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Using National Statistics to Increase Transparency of Large Land Acquisition

Evidence from Ethiopia

Daniel Ali
Klaus Deininger
Anthony Harris

WORLD BANK GROUP
Development Research Group
Agriculture and Rural Development Team
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Abstract

The 2007/08 commodity price boom triggered a 'rush' for land in developing countries. Yet, many affected countries lacked the regulatory infrastructure to cope with such demand and reliable data on investors' performance. This study uses the example of Ethiopia to show how simple improvements in administrative data collection can help to address this by (i) allowing assessment of the productivity of land use and taking measures to increase it; (ii) comparing productivity between large and small farms to identify spillovers and ways to improve these; and (iii) setting in motion a process of continuing improvement. Implications for global investment in this area are drawn out.

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The authors may be contacted at dali1@worldbank.org, kdeininger@worldbank.org, and aharris3@worldbank.org.

Using National Statistics to Increase Transparency of Large Land Acquisition: Evidence from Ethiopia[¶]

Daniel Ali, Klaus Deininger, Anthony Harris

World Bank, Washington DC
dali1@worldbank.org, kdeininger@worldbank.org, aharris3@worldbank.org

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1. Introduction

Nearly a decade after the 2007/08 commodity-price boom triggered a global 'rush' for agricultural land by investors, a number of stylized facts regarding this phenomenon seem agreed. First, weak or fragmented institutions compromised countries' ability to channel such demand towards areas where it would yield the highest returns or to reject non-viable proposals from inexperienced investors. As a result, the benefits have been less than expected and a sizeable share of investors either went out of business or failed to fully utilize all the land allocated to them. Second, although land demand retreated from 2008 levels, it is expected to continue, albeit at levels much lower than what had been observed at the height of the land rush. In fact, if guided by a coherent and enforceable policy, responsible agricultural investment could provide countries whose economy depends on agriculture with opportunities to add value and generate local benefits.

To realize these benefits, policy decisions are required on a number of issues, including (i) where in the value chain—up-stream in agro-processing, in mixed nucleus estate models with outgrowers, or fully own production—investment would be most desirable and what complementary public inputs may encourage such investment; (ii) how well land that has been transferred to investors is utilized and if not what remedial action (e.g., canceling licenses) may be needed or appropriate; and (iii) how performance compares between local producers and outside investors and what this implies for regulating the sector. Policy decisions on these as well as private investment will require regular access to up-to-date information. Yet, few countries developed the systems to regularly provide the data needed and even much of the empirical literature is still based on case studies the representativeness of which is difficult to establish, often focusing on process rather than quantification of outcomes. Lack of reliable and regular information will make it difficult to manage investment- or country- risks, enforce laws, and document compliance with global standards to attract capable and responsible (institutional) investors.

To explore ways of satisfying such information needs in a sustainable and effective way, we draw on a nationally representative large farm survey in Ethiopia conducted between 2010/11 to 2013/14. Ethiopia is an interesting case as it has a long tradition of collecting systematic data on large (state) farm performance which, due to poor data quality, were often not reported or even stopped intermittently. Data collected with an improved survey instrument allow to draw interesting conclusions on commercial farming in the country. First, even at the peak of the 'land rush', the amount of land transferred to investors in commercial farms that are at least partly operational, the vast majority of which was to Ethiopians rather than foreigners, was much less than claimed in some widely quoted reports (Land Matrix 2015; Oakland Institute 2011; Rulli et al. 2013). Since 2007/08, the level of annual land transfers reverted more or less to what was observed before 2007. Second, about 55% of the land transferred remains unutilized with main constraints to expansion related to technology and labor. Third, with one permanent job per 20 ha plus some temporary

jobs, commercial farms fail to generate much employment. Finally, for most crops, commercial farms' yields are roughly double those by smallholders though the highest yields are normally obtained by those in the 10-20 ha category which often also managed to expand area cultivated quite rapidly. While lack of data on prices and inputs makes it impossible to assess how much of this difference is due to higher efficiency rather than just more intensive use of inputs, in particular improved seeds, or locations, commercial farms could create spillovers for small farms through a number of channels that would merit further study.

Beyond providing analytical insights that are of interest in their own right, having reliable data on outcomes by commercial farms can generate feedback loops for policy formulation. In our case, these include a continued impetus to improve the survey instruments used, efforts to better link to existing data, such as investment licenses and survey plans, that are issued and maintained by other agencies, and exploration of ways, such as yield monitoring based on remotely-sensed data, that could help to complement, cross-check, and eventually even partially replace survey information.

The paper is structured as follows. Section two provides background information on the 'global land rush' and discusses the Ethiopian context with efforts to improve the quality of data collected in the sector. Section three and four use the case of Ethiopia to illustrate how a relatively modest investment can significantly improve availability of information on key parameters in the debate, including (i) the share of national vs. foreign investors; (ii) the amount of large farm land that is not utilized; (iii) key constraints used by large farmers; (iv) input use and yields for main crops in different farm size groups; and (v) comparing yields between large and small farmers. Finally, in addition to describing outcomes, we highlight potential alternatives for situations where no regular farm surveys are conducted and draw out how these data can inform the research agenda.

2. Background and literature

Although the volume of new land deals has declined, large-scale land acquisition will not disappear quickly. To regulate it in a way that allows to attract capable investors and to address the legacy of failed land acquisition, good information on the overall level of land transfers and the efficiency of land use is indispensable. Yet, while a review of the literature points towards a number of stylized facts regarding such investment, it is often based on one-off case studies the representativeness of which is not clear. The case of Ethiopia provides some lessons in the area.

2.1 The global land rush (nearly) a decade on

After decades of stagnant or declining commodity prices when agriculture was considered a "sunset industry", increases in the level and volatility of commodity prices and a concomitant rise in global demand

for land have led to what many observers view as a "land grab" (Pearce 2012) that risks depriving local farmers and communities of resources rather than providing them with opportunities for development. The size of land demand took many host country governments by surprise. Without the requisite institutional infrastructure to check investors' business plans, provide information or assistance with negotiation to communities where land demand had surfaced, and document and verify compliance with contractual terms and the impact of large land acquisitions, many of the relevant cases did indeed fail to increase productivity of land use or generate local benefits (Deininger and Byerlee 2011).[1] There is indeed evidence for investment having failed to not only live up to high and possibly exaggerated expectations by its proponents, something that should not have come as a surprise given the historically high failure rate of such investments (Tyler and Dixie 2013).

At the same time, it is argued that in many developing countries, there is a need to go beyond the dichotomy of large vs. small and look instead at new ways of combining the two (Collier and Dercon 2014). There is now indeed a wealth of guidelines to support responsible investment throughout the agricultural supply chain (OECD 2014) and it is often argued that the most effective arrangements may be those aiming at exploiting synergies between upstream investments in agro-processing industries or through nucleus estate or outgrower arrangements.

This leads to two challenges. First, there is a need to distinguish between 'pioneers' increasing productivity and generating local benefits and 'speculators', including possibly urban elites (Sitko and Jayne 2014), who acquire large tracts of land in the hope of benefiting from future land price appreciation (Collier and Venables 2012). Pro-active steps to protect existing rights, strengthen negotiating and monitoring capacity, and establish the regulatory framework and transparency in terms of access to information and accountability are needed to attract investors who are financially and technically capable as these are not just going to show up at a country's doorstep. Second, a strategy on discovering and dealing with failed enterprises, including ways for failed ventures to exit the sector in ways that do not imperil local people, ia important. This is particularly relevant in light of the fact that in many of the cases of large-scale investment, land markets do not exist or may be legally prohibited. History demonstrates that large land owners who are unable to make effective use of land may use political channels to affect factor prices, e.g., by trying to keep down labor cost or constrain access to capital, with unfavorable long-term consequences.[2]

[1] The land available for expansion in Africa, most of it is concentrated in few countries (Deininger and Byerlee 2012), with poor access to infrastructure and low levels of profitability (Chamberlin *et al.* 2014), and often also very weak governance (Arezki *et al.* 2013).

[2] The importance of this issue is demonstrated by the many historical examples where accumulation of large tracts of land by large but relatively inefficient farms led to rent-seeking behavior and, using their locally dominant position, to monopolize input or output markets (Binswanger *et al.* 1995), subvert provision of public goods such as education (Nugent and Robinson 2010; Vollrath 2009), undermine financial sector development (Rajan and Ramcharan 2011), or restrict political participation (Baland and Robinson 2008).

Although the uptick in land-related investment prompted efforts at systematic data collection (Anseeuw *et al.* 2012), available global databases suffer from considerable weaknesses (Arezki *et al.* 2015) and fail to reflect the complexities of land acquisitions (Hall 2011) or representativeness (Cotula 2014). Still, a large amount of the current knowledge comes from case studies, which can provide qualitatively valuable insights but, without information on the universe from which cases were selected, will still have to be accompanied by ways to test their representativeness and replicability (Schoneveld 2014). Moreover, many of the case studies focus on process rather than robust evidence on outcomes.

From an analytical point of view, systematic data at country level are needed to explore the extent to which these investments target easily accessibly areas or compete with smallholder agriculture (Messerli *et al.* 2014), investors live up to their commitments (Burnod *et al.* 2013), and to identify indirect effects of agricultural investment (Andrade de Sa *et al.* 2013). In terms of policy, lack of good and regular data makes it more difficult to attract capable investors by (i) increasing the transaction costs of identifying good opportunities; and (ii) making it more difficult to access institutional sources of funding which require minimum levels of reporting and are increasingly bound by a trend towards traceability and 'responsible' investment. It may also reduce security of tenure for investors as, without a basis to document claims, they may be subject to frequent and disruptive renegotiation.

2.2 Ethiopia's context

Large farm investment is not new to Ethiopia; in fact in the pre-revolutionary period, the state used large subsidies to attract commercial investment in agriculture. This led to establishment of highly mechanized cash crop production in so-called 'model farms' the establishment of which was often associated with tenant evictions.[3] After the 1974 revolution, the Derg converted most of these into state farms for food production. Though their yields were above those by peasants, their efficiency and contribution to national agricultural output (2%) remained low (Abebe 1990).

After 1990, a strategy of market liberalization and agriculture-led industrialization focusing on small-scale producers was adopted.[4] To assess its success, Ethiopia's Central Statistical Agency (CSA) started collecting of annual data on smallholders' productive performance using a survey administered by resident enumerators to a representative sample of some 40,000 farmers nationally. It complements information on inputs application with a crop cutting exercise for a minimum number of plots in each enumeration area.

The transition to a free market economy was followed by higher private investment in commercial farms whose share of the country's gross agricultural output increased to about 7%. In fact, reference to potential

[3] Main areas included Awassa, Arbaminch, Zeway and Shewarobit.
[4] Small producers are defined as those with a size below 10 hectares and all farms above this size fall into the 'commercial' category.

benefits in terms of food security, job creation, technology transfer, capital accumulation, export promotion, and environmental sustainability led the government's latest 5-year Growth and Transformation Program (GTP) to put considerable focus on investment in commercial farms. To assess if such benefits materialize, reliable information on large farms' productivity is essential. A 'State Farms Survey' completely enumerate the universe of commercial farms had been part of the country's annual agricultural sample survey from the very beginning. Yet, the underlying data were based on farms' administrative records rather than actual enumeration with often little relationship to field realities.[5] To reduce such reliance on secondary sources, CSA included a complete enumeration of commercial farms, using a sample frame assembled from information provided by zonal investment offices,[6] in its 2001/02 agricultural sample enumeration. However, high non-response and weak supervision reduced data quality. Although large and medium commercial farm surveys (LMSCFS) were conducted on a regular basis in subsequent years, results were not published or underlying data disseminated. Eventually, CSA's program of large- and medium-scale commercial farm surveys was suspended in 2005/06, just before investor interest in large-scale land-based investment peaked.

In 2007/08, such surveys were thus resumed, with a number of modifications, namely (i) use of a smaller number of more highly qualified field staff to gather information; (ii) a reduction of the sample size by only covering the universe of farms above a certain cut-off point (50 ha) and using a sample for commercial farms below this size; (iii) streamlining the survey instrument to focus on essential information first with the option of expanding as experience accumulates; (iv) collaboration with other agencies, in particular the Investment Agency, to ensure a sample frame; and (iv) area measurement by GPS to get a point of reference that makes it more difficult for respondents to intentionally provide mis-information. Still, when policy makers required information on the contribution of different types of commercial farm investment to the national economy and regulatory measure to maximize such impact, survey data proved insufficient to answer any questions beyond simple output estimates for national production statistics.

To remedy this, a technical cooperation with the World Bank's research department was initiated starting with the 2013/14 survey focusing on two aspects. First, the questionnaire was expanded to include time and amount of original land receipt, basic data on labor use, investment, and markets, and perceived obstacles to further expansion. Second, efforts were made to link data over time and use the frame to obtain an

[5] Information obtained included area and production of temporary and permanent crops; land use, i.e., total cropland area, fallow land, grazing land; agricultural practices, such as use of various inputs, quantity and cost of inputs used; number of livestock and poultry by type, purpose, age and sex; number of farm machineries used by type and market value of each; number of permanent and temporary employees by type of profession.

[6] In principle, the most immediate candidate for a sample frame is the list of potential investors who either applied for or obtained an investment license. This would include those who proceeded to invest and those who did not, thus allowing to obtain information on obstacles encountered throughout the process. Unfortunately, although a list of more than 10,000 investors was available, it was not a viable strategy due to limited documentation gathered in the process and the fact that most of the phone numbers provided could not be reached.

estimate of the amount of land transferred to commercial farms that is entirely unused and to link different survey rounds over time to measure changes in performance over time by any given farm (Beyene 2015).

The positive impact of these changes, as described below, led CSA to further modify the instrument for the 2014/15 season to collect data on inputs and outputs at the plot rather than the farm level. For 2015/16, it is planned to (i) have plot boundaries recorded to allow yields to be cross-checked against independent estimates obtained from satellite imagery; and (ii) link the survey frame more clearly to data from other sources, especially the Agricultural Investment Office's list of investment licenses to determine what types of projects were abandoned and possibly probe into reasons why this happened.

3. Descriptive evidence

Survey data on operational farms allow us to characterize overall land transfers as well as performance of commercial farms in a way that can dispose of some common myths. First, with some 160 ha per farm, mean area transferred to large farms is below what has been reported in other databases (Land Matrix 2015) and studies (Oakland Institute 2011; Rulli et al. 2013; Rahmato 2011). With land disputes, technology, and manpower given as main reasons for 43% of commercial farms' land not being fully utilized, tighter screening of applications in the pre-investment phase or monitoring once ventures started may improve outcomes. Second, positive spillovers may be limited by the fact that most investment is focused on on-farm infrastructure, less than 5% of large farms have outstanding credit, and the amount of lease fees paid seems modest. Third, with one permanent employee per 20 ha, job creation is below the amount of labor that could be productively absorbed by smallholder agriculture, possibly through investment upstream in the value chain.

3.1 Scale and use of lands transferred

Starting from 1991, some 1.33 million ha had been allocated to 6,600 commercial farms with the rate of transfer having peaked in 2008 but since then fallen to pre-2007 levels.[7] As large farms' plots were geo-referenced and the start date for each farm in the sample is known, we can map the evolution of commercial farms over time.[8] Results show an initial cluster of sesame and sorghum farms comprising transformed state farms in the North-West, followed by expansion of commercial farming for maize and wheat in the center, and eventually a movement towards the border regions of Benishangul-Gumuz and Gambella (fig. 1-4).[9]

[7] Note that the sampling strategy implies that, subject to non-response, the survey provides a reliable measure of the area transferred to farms that were fully or partly operational (CSA, 2011). A simple check of land transferred by the Investment agency against those that have been identified by CSA as operational on the ground could provide information on land area under non-operational farms. In terms of non-response, information on 300 farms with size 50 and above, who did not respond to the detailed survey, is not included. The total farm size of these farms (excluding Karuturi Global Limited with 100,000 ha), based on administrative information, is about 117,000 ha.

[8] Although GPS was used to determine plot area, the waypoints generated in this way were not saved and instead only one point was recorded per plot. While this allows us to locate farms, it makes it impossible to obtain precise plot boundaries.

[9] In interpreting these figures, it is important to note that there will be survivor bias, i.e., farms that have gone out of business are no longer included.

Table 1 provides information on total land area allocated to commercial farms in different regions by time of establishment, owner's nationality, main crop, and the main negotiating partner (direct negotiation with locals, woreda, region, or federal government). While commercial farms acquired sizeable amounts of land over time, neither total nor average amounts of land transferred are close to figures reported in some of the literature (Land Matrix 2015; Oakland Institute 2011; Rulli et al. 2013).[10] A total of 1.33 million hectares was transferred to 6,612 commercial farms operational in 2013/14, i.e., some 200 hectares per farm, compared to 9.6 million hectares cultivated by smallholder farms. Average farm size varies across regions: it is highest in Gambella (462 ha per farm)[11] followed by Benishangul and Oromia (293 and 290 ha per farm, respectively), and that of SNNP and Afar regions (163 and 140 ha, respectively). Average farm size in Tigray and Amhara regions is roughly a fourth and a fifth of what is observed in Gambella, and the lowest in Somali region with just 16 ha per farm.

Of the 6,612 commercial farms, most (28%) are in of Amhara, followed by SNNP (25%), Tigray (15%), Benishangul (12%), Oromia (11%), and Afar, Gambella, and Somali (together 9%). The highest share of land area initially transferred to investors was in SNNP (25%), followed by Benishangul (21%), Oromia (18%), Amhara (15%) and Tigray (10%). Meanwhile, the contribution of Gambella (excluding land transferred to Karuturi Global Limited) and Afar was, respectively, about 7% and 4% of the total land transferred, and that of Somali region was a mere 0.01%. About 87% of the 6,344 farms that provided information on the size of the initial land allocation on average received area of land between 20 and 500 ha and only 6.4% received above 500 ha. Similarly, of the farms providing information on the owner's nationality, 97% are purely Ethiopian owned and only 134 or 36 are, respectively, held purely by or jointly with foreigners. In line with the policy change since 1991, most of Ethiopia's commercial farms are owned and operated by private owners (93% of the farms holding about 78% of initially land transfers) while some 2% of farms with 15% of initially awarded land are owned by government and the remainder are owned and operated by producer cooperatives. Government owned farms are primarily located in Oromia where they account for 93% of initial land transfers, with 83% of farms having been established before 1991.

A total of 302 farms were established before 1991, mainly in Oromia and SNNP, with a mean initial land allocation of 684 ha per farm. Subsequently, the number of farms established per year reached 315 in 2002-06, peaked at 793 during the 2007/08 commodity price boom, and fell to 546 and 371, respectively, in the 2009/10 and 2011/13 period. In other words new commercial farm establishment in 2013 had dropped to the level attained before the 2007 food price boom. Mean size of initial land transfer was, with some 80 ha, smallest in 1991/2, gradually increasing to 223 ha during the 2011-13 period.

[10] "Our research shows that approximately 3,619,509 ha of land have been awarded, as of January 2011" (Oakland Institute 2011: p. 18).
[11] Note that Karuturi Global Limited, a company that acquired 100,000 ha of farmland in Gambella in 2008 and that is now deemed to be bankrupt, is not included in the computation of total area and average farm size.

Regionally, the location of newly established farms shifted from the central highlands (Tigray, Oromia, Amhara, and to some extent SNNP) to the periphery (Benishangul and, to a lesser extent, Afar, Gambella, and Somali regions). Across regions, the share of farms and area allocated are highest for sesame (38% of farms and 27% of area, with an average farm size of 142 ha primarily located in Amhara, Tigray, and Benishangul regions), followed by coffee (15% of farms and 12% of area, with a farm size of 167 ha mainly in SNNP and Oromia), maize (13% of farms and 12% of area, with a farm size of 183 ha mainly in SNNP and Oromia), sorghum (13% of farms and 7% of area with a mean farm size of 116 ha in Tigray, Amhara, and Benishangul), cotton (6% of farms and 9% of area, with a mean farm size of 324 ha focused on Afar region), wheat (4% of farms and 9% of area, with a mean farm size of 498 ha mainly in Oromia and SNNP regions), and all other crops (12% of farms and 23% of the area, with a mean farm size of 389 ha).

Ethiopian law, similar to that in many other countries, allows land transfers below a certain size to be processed locally, with cascading thresholds, which were adjusted over time, requiring approval at woreda, regional, or national level. A total of 380 farms with an average size of 113 ha, mainly in Afar and SNNP, had been acquired through direct negotiation with farmers with little effective government. With 32% of area transferred, the majority of land acquisitions were negotiated at woreda level (3,499 or 56% of farms with a mean size of 115 ha) or the region (34% of farms with a mean size of 241 ha accounting for 41% of area). The federal government accounted for 252 land transfers (4% of the total) although larger land sizes (average farm size of 1,155 ha) imply that these accounted for 23% of total area transferred.

3.2 Structural characteristics

Farms in our sample expanded from 1.33 million ha to 1.77 million ha, though only some 57% of this area (1.01 million ha or 153 ha per farm) is actually utilized (table 2). Levels of land utilization are highest for farms established before 1991 (72%) and those cultivating wheat (72%) and cotton (62%). Contrary to anecdotal evidence of larger farms utilizing less of the land transferred to them, we find that farms with a size above 1,000 ha use 64% of their land, compared to below 55% for the farm size group below 100 ha.

Discrepancies between the size of land originally allocated and what is currently cultivated point towards dynamics that would be worth exploring in their own right. Farms with initial allocations of less than 500 ha expanded significantly so that they now hold areas that are, on average, much larger than what had been originally transferred to them. By contrast farms in the above 500 ha group cultivate much less than what they received initially. As Ethiopia does not allow land sales, it would be of great interest to find out how expanding farms received their land from and what happened to land transferred but no longer used.

The average size of utilized land ranges from 7.4 ha in Somali region to 312 ha in Gambella and the time profile of land transfers illustrates that, in most regions, average utilized area per farm peaked in 2007/8

and decreased thereafter. Data on average used land by size of initial land transfer point towards some interesting dynamics by farm size. For example, in all regions except Benishangul (Somali and SNNP), commercial farms that had initially been allocated less than 20 ha (20-50 ha) expanded, in some cases quite significantly. At the same time, farms initially allocated between 500 and 1000 ha or above 1000 ha cultivated less than this amount in 4 of the 8 regions. While detailed analysis of farm dynamics, sources of additional land acquired, and underlying factors (e.g., productivity) will be of interest, opening up options for a gradual increase in farm size for investors who prove to be successful may thus be a better strategy than giving large initial amounts of land to relatively unproven investors.

Average land size transferred and utilized is larger for foreign than for national investors throughout, being largest in Gambella (2,212 ha) and Tigray (1,441 ha). It is larger for farms approved at higher levels, although, with the exception of Tigray, Amhara, and SNNP, area currently used by farms acquired by direct negotiation exceeds that of farms established through negotiations at woreda level. Farm size is higher for government owned farms—predominantly located in Oromia (1,509 ha/farm) and SNNP (220 ha/farm) — and for cotton in Benishangul (1,126 ha) and Gambella (1,070 ha), followed by wheat in Oromia (671 ha).

To allow a first assessment of the extent to which commercial farms generate benefits for locals, table 3 tabulates key parameters in this respect (land acquisition, investment, credit market participation, use of improved inputs, and job creation) overall and by main crop. It illustrates that, overall, less than half the land area acquired (95 of 197 ha) was utilized during the first year of operations, increasing to 153 ha in the 2013/14 growing season. Only some 37% (close to 60% for maize, wheat, coffee and 'others', a category that is likely to include horticultural crops) report either lease length or annual lease fee. For those who do so, average lease length is 32 years at a fee of B 474 per ha (about USD 24 at the current exchange rate), although it is more than double this amount for wheat and 'other' crops.

With the exception of wheat farms, more than 90% of the farms reported to have made investments amounting to an average of B 13,000 per ha (USD 650 at today's exchange rate), from B 8,000/ha for coffee to B 34,000/ha for others. While there are differences across crops, most investment was for tractors and other machinery (39%), followed by land clearing (37%), buildings (18%), and roads/infrastructure (6%).

Contrary to the perception of investors having near unlimited access to working capital, most of the initial investments seem to have been made out of own equity rather than by tapping into credit markets: in fact, less than 20% of commercial farmers indicated having taken a loan during the last 5 years with a mean loan size close to B 14,000. Even less, only 5% of commercial farms, had outstanding credit (of some B 11,500 or less than USD 600) with the incidence of outstanding loans lowest for Sorghum (3.6%) and highest for maize (8.1%) with mean outstanding loan amounts of less than B 7,000 for sesame and cotton and more

than B 25,000 for 'others'. Establishing commercial farms is unlikely to increase credit market access for neighboring small-scale farmers.

While some 50%, 60%, and 25% of commercial farms overall applied fertilizer, crop protection chemicals and improved seeds, incidence and magnitude of the use of these inputs varied by crop and farm size. Fertilizer use averaged 200 kg/ha, with an incidence between 13% for cotton and coffee (using 17 and 60 kg/ha, respectively), 52% for sesame (33 kg/ha), 65% for 'others' (785 kg/ha), and 80% or 82% for maize and wheat (with 215 and 187 kg/ha, respectively). Incidence of crop protection chemical use ranged from 20% for coffee to 91% for cotton while, for crops where improved seeds are important, incidence of their use ranged between 57% for 'others' and 81% for maize.

The notion that large farms do not create large amounts of permanent employment is supported by the fact that, with an average of 0.05 permanent jobs per ha or one permanent worker per 20 ha farmed (plus 6.4 temporary workers, most of them male), commercial agriculture generates much less gainful employment than smallholder agriculture. Interpreting these figures is made difficult by the fact that the survey does not provide information on number of days worked and failed to indicate whether such employment was during the startup phase or during regular operations. Also, as smallholders may grow crops similar to those cultivated by commercial farms, seasonality will be an issue.

3.3 Constraints to expanding operations and interactions with smallholders

As large amounts of land are transferred but not fully utilized, assessing perceived constraints to better land utilization may help identify areas to be strengthened in the pre-transfer review process. Indeed, as illustrated in table 4, some 50% of commercial farms, from 17% in Tigray to of 88% in Benighangul and some 70% in Gambela and SNNP indicate that they do not effectively utilize all of the land received. Key constraints to full use of available land relate, in descending order, to technology, manpower, land disputes, infrastructure access, and lack of resources for land clearing or credit. Regional differences are, not surprisingly, considerable: delayed availability of machinery, possibly due to import regulations, comes top in Gambella, followed by manpower which is a top issue in Benishangul and the second most important one in SNNP. Capital needs for land clearing need are important in Amhara and marketing in Afar.

While earlier figures suggest limited credit market access, almost two thirds of farms, from 80% in Tigray, 78%, 68%, and 67% in SNNP, Oromia, and Gambella, respectively, to 33% in Afar and Somali regions, reported having given advice or other support to neighboring smallholders. If true and if no countervailing negative effects (e.g., from monopolizing access to resources) exist, one would expect commercial farm establishment to generate positive spillover for smallholders. Testing existence or magnitude of such effects empirically, though beyond the scope of this paper, would be of interest.

4. Resource use and productive performance across the farm size distribution

To assess relative productive performance, we pool data on commercial farm with those from smallholders. Overall yields by commercial farms' are double those by smallholders most often achieved by farms in the 10-20 ha category. More intensive use of inputs by large farms may account for part of this advantage, but lack of data on these, especially on labor, makes it difficult to assess productivity. The inverse relationship between farm size and productivity tends to disappear for commercial farms.

4.1 Descriptive evidence

While there has been a large literature on the relationship between farm size and productivity (Ali and Deininger 2015), most analyses use data from smallholders or commercial farms separately, a separation that can yield biased estimates (Muyanga and Jayne 2014). To overcome this, we pool smallholder and commercial farms to explore the farm size-productivity relationship using data for the entire farm size distribution. Table 5 reports summary statistics of cultivated area and yield for selected major crops, as well as incidence and intensity of chemical fertilizer and improved seeds use by crop.[12]

The top panel highlights the marked differences in area cultivated between smallholders who all use less than one hectare on average for each specific crop and commercial farms, the largest group of which use 1,650 ha for wheat and about 1,200 and 1,000 ha for cotton and sesame. Comparing yields between smallholders and commercial farms suggest that, except for teff and coffee,[13] the latter obtain about double the yield of the former, though better information on specific inputs, especially labor, and their cost would be required to translate this into productivity. Among commercial farms, those between 10 and 20 ha obtain the highest yields for most crops (maize with 4.2 t/ha, sorghum with 3.1 t/ha, teff with 0.9 t/ha, wheat with 4.2 t/ha, sesame with 1.4 t/ha, and soya beans with 2.4 t/ha). Exceptions are beans and coffee where yields are highest in the 20-50 ha category, and cotton, where they peak in the 50-100 ha bracket.

Beyond yield differences, incidence of fertilizer use varies across farm size groups. In maize, only 35% of smallholders but 53% of commercial farms below 20 ha and 84% of those in the 100-500 ha group use fertilizer although, with 160 to 190 kg/ha, amounts applied by users are very similar. Differences are similarly pronounced for sesame, where 10% of smallholders vs. 65% of the largest farms use fertilizer, coffee (5% vs. 60%), and sorghum (17% vs. 45%) but less strong for wheat (65% vs. 75%) and teff, a typical smallholder crop where fertilizer use is highest for commercial farmers below 20 ha. The gap in improved input use between large and small farms is even more pronounced for improved seeds which was used by 20%, 1%, 4%, 12%, 1% of smallholders in maize, sorghum, teff, wheat, and sesame, respectively,

[12] The number of observations in each of the cells is reported in the bottom panel of table 5.

[13] Estimating coffee output could be tricky as it can be reported in different conditions and states (e.g., cherry coffee harvest vs. washed and dried coffee beans). Apparently, without the conditions and states reported in the two surveys, we need to be cautious while comparing coffee yield between smallholder and commercial farms.

compared to 80%, 42%, 85%, 74% and 60% in these crops for the largest commercial farms. As fertilizer will be most effective if applied together with seed, this could pose a serious constraint; in fact smallholders may even apply more fertilizer than can productively be absorbed by their traditional seed material.

4.2 Regression results

While lack of prices and labor input in our data makes it difficult to estimate a production function, we use pooled smallholder and commercial farm data to run naïve regressions to estimate the relationship between farm size and yields as well as the likelihood of applying fertilizer or improved seeds. Assuming a quadratic relationship and allowing for structural differences in technology between smallholders and commercial farms, our estimating equation takes the form:

$$y_i = \alpha_0 + \alpha_1 A_i + \alpha_2 A_i^2 + \beta_0 D_i + \beta_1 A_i \times D_i + \beta_2 A_i^2 \times D_i + \theta_w + \epsilon_i \quad (1)$$

where y_i is the log of physical yield of farm *i* from a given crop (maize, sorghum, teff, wheat, haricot beans, sesame or coffee) in quintals per ha; A_i is the log of cropped area allocated to this crop; D_i is a commercial farm dummy; θ_w denotes district (woreda) fixed effects to capture differences in agro-ecological conditions or infrastructure; $\boldsymbol{\alpha}$ and $\boldsymbol{\beta}$ are vectors of parameters to be estimated, and ϵ_i is a random error term. We use a similar specification to estimate a linear probability model for the incidence of chemical fertilizer and improved seed use. As output is in physical units and no information on prices was collected, computing monetary output values is impossible.

Results from regressions for yield and the incidence of fertilizer and improved seed use are given in table 6, 7, and 8, respectively. Figures 2-6 graphically depict the relationship between farm size and yield as well as incidence of fertilizer use by plotting the marginal effects together with the associated 95% confidence interval for different farm sizes (in logs), separately for smallholders and commercial farms in maize, sorghum, teff, wheat, and sesame. We focus on three parameters, namely (i) if marginal effects are different from zero at 5% statistical level (as indicated by the 95% confidence band in the graph); (ii) if the marginal effect, at a given farm size, is greater or smaller than zero; and (iii) the slope of the marginal effect.

In line with what was obtained earlier, our analysis illustrates that underlying relationships may be crop specific. For maize, we obtain a significant negative and slightly downward-sloping relationship between farm size and yield for smallholders, implying that the marginal effect is negative and decreases with farm size. For commercial farms, the marginal effect of farm size is marginally positive at the smallest farm size (1.4 ha) but turns negative above a farm size of some 30 ha. By contrast, the impact of farm size on fertilizer application is positive but downward-sloping, i.e., larger farm size makes fertilizer application more likely but at a decreasing rate. For wheat, marginal effects are also negative throughout but increase and become indistinguishable from zero for the largest smallholder and commercial farms. The likelihood of fertilizer

use in wheat fields is unaffected by size for commercial farms and is positive, but with a decreasing slope, for smallholders. By contrast, for sesame and sorghum, we find a negative relationship between size and productivity for small farms, approximate neutrality of yields with respect to size for large farms, and a positive relationship between fertilizer application and farm size for commercial farms.

5. Conclusion and policy implications

A key premise of this paper is that, without sustained improvements in the quality and publicity of data on large-scale land-based investment, target countries may struggle to put in place a regulatory framework to increase the likelihood of such demand being translated into sustained local benefits or to attract responsible investors and institutional capital. The case of Ethiopia shows that a modest investment in data collection can have high returns and can incrementally build local data collection and analytical capacity.

Although the descriptive evidence reported here only scratches the surface, it provides an interesting basis for future research. From a research perspective, it will be interesting to link this more directly to ongoing data collection efforts in the smallholder sector, among others, to look at the interaction between large farms and neighboring smallholders; in particular, the nature and size of potential spillover effects and the channels through which they materialize. Among commercial farms, determinants of entry and exit, and more generally the dynamics of firm performance over time would also be of interest.

The usefulness of such data for government decision-making can be improved by linking more closely to data that are—or should be—held by other parts of the administration in at least two respects. First, business plans or licenses held by investment promotion agencies can serve as a basis for enforcement of contractual terms (e.g., fee collection) and meaningful monitoring of compliance with contractual obligations and, if necessary, adoption of remedies to bring about improvements. Second, linking geographic data on land cultivated with parcel boundaries kept by land administration institutions will be useful, as it allows comparison between the area adjudicated and what is actually used, thus possibly providing an opportunity to either cleanse or establish records through a process of negotiation to avoid border disputes.

The fact that, in Ethiopia, the statistical agency is now initiating experiments to use the parcel boundaries as a basis for yield monitoring illustrates that, beyond its immediate usefulness in terms of providing vital information to assess and take regulatory action to manage an important part of the agricultural sector, such investment in data also create opportunities for realizing synergies with other institutions that can help to increase transparency to better assess and manage risk in production or upstream in the value chain. This can in turn be an important input into attracting higher levels of investment to the sector, something that by itself can generate the returns needed to justify such an investment.

Table 1: No of large farms in Ethiopia and land area initially transferred to them

	Farms No.	Area ha	Avg. ha	Tigray	Afar	Amhara	Oromia	Somali	Benish.	SNNP	Gambella
				Number of farms							
Total[1]	6,612	1,328,883	200.99	1,028	295	1,857	701	60	811	1,686	169
By Year of establishment											
Before 1991	302	211,074	698.41	17	1	36	103	46	1	86	10
1991-1992	394	31,431	79.72	372		14	1			6	
1992-2002	1,234	206,587	167.46	372	30	342	175	1	18	265	30
2002-2006	1,261	168,211	133.40	93	39	694	124	4	54	242	10
2007-2008	1,586	314,775	198.47	105	93	280	173	6	289	587	53
2009-2010	1,093	231,651	211.99	39	66	287	72		324	254	51
2011-2013	742	165,154	222.62	30	66	204	53	3	125	246	15
By Size											
< 20 ha	392	4,940	12.62	155	58	57	34	15	2	63	4
20 - 50ha	1,031	32,533	31.54	466	59	239	110	6	20	120	11
50 - 100 ha	2,224	140,260	63.06	112	93	1020	131	4	150	690	23
100 - 500 ha	2,292	495,104	215.99	228	75	494	278	1	487	656	74
500 - 1000 ha	243	147,966	609.47	26	1	16	30	1	109	32	28
> 1000 ha	162	508,079	3,143.28	12	6	4	30		29	61	19
By owner's nationality											
Ethiopian	6,287	1,085,593	172.67	1018	296	1824	566	60	786	1570	160
Foreign[2]	134	112,363	840.60	3		10	46		18	56	3
Joint	36	18,368	506.28				27		5	5	
By ownership type											
Government[3]	121	203,304	1,677.70	1	1	8	67		1	33	10
Private	6,170	1,038,373	168.31	1001	290	1797	549	42	738	1606	143
Cooperatives	306	81,679	267.17	24	5	52	75	18	69	47	13
Others	15	5,526	361.67	1			10		1		2
By main crop cultivated											
Maize	885	162,063	183.09		23	89	178	7	94	452	43
Sorghum	843	97,466	115.59	429	1	238	30	5	103	31	6
Wheat	242	120,497	498.21	1		10	120	25		79	5
Sesame	2,494	354,688	142.19	581	18	1390	46		418	27	15
Coffee	977	162,944	166.76			1	202			749	26
Cotton	373	120,959	324.29		236	41	6		17	32	42
Other	797	310,267	389.32	16	18	88	120	23	178	317	32
By mode of original land acquisition											
Direct negot.	380	43,143	113.64	24	223	18	23	4	4	64	17
Woreda	3,499	400,883	114.58	933	4	1429	297	9	218	580	29
Region	2,162	520,603	240.75	53	20	372	230		571	823	94
Fed'l Gov't	252	291,533	1,155.32	1	11	5	66	3	17	130	19
Initial land acquisition by region											
Area in ha				114991	41201	172451	384968	1610	237540	293117	83005[2]
Avg size in ha				112	140	93	549	27	293	174	491

Source: Own computation from 2013 CSA large farm survey

[1]About 299 (excluding Karuturi Global Limited) farms with size 50 ha and above did not respond to the detailed survey, and hence are not included in the analysis. The total area of these farms is 118,000 ha, and of which the total area for those with 1000 ha (24 farms) and above is 57,000 ha.

[2]A notable omission from the data is Karuturi Global Limited that acquired 100,000 ha of farm land in 2008 in Gambella region, but it is now deemed to be bankrupt.

[3]Most of the government owned farms are located in Oromia region accounting about 93% the initially transferred land, and note also that of which 83% of the land was acquired before 1991.

Table 2: Area transferred to and cultivated by commercial farms in different regions

	Area		Tigray	Afar	Amhara	Oromia	Somali	Benish'gl	SNNP	Gambella
	Transferred	Cultivated								
Total (ha)	1,768,540	1,008,809	200,310	70,651	186,360	284,141	1,487	70,343	142,019	53,498
…ha/farm	267.5	152.6	195	239.1	100.4	405.9	24.8	86.9	84.2	317.9
By Year										
Before 91	216,278	155,873	107.5	74	133.1	1333.8	22.7	22	114.8	86.3
1991-92	71,703	36,369	91.1		114.9	51			138.7	
92-2002	492,181	254,134	339.6	191.2	123.8	244.2	3	146.3	97.9	280.8
02-2006	293,027	158,101	105.7	501.6	89.4	231.3	14.5	131	116.8	260.4
07-2008	394,800	227,945	142.7	275	132.9	276.8	3.3	124.5	65.4	526.4
09-2010	180,043	104,569	275.4	132.3	85	165.4		59.3	67.2	245.7
11-2013	120,508	71,816	90.9	166.3	68.5	292.5	120.3	43.5	88.1	78.5
By Size (ha)										
< 20 ha	45,409	23,921	29.5	166	40.4	126.7	66.9	9	24.1	141
20-50	252,779	129,940	188.1	133.4	51.9	131	16.3	85.9	43.4	51
50-100	329,036	176,438	90.9	131.7	76.4	306.2	51	39.2	37.3	182.3
100-500	682,137	396,692	264.9	489.4	161.5	319.6	179	52.1	115.8	397.3
500-1000	155,970	88,106	628.1	1115	498.1	916	2	157.1	320.9	279
>1000 ha	303,211	193,712	1762	514.7	1497.3	3633.1		697	382.3	577
By owner's nationality										
Ethiopian	1,570,323	859,211	192	238.7	98.3	304.6	24.8	87	79.4	292.7
Foreign	80,445	47,677	1441		476.5	497.7		57.2	143.4	2,212.3
Joint	11,989	7,087				198		148.4	200	
By ownership type										
Government	175,760	120,658	31.0	15,638.1	320.8	1,509.3		21.5	220.9	101.4
Private	1,495,524	833,108	194.0	202.7	97.4	298.5	31.7	89.8	78.2	337.8
Cooperatives	87,440	49,276	232.1	519.0	170.8	243.8	8.9	56.7	191.4	60.0
Others	9,815	5,767	483.8			177.1		102.0		1,593.7
By main crop cultivated										
Maize	165,995	93,493		41.6	182.5	209.8	9.1	73.3	70.1	6.9
Sorghum	117,612	62,316	71.9	58	74.2	163.7	8.6	76	29	13.3
Wheat	118,816	85,419	41		262.2	670.7	15.1		23.9	0.8
Sesame	607,417	314,268	290.1	18.9	83.1	160.8		51.4	28.4	18.4
Coffee	209,152	124,579			204	245.1			92.3	219.3
Cotton	263,526	163,442		253.3	369	326.3		1125.9	703.2	1,069.8
Other	286,021	165,293	57.1	528.5	216.2	854.5	43.6	84.2	47.6	69.1
By mode of original land acquisition										
Direct neg.	125,118	64,669	141.7	208.2	106.7	227	39.5	64	51.2	235.6
Woreda	759,636	396,857	185	568.8	89.1	147.9	6.8	54.4	64.3	53
Region	585,337	342,313	348.1	89.9	136.4	468.7		93	83.9	440.3
Fed'l Gov't	175,203	100,952	4158	1257.4	549.2	670.8	120.3	302.7	188.8	310.3
No. of obs.	6,612	6,612	1,027	296	1,857	700	60	810	1,686	168

Source: Own computation from 2013 CSA large farm survey

Table 3: Key production decisions by commercial farms overall and by main crop cultivated

	Total	Maize	Sorghum	Wheat	Sesame	Coffee	Cotton	Other
Land								
Area acquired (ha)	197.29	179.93	115.59	410.66	142.19	166.69	322.86	390.14
.. developed first year (ha)	94.55	78.80	62.88	214.93	76.62	60.91	106.32	219.08
Cultivated now (ha; GPS)	152.59	105.62	73.90	353.39	125.99	127.50	438.19	207.42
Has irrigation facility (%)	13.78	19.65	6.88	9.17	5.39	3.43	66.87	30.25
Attempted to expand operation	38.75	27.96	39.01	27.28	45.73	42.08	35.35	28.18
Length of lease reported (%)	37.65	56.36	20.97	61.67	20.72	59.50	22.56	60.52
.. if yes, years	31.77	31.77	24.31	26.43	23.01	39.54	31.26	36.25
Annual lease fee reported (%)	36.43	54.89	20.12	52.81	20.22	59.38	20.83	58.06
. if yes, lease fee (Birr/ha)	474.07	190.44	115.56	1539.29	167.13	210.67	904.57	1202.01
Other annual payments reported (%)	10.09	18.65	6.59	10.54	6.91	8.16	10.47	16.27
. if yes, amount (Birr/ha)	375.31	724.47	86.38	438.17	212.84	99.44	99.48	510.91
Incidence and type of investment								
Made any investment (%)	94.10	90.44	99.01	61.30	99.47	92.97	91.48	88.70
If yes, size (Birr/ha)	13067	12,352	12,809	17,229	8,887	7,920	14,680	34,006
… of which on roads (%)	6.67	8.02	1.89	28.24	2.95	9.24	23.38	7.91
… of which on land clearing	36.51	20.49	43.86	14.16	42.82	41.30	24.20	28.28
… of which on buildings	18.21	24.93	10.80	14.54	13.00	30.59	12.44	25.26
… of which on tractors & machines	30.16	40.95	33.82	30.80	33.79	10.54	24.00	28.93
Credit market participation								
Took any loans last 5 years (%)	19.08	11.36	31.99	10.73	22.19	10.31	26.72	12.83
.. if yes, amount (Birr/ha)	13783	17,260	10,310	54,250	10,973	19,833	15,838	28,169
Has outstanding loans (%)	5.05	8.06	3.63	4.20	4.63	3.84	4.89	6.36
Outstanding loans (Birr/ha)	11560	10,085	15,944	14,249	6,584	9,351	6,991	25,634
Input use								
Used chemical fertilizer (%)	49.18	80.15	43.78	82.06	51.72	12.51	12.87	64.54
.. if yes, amount (kg/ha)	205.23	215.10	63.70	186.65	33.31	59.91	17.46	784.75
Used chemicals (pest/herb/fungic.)	60.22	48.49	81.16	79.65	68.65	20.62	90.85	53.01
Used improved seed	25.16	81.05	8.34	62.44	6.47	4.94	15.64	57.30
.. if yes amount (kg/ha)	156.85	60.66	4.41	210.64	26.49	11.45	1.92	393.14
Job creation								
Permanent farm workers/ha	0.05	0.02	0.03	0.03	0.04	0.03	0.05	0.15
Male temporary workers/ha	5.42	3.38	4.02	38.84	4.03	1.22	10.74	8.37
Female temporary workers/ha	1.39	2.76	0.22	0.16	0.28	0.76	5.31	4.04
Temporary workers per/ha	6.37	6.13	4.25	39.00	4.32	2.14	7.35	12.43
Total workers on the farm/ha	7.41	10.68	4.41	40.72	4.54	2.74	7.66	13.84
Crop shares (% of total land)								
Maize	11.64	74.32	1.56	1.79	1.26	0.56	0.32	7.03
Sorghum	16.96	3.56	73.74	2.47	16.79	0.21	2.74	3.91
Whet	3.58	0.87	0.15	87.33	0.08	0.00	0.03	1.84
Sesame	33.48	3.32	20.25	0.05	79.37	0.11	3.23	2.53
Coffee	14.49	0.13	0.06	0.02	0.02	97.69	0.00	0.14
Cotton	5.76	0.06	0.49	0.02	0.90	0.00	92.75	0.99
Others	14.09	17.74	3.74	8.32	1.59	1.43	0.93	83.56
No. of obs. (farms)	6612	885	843	242	2494	977	373	797

Source: Own computation from 2013 CSA large farm surveys

Table 4: Reasons for commercial farms' failure to cultivate all of the area allocated to them

	Total	Tigray	Afar	Amhara	Orom	Som.	B'gl	SNNP	Gmbla
Incidence & reasons for cultivating less than the total allocated area									
Cult. <100% of area	48.22	16.62	13.51	26.95	59.71	40.52	88.22	70.88	69.54
Technology	30.91	43.73	96.55	29.48	39.74	37.76	14.57	33.55	41.01
Manpower	29.77	4.23	0.00	11.21	24.93	0.00	50.60	30.54	37.26
Land dispute	21.09	26.33	1.90	18.76	19.80	10.32	31.57	15.83	22.95
Land clearing need	18.07	24.12	0.00	40.25	11.82	6.87	24.05	6.97	15.15
Infrastructure	17.79	10.20	0.00	10.23	24.22	3.46	23.26	17.50	17.74
Credit	17.71	7.46	1.90	17.85	11.25	54.09	22.24	17.38	23.92
Delayed machinery	9.87	8.67	2.95	2.25	3.13	23.74	9.37	12.24	44.07
Lack of irrigation	6.26	3.75	1.56	2.15	6.55	31.47	7.07	7.44	4.31
Lack of skilled workers	3.88	3.88	0.00	5.67	4.84	0.00	6.04	1.11	7.61
Input shortage	3.67	0.92	0.00	2.19	5.56	7.45	7.07	0.83	13.34
Marketing	3.47	6.53	37.20	3.16	3.85	0.00	3.39	1.26	10.08
Foreign exchange	1.06	0.00	0.00	0.69	3.70	0.00	0.00	0.84	3.73
Scope for expansion									
Tried to expand	38.75	23.72	37.63	60.52	38.33	3.04	38.62	26.98	18.05
If yes, faced problems	64.50	39.49	47.30	68.82	68.61	0.00	70.01	64.40	72.01
Gave advice to farmers	63.79	79.54	32.99	50.20	68.13	34.16	55.40	77.84	66.72

Source: Own computation from 2013 CSA large farm survey

Table 5: Productive performance of smallholders vs. commercial farms in different farm size classes

	Maize	Sorghum	Teff	Wheat	H. beans	Soya	Sesame	Coffee	Cotton
					Area cultivated				
Smallholder	0.25	0.43	0.46	0.34	0.11		0.69	0.14	
< 20 ha	4.96	7.08	3.90	6.00	5.81	2.87	8.57	12.66	3.28
20-50	14.95	13.59	6.20	15.15	4.88	13.56	24.07	32.07	23.26
50-100	29.4	21.9	7.1	46.6	16.4	26.8	45.5	65.4	33.5
100-500	96.2	55.5	10.0	118.7	31.3	45.3	114.4	201.7	214.5
> 500 ha	339.0	217.1	32.3	1654.6	147.6	496.7	1008.7	672.0	1194.3
					Output (quintal/ha)				
Smallholder	18.73	14.90	8.44	14.59	13.74		6.00	16.79	
< 20 ha	42.04	30.88	9.18	41.69	23.86	24.39	13.94	4.24	5.18
20-50	37.42	24.52	8.79	33.68	38.31	13.91	10.74	8.43	17.75
50-100	36.89	25.64	8.61	26.11	20.95	18.82	8.46	6.38	30.81
100-500	39.30	28.21	7.75	24.64	30.52	23.71	9.77	6.37	29.31
> 500 ha	33.81	29.51	9.90	28.32	34.96	22.50	10.84	7.02	18.92
					Used chemical fertilizer				
Smallholder	34.52	17.06	61.56	65.01	18.10		10.40	4.82	
< 20 ha	52.85	19.48	85.44	65.79	30.52	23.83	12.99	0.00	0.00
20-50	58.39	20.18	77.00	59.62	20.76	2.05	33.29	0.91	0.00
50-100	73.79	18.28	61.34	74.22	18.26	2.88	48.19	3.13	10.46
100-500	84.31	33.18	62.44	64.74	25.77	27.83	51.25	14.99	12.32
> 500 ha	82.70	44.79	48.01	74.45	31.69	40.82	64.93	59.41	15.09
					Quantity of chemical fertilizer used (kg/ha)				
Smallholder	179.32	112.01	133.07	187.57	105.32		77.86	69.98	
< 20 ha	165.43	84.99	122.63	363.65	32.79	340.37	171.62		
20-50	187.22	80.60	155.68	270.65	115.41	48.33	38.53	4.68	
50-100	151.59	51.86	101.79	97.74	78.08	73.85	32.33	17.99	12.04
100-500	187.09	63.42	89.83	118.91	127.90	129.88	40.73	96.37	51.04
> 500 ha	163.68	82.05	64.34	72.46	163.64	32.19	59.02	88.05	64.57
					Used improved seed				
Smallholder	20.30	1.77	4.23	12.51	1.59	0.45	1.24	0.38	
< 20 ha	51.99	17.58	85.44	65.79	30.52	23.83	11.18	0.00	0.00
20-50	57.87	18.66	76.23	58.25	17.03	0.82	29.67	0.91	0.00
50-100	69.57	15.88	58.66	74.22	18.26	1.44	40.22	2.71	10.46
100-500	86.21	4.21	45.86	40.32	26.84	21.19	3.72	0.95	10.14
> 500 ha	80.30	42.08	40.93	74.45	21.23	40.82	59.81	56.85	12.64
					Quantity of improved seed used (kg/ha)				
Smallholder	40.93	33.09	53.17	183.24	121.14			73.31	
< 20 ha	53.90	9.92	36.12	581.88	36.79	125.20	17.24		
20-50	46.49	25.71	79.62	262.04	115.11	21.22	7.11		6.38
50-100	28.93	17.30	40.67	138.65	59.42	91.68	3.26		8.21
100-500	24.47	10.01	52.12	156.68	69.57	148.37	5.35	116.92	8.39
> 500 ha	47.44	2.86	33.91	67.52	171.41	60.91	3.27		1.37
					No. of observations				
Smallholder	1703	1216	1189	794	521		180	838	
< 20 ha	358	295	291	162	46	79	349	87	73
20-50	479	1122	212	109	40	122	1207	220	27
50-100	351	833	124	28	100	104	1000	358	90
100-500	382	724	165	128	142	178	792	315	234
> 500 ha	89	103	34	37	29	33	109	39	96

Source: Own computation from 2013 CSA large farm and smallholder farm surveys

Table 6: Naïve estimates of the farm size productivity relationship for all Ethiopian producers

	Maize	Sorghum	Teff	Wheat	H. Beans	Sesame	Coffee
				Panel A: All observations			
Cropped area (α_1)	-0.337***	-0.294***	-0.270***	-0.134**	-0.602***	-0.434***	-0.279***
	(-8.213)	(-8.129)	(-5.553)	(-2.032)	(-9.064)	(-6.512)	(-3.357)
Cropped area squared(α_2)	-0.007	0.020**	0.015	0.023	-0.019**	-0.007	0.012
	(-1.016)	(2.282)	(1.029)	(1.626)	(-2.020)	(-0.330)	(1.050)
Commercial farm dummy	1.236***	1.345***	0.333***	1.584***	3.319***	0.883***	1.167*
	(9.116)	(10.084)	(2.620)	(4.938)	(10.259)	(5.349)	(1.842)
Cropped area * commercial (β_1)	0.454***	0.146**	0.203*	-0.250*	0.507***	0.561***	-0.270
	(5.654)	(2.061)	(1.883)	(-1.834)	(3.270)	(6.402)	(-0.998)
C. area squared * commercial (β_2)	-0.021	-0.002	-0.016	0.002	-0.016	-0.014	0.062**
	(-1.592)	(-0.169)	(-0.446)	(0.124)	(-0.673)	(-0.669)	(2.076)
Constant	1.892***	1.877***	1.407***	2.063***	0.246*	1.061***	1.047***
	(32.994)	(35.378)	(34.047)	(28.930)	(1.845)	(9.348)	(7.203)
Number +of observations	2,124	2,559	1,403	970	625	1,699	1,019
R^2	0.148	0.135	0.114	0.083	0.379	0.082	0.163

Note: Woreda fixed effects included throughout. Cropped area is in logs, denominated in hectares.

Table 7: Farm Size and Incidence of fertilizer use

	Maize	Sorghum	Teff	Wheat	H. Beans	Sesame	Coffee
				Panel A: All observations			
Cropped area (α_1)	0.027*	-0.006	0.054**	0.022	-0.037*	0.012	-0.000
	(1.798)	(-0.370)	(2.378)	(0.911)	(-1.716)	(0.328)	(-0.011)
Cropped area squared(α_2)	-0.004	-0.000	0.001	-0.008*	-0.008***	-0.001	-0.001
	(-1.582)	(-0.151)	(0.094)	(-1.706)	(-2.867)	(-0.214)	(-0.406)
Commercial farm dummy	0.152***	0.082	0.053	0.042	-0.076	-0.166*	0.159**
	(3.404)	(1.379)	(0.914)	(0.439)	(-0.787)	(-1.790)	(2.116)
Cropped area * commercial (β_1)	0.044*	-0.045	-0.025	-0.021	-0.030	0.083*	-0.196***
	(1.818)	(-1.480)	(-0.612)	(-0.530)	(-0.659)	(1.667)	(-5.637)
Cropped area sq. * commercial (β_2)	-0.000	0.021***	-0.003	0.010	0.027***	0.004	0.039***
	(-0.014)	(4.144)	(-0.203)	(1.548)	(3.541)	(0.522)	(9.355)
Constant	0.416***	0.155***	0.646***	0.690***	0.201***	0.231***	0.048*
	(18.726)	(6.088)	(31.806)	(24.819)	(4.366)	(3.682)	(1.802)
Number +of observations	2,276	2,620	1,425	998	674	1,724	1,147
R^2	0.106	0.048	0.024	0.037	0.041	0.109	0.184

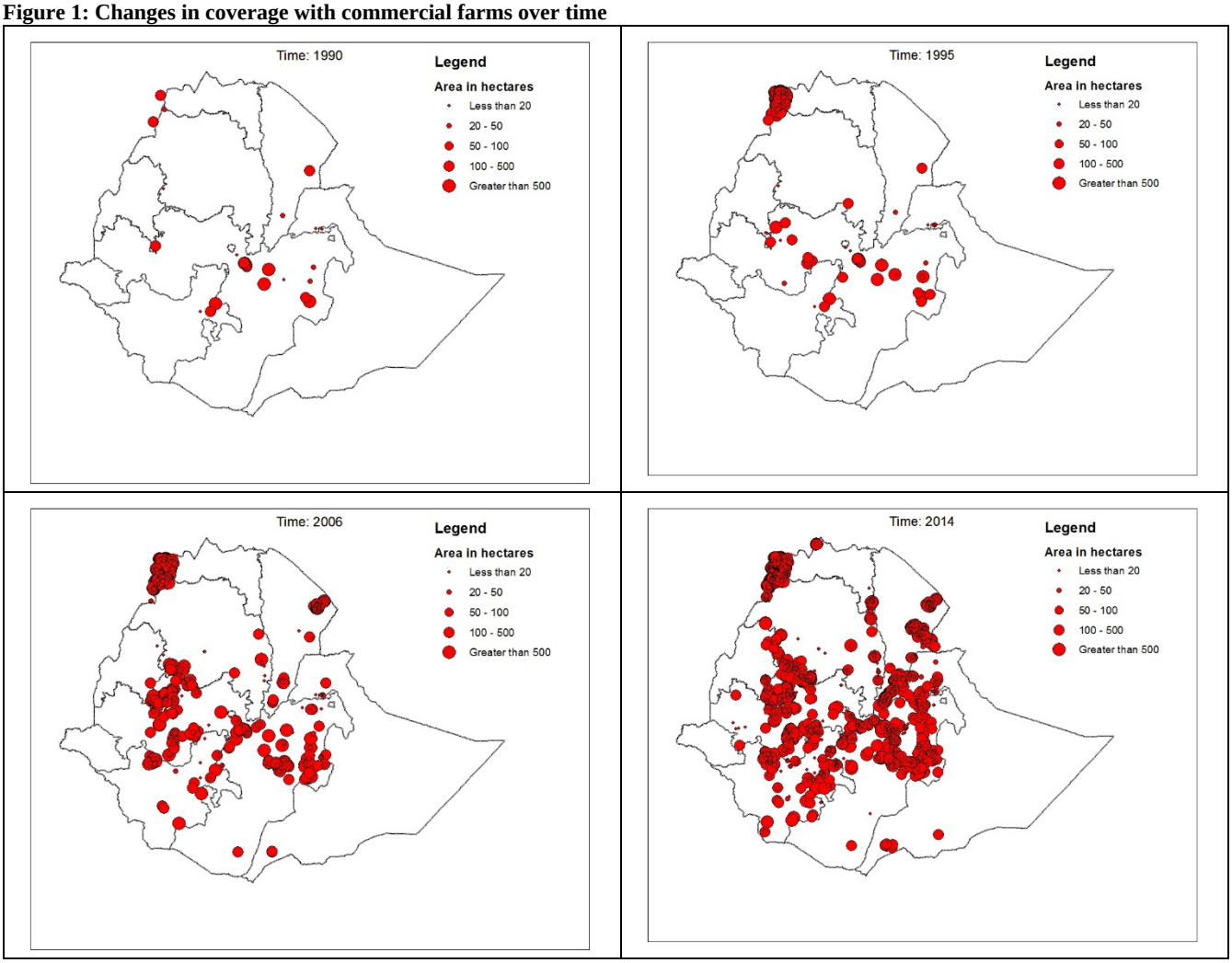
Note: Woreda fixed effects included throughout. Cropped area is in logs, denominated in hectares.

Table 8: Farm Size and incidence of improved seed use

	Maize	Teff	Wheat
	Panel A: All observations		
Cropped area (α_1)	0.037**	0.001	0.037
	(2.510)	(0.091)	(1.397)
Cropped area squared(α_2)	-0.002	-0.000	0.008
	(-1.028)	(-0.012)	(1.641)
Commercial farm dummy	0.350***	0.408***	0.306**
	(7.155)	(10.142)	(2.295)
Cropped area * commercial (β_1)	0.077***	0.059**	0.149**
	(2.991)	(2.111)	(2.389)
Cropped area sq. * commercial (β_2)	-0.009**	0.012	-0.033***
	(-2.176)	(1.261)	(-3.844)
Constant	0.315***	0.014	0.091***
	(14.547)	(0.988)	(3.068)
Number +of observations	1,760	1,228	547
R^2	0.249	0.236	0.224

Note: Woreda fixed effects included throughout. Cropped area is in logs, denominated in hectares.

Figure 1: Changes in coverage with commercial farms over time



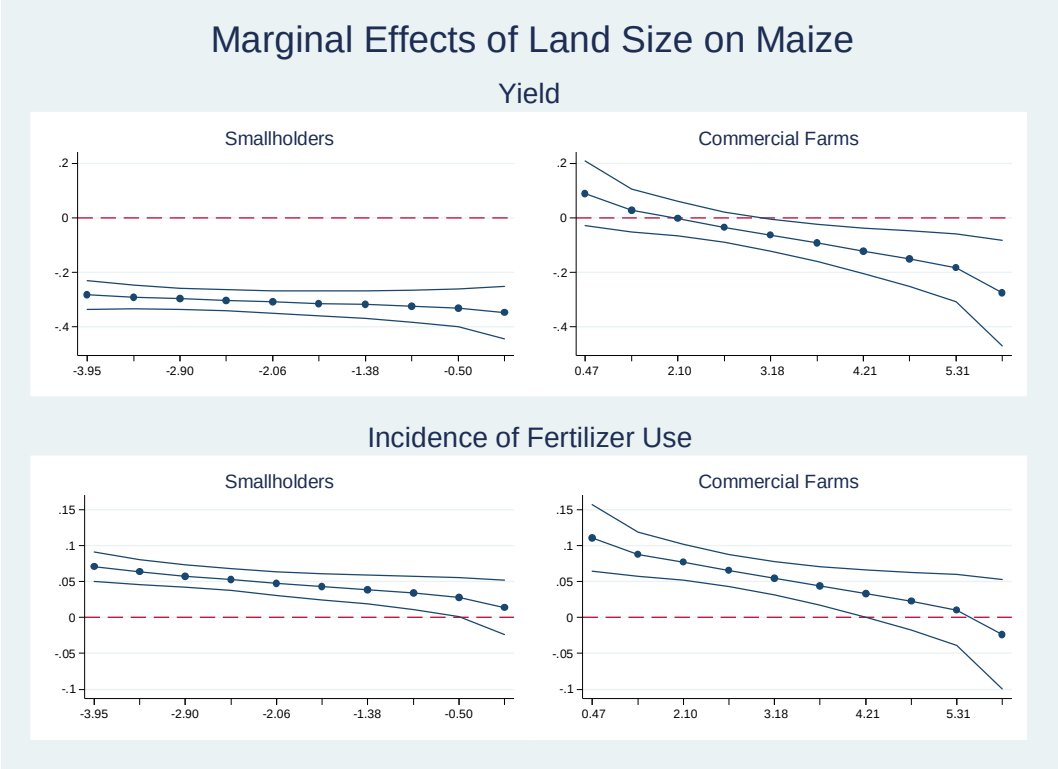


Figure 2: Marginal effects of land size on maize

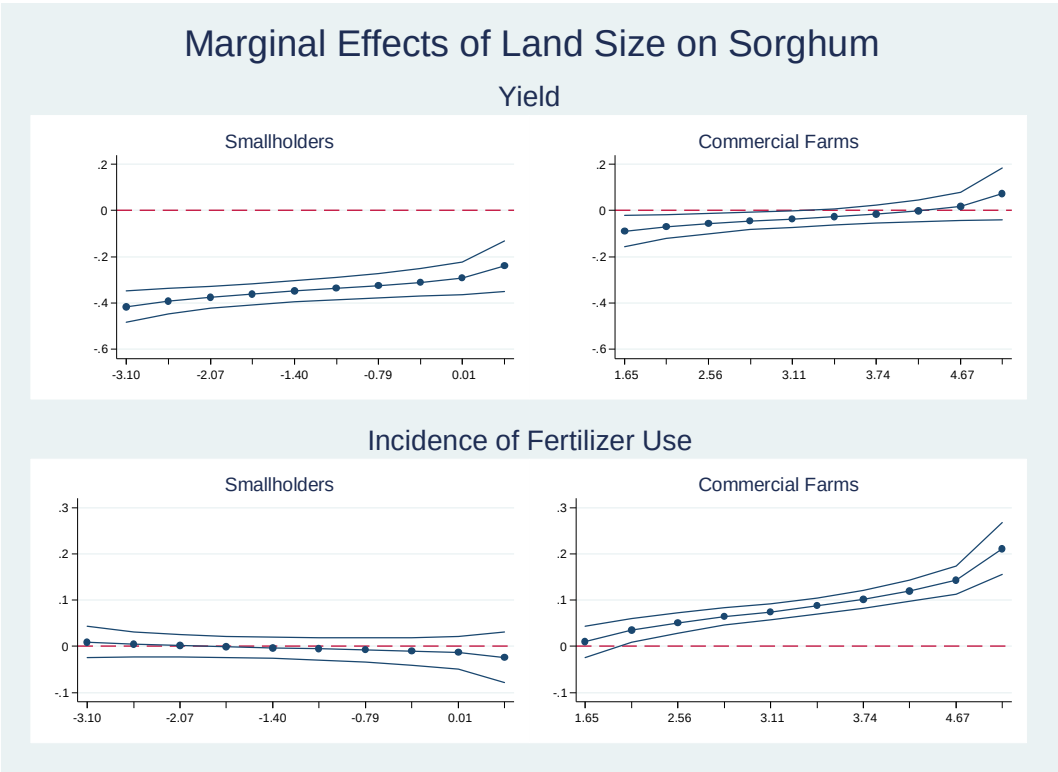


Figure 3: Marginal effects of land size on sorghum

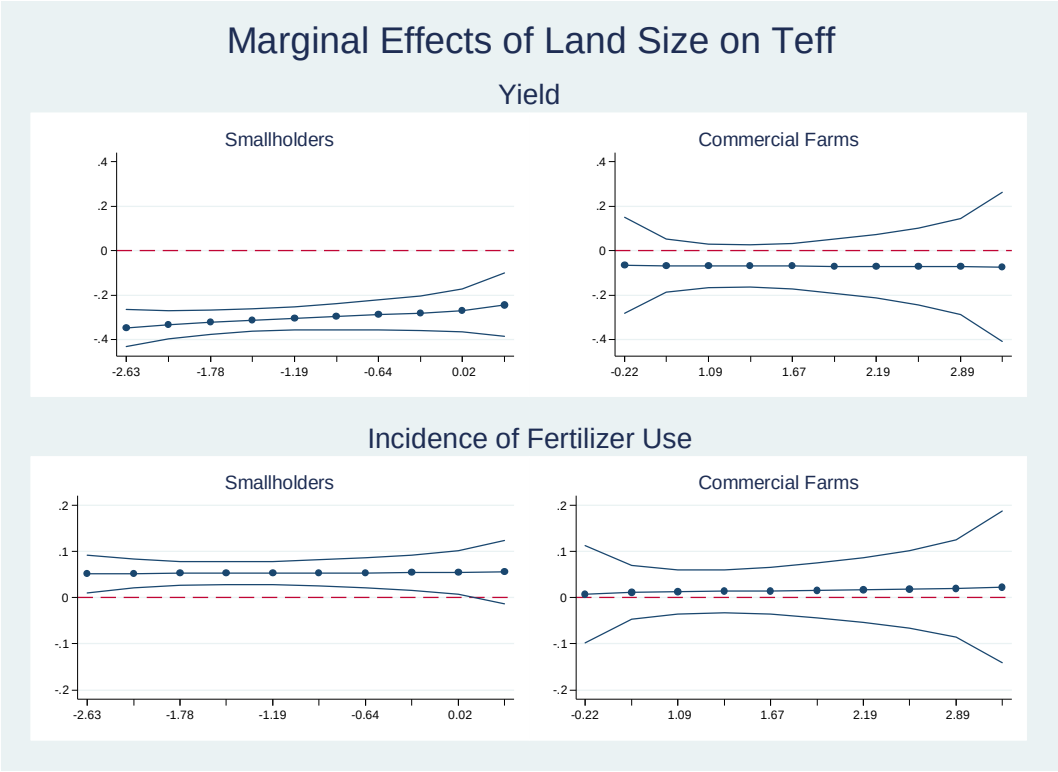


Figure 4: Marginal effects of land size on teff

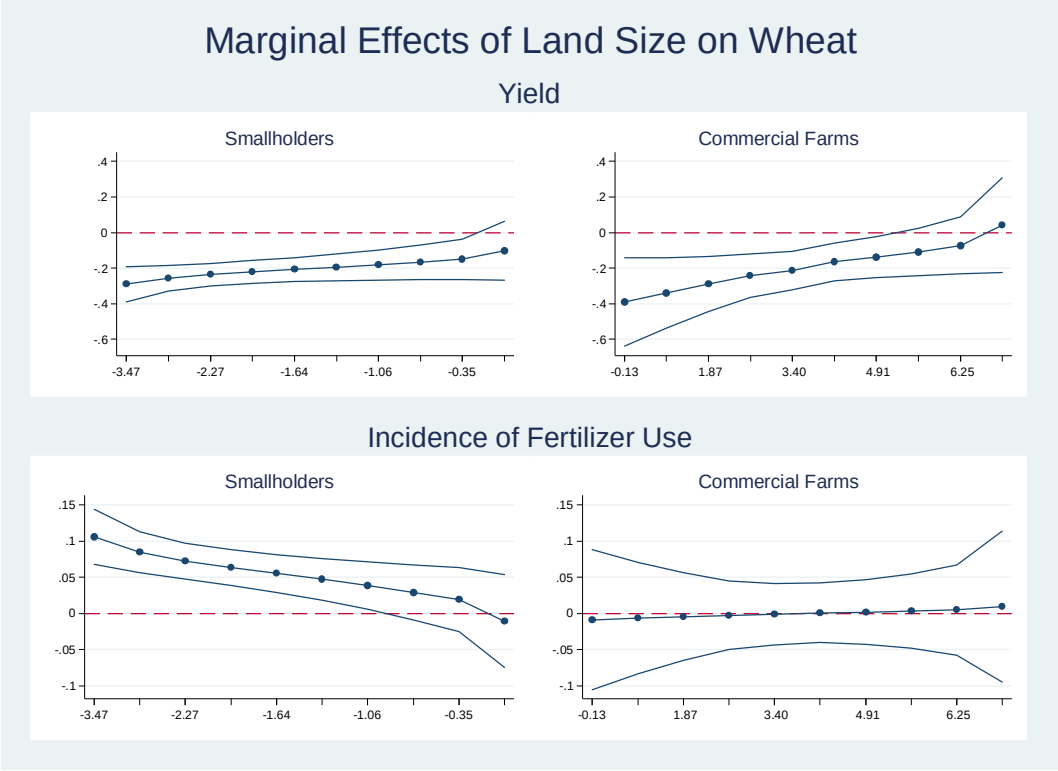


Figure 5: Marginal effects of land size on wheat

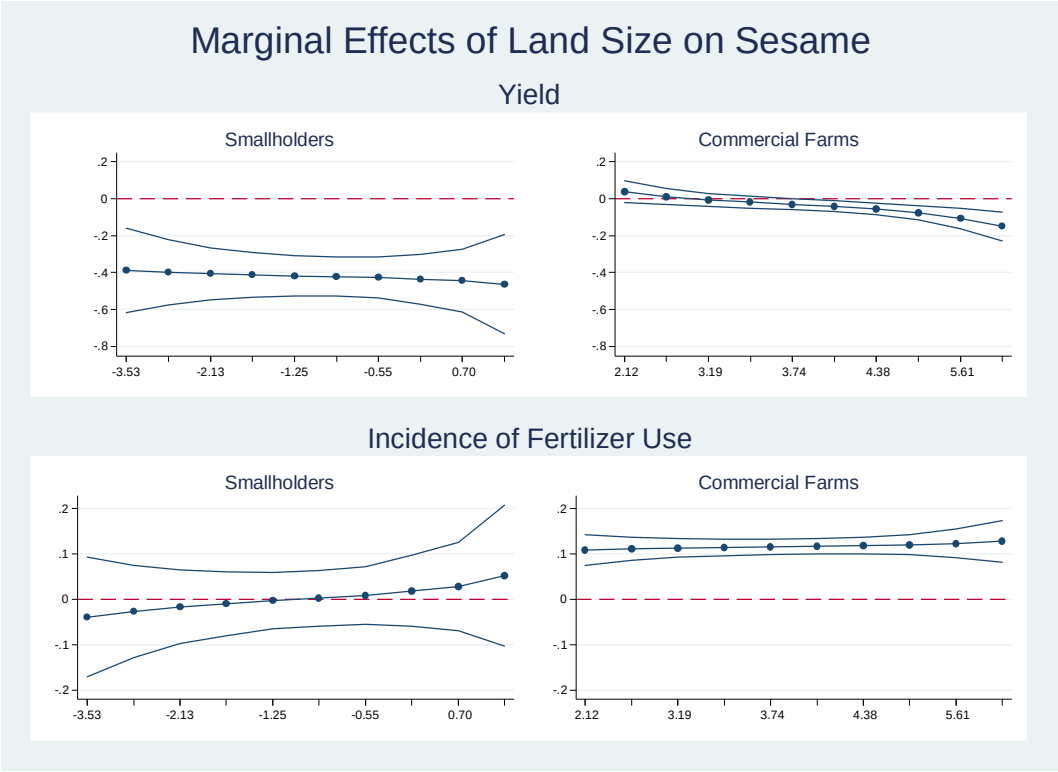


Figure 6: Marginal effects of land size on sesame

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