicator and the coefficient on urban indicator.
Source: World Bank LSMS (1993, 1996, 1997 and 1998) and Life In Kyrgyzstan Study (2016).