Assessing effects of large scale land transfers: Challenges and opportunities in Malawi's estate sector

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Abstract: Data from complete computerization of agricultural leases in Malawi, a georeferenced farm survey, and satellite imagery allow us to document opportunities and challenges of land-based investment in novel ways. With 1.5 mn. ha, total area under estates area is large. But 70% of agricultural leases expired and 140,000 ha are subject to overlapping claims. This reduces public revenue from ground rent by up to US$ 35 mn/a or 5% of public spending. By lowering tenure security it may also affect economic performance, a notion supported by the fact that large farms underperform small farmers in terms of yield, productivity, and intensity of land use and fail to generate positive spillovers. The recently passed Land Act creates opportunities to address this by clarifying boundaries and lease status for existing estates before demarcating customary estates. Failure to follow this sequence could, however, exacerbate insecurity with undesirable effects on productive performance.

1. Background

Ever since the 2007/08 commodity price boom, transfers of large tracts of land for agricultural production have been a key issues in policy debates on African agriculture (Collier and Dercon 2014; Cotula 2014; Deininger and Byerlee 2011). Yet, while there has been enormous interest in the size (Dell'Angelo *et al.* 2017; Holmen 2015), causes (Arezki *et al.* 2015), and aggregate impact (Davis *et al.* 2014) of such transfers, actionable assessment of the extent to which transferred land is being used, the efficiency of such use, and potential impacts on neighboring smallholders has been limited. Such evidence would be of importance for Governments to manage public land transfers in ways that can reduce risks and maximize positive socio-economic impacts. Experience from Latin America shows the advantages of combining administrative with remotely sensed data for real-time monitoring for the public (Assuncao *et al.* 2015) and the private sector (Gibbs *et al.* 2016). But use of such methods in Africa is still in its infancy (Lemoine and Rembold 2016).

In this paper we show that land registries contain a wealth of information but that lack of maintenance and failure to use these data, partly because they were locked up in analog form, affected economic performance by reducing tenure security and the ability to harness land's economic potential. We show how digitizing such data and combining them with survey information allows closing this gap for the case of Malawi, a country where large areas had been transferred to estates in the 1980s and early 1990s (Mandondo and German 2015). While or analysis suggests that poor maintenance of land transfer records increases the risks of large land-based investment while reducing potential benefits in several dimensions, recent land policy developments create a window for improvement and we highlight how this could look.

With some 1.35 million ha or about 25% of the country's arable area, agricultural estates are an important part of Malawi's rural economy. But their contribution to public revenue is negligible as 70% of agricultural estate leases have expired and failure to index ground rent to inflation has reduced revenue even for non-expired leases. Associated losses are large: charging half the market price for land rental would increase public revenue by US$ 35 million or 5% of total public spending a year. It also undermines incentives for

record maintenance, with negative and potentially far-reaching implications for performance of what was intended to be an economically leading sector.

Spatial records are also of poor quality: 28% of agricultural estates have at least 20% of their area overlap with another estate, an issue affecting a total of 137,064 ha and less than 5% of estates have a remaining lease term of more than 10 years and thus a time horizon long enough to make longer-term investments may also reduce productivity directly. First, survey data suggest that for all crops with the exception of cassava, smallholders' yields are significantly above those by estates. As estates use consistently more inputs than smallholders, this implies a negative relationship between farm size and productivity on the land area actually cultivated. Second, overlaying recorded estate boundaries with land use categories from supervised classification of medium-resolution satellite imagery implies that only about 40% of estate land is used for crop cultivation. While we lack data on soil quality, the fact that estate land was the best makes this rather surprising (and of course they could rent out to smallholders). Finally, and not surprisingly in light of the above, estates fail to act as a motor for the rural economy and a source of positive spillovers for neighboring smallholders, a function they were expected to perform when established.

Our findings are particularly policy relevant because in late 2016, after protracted debate, Malawi passed a serious of Land Bills that aim to increase security of customary land users' rights and overcome the dualism of the country's post-independence tenure system among others by allowing sporadic registration of customary land under so-called 'customary estates'. Literature suggests that low-cost, participatory, and systematic land tenure regularization can encourage investment and effectiveness of land use (Fenske 2011; Lawry *et al.* 2016), empower women (Ali *et al.* 2016a; Newman *et al.* 2015), and improve scope for lease markets to transfer land to more efficient operators (Ali *et al.* 2014). A sporadic approach that fails to first clarify the boundaries of land currently under estates; the status of rights to such land; and the ultimate owner of unutilized estate land is (i.e. if it is government land that can be transferred to investors or reverts to the traditional domain) may -contrary to intentions- increase tenure insecurity, conflict, and inequality.

The paper is organized as follows: Section two situates the paper in the debate on large scale agricultural investment by highlighting the challenge of assessing productive efficiency by large agricultural enterprises and provides background on the evolution of Malawi's estate sector. Section three discusses administrative and remotely-sensed data sources, using them to quantify the evolution of Malawi's agricultural estates, to identify challenges to the quality of the textual and spatial land records, and draw out implications in terms of public revenue and intensity of land use. Section four builds on this by comparing productivity between estates and smallholders and exploring the extent to which presence of estates benefits nearby small farmers via spillovers in terms of technology or market access. Section five concludes with implications for policy and research.

2. Background and justification

We argue that a key limitation of the debate on large land-based investment has been the methodological challenges associated with documenting land transfers to large farms and, as a consequence, measuring their performance. This is also observed in Malawi where estates were established to boost agricultural performance in the late 1980s but discontinued thereafter, giving rise to prolonged debate and eventually passage of a 2016 Land Bill. We discuss the evolution of Malawi's agriculture and the size, composition, and economic impact of the country's estate sector.

2.1 The challenge of assessing large farm performance

Almost a decade after concerns about large scale agricultural investment first appeared in the literature, there seems agreement that, beyond any direct benefits, e.g. in terms of lease fees, transfer of land to investors has the potential to generate positive indirect effects (Collier and Venables 2012). Such effects may be realized by 'pioneer investors' helping with discovery of agro-ecological suitability and provision of access to technology and markets for credit, input, labor, and output for local smallholders. The desire to harness such effects led to formation of agricultural investment promotion agencies all over the world.

In African countries with often large land areas not all of which is deemed to be fully utilized,[1] low quality and weak maintenance of (often non-digital) records, weak technical capacity, and lack of transparency often limited the ability to satisfy these conditions (Deininger and Byerlee 2011). This may result in uncoordinated or poorly recorded land transfers, weak or non-existent business plans and a promotion of speculators and urban elites (Sitko and Jayne 2014; Jayne *et al*. 2016) rather than pioneers. Together with the high risk of such investments (Tyler and Dixie 2013), this often dashed high expectations. It also created a danger of unsuccessful investors trying to use political channels to affect factor prices, e.g., by trying to keep down labor cost or constrain access to capital, with potentially unfavorable long-term consequences.[2]

Yet, although a large number of studies assessing the impact of specific investments now available provides valuable insights regarding the dynamics of establishment and performance of large farms in specific cases, the extent to which these are representative of the sector at large is difficult to ascertain. Addressing this issue would require dealing with two issues. First, data on the universe of land transfers is needed to avoid that results are due to sample or case selection. If only one agency can transfer land, this can be based on a complete transaction record. If multiple agencies have the authority to transfer land, a field-based sample

[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 (Jayne *et al.* 2014), and often also weak governance (Arezki *et al.* 2015).

[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).

frame, ideally constructed and maintained by the national statistical agency is needed.[3] Second, to be able to assess how policy affects outcomes, time series information provided at regular intervals will be desirable. While traditionally this has been provided through farm censuses or sample surveys, availability of large farm boundaries and ground-truthed data could allow use of machine learning algorithms based on high frequency imagery that is freely available on cloud-based platforms to generate data on land use at field level (Lobell *et al.* 2015). Combining such data with administrative records could eventually address many of the issues that have traditionally made monitoring of large investments' performance difficult.

Malawi is an interesting case due to a number of characteristics that allow assessing longer-term impacts of large farm investment because of the scale of large farm investment and the length of time for which these have been in operation. Some 20-25% of its land was leased to commercial farms or local entrepreneurs in the late 1980s to help commercialize the sector and partly to overcome shortcomings in regulatory regimes for customary tenure. The time elapsed since then allows discerning longer-term impacts and identifying challenges not yet apparent in cases where land transfers have happened more recently.

Analyzing this case allows us to contribute methodologically by bringing together administrative data with those from other sources to describe gaps in such data and to assess how they may have affected the extent to which benefits from estates did materialize. As Malawi has just passed new land laws the implementation of which still needs to be regulated, insights from such analysis can directly feed into the policy debate. In particular, we not that efforts to implement new policies without first resolving pending issues with estate leases or substantially improve the quality of record keeping risk adding just another layer of unconnected 'rights' that could increase complexity and conflict potential.

2.2 The evolution of Malawi's estate sector

Malawi has traditionally been characterized by a dualistic land tenure structure geared towards cash crop production. In colonial times, cultivation of tobacco, the country's main cash and export crop, was restricted to white settlers who had preferential access to land, labor, and credit (Binswanger *et al.* 1995), and guaranteed market access via a quota system (Mataya and Tsonga 2001). After independence in 1964, estate land was transferred to Malawians (Jaffee 2003) with direct and indirect public support: Until 1994, only estates were allowed to produce tobacco and smallholders had to sell their output to the marketing board at low prices. The surplus thus generated was funneled to estate owners in the form of soft loans, thus providing an implicit subsidy that reinforced the dualistic structure of the country's agriculture (Kydd and Christiansen 1982).[4] Thereafter, tobacco quotas were gradually extended to smallholders by licensing

[3] Ali *et al.* (2017) illustrate how this can work or the case of Ethiopia.

[4] Transactions were directly supported through loans from the Farmers Marketing Board (FMB), a successor to the Native Tobacco Board, later transformed into the Agricultural Development and Marketing Cooperative (ADMARC). Indirect support came from restricting tobacco cultivation by smallholders and from establishing ADMARC as the sole marketing option with a power to fix prices (Mandondo and German 2015).

clubs of 10-30 members. Rapid take-up led to marked improvements in socio-economic indicators (Jaffee 2003) and soon brought small farmers' share in tobacco production to some 70% (Lea and Hanmer 2009).

Yet these reforms did little to improve smallholders' tenure security under customary tenure that historically allowed egalitarian land access and high levels of security by community members (Bruce and Migot-Adholla 1994) but over time came under increasing stress. Land scarcity due to population growth, migration, and urban expansion, increased the frequency of land transactions with outsiders (Ricker-Gilbert *et al.* 2014). As these are liable to challenges (van Donge 1999), often after long periods of dormancy (Jul-Larsen and Mvula 2007), perceived tenure insecurity increases (Lovo 2016; Place and Otsuka 2001) with negative impact on output, especially by females (Deininger *et al.* 2017).

To boost commercial crop production, 21-year leases to a large number of estates, most sized from 10 to 30 hectares were, in the late 1980s, carved out of what was deemed unutilized customary land and transferred to aspiring farmers (Devereux 1997; Mandondo and German 2015).[5] The formal process to obtain a lease comprised four steps (van Setten 2016): An application stating size, intended use, and location of the desired piece of land (normally a sketch map), together with a 'no objection' document by the chief certifying that neither chief nor village headman object to the proposed transfer had to be submitted. Having validated the application, Government issued an offer that details the length of the lease, permitted land use, assessed fees, and annual ground rent, ideally accompanied by a survey plan that describes the property's location more precisely. Acceptance transformed the offer letter into a preliminary lease contract. The lease contract would then be formalized by a deed that is formally registered. As each step normally required side payments, the process followed in reality was often quite different or remained incomplete.

Dissatisfaction with the results of such a strict distinction between estates and the customary sector led to a moratorium on lease issuance in 1994 together with the launch of a more comprehensive land policy reform process.[6] In 2016, this culminated in Parliamentary approval of a series of Land Bills, key provisions of which are discussed below. The new Land Act limits land rights of non-national and classifies land into public (government or unallocated customary land) or private (freehold, leasehold, and customary estates). 'Customary estates' are defined as all land owned, held or occupied as private land within a traditional land management area (TLMA). The Customary Land Act defines mechanisms for registration of customary estates, formalizes the role of chiefs in land allocation and conflict resolution, mandates establishment of land committees and land tribunals at TA, district, and national level to perform this role.[7] It allows for

[5] As access to a minimum of 12 ha of land was required to access tobacco marketing quotas, an unknown number of so-called 'ghost estates' was established, often in office-based processes without corresponding to actual land on the ground.

[6] A Presidential Commission had been established in 1996 and submitted a report (Saidi 1999) that prompted adoption of a National Land Policy and implementation strategy in 2002. Draft legislation was submitted to Parliament in 2006.

[7] So-called Traditional Land Management Areas (TLMAs) at Group Village Headman (GVH) level, as identified in a certificate and map of customary land (CCL), are established as basic spatial units. In each TLMA, a customary Land Committee (CLC) with six elected members (half

systematic identification and recording of parcel boundaries to be followed by adjudication of rights that is impossible key policy decisions having been made about renewal/cancellation of leases for existing estates.[8] The Survey Act creates opportunities to use general boundaries and use modern technology, opening the door for using low-cost (US$ 5-6/parcel) approaches as in neighboring countries (Nkurunziza 2015). It also provides for surveying of TLMAs as part of national spatial data infrastructure. Also, the Registration Act decentralizes registries to district level, and stipulates filing requirements including provision of registry maps to chiefs. The Physical Planning Act aims to expand the reach of planning beyond urban areas.

2.3 Earlier evidence on estate sector performance

The 1997 Estate Lands Utilisation Study or ELUS remains a key source of information on the estate sector (Ministry of Lands and Valuation 1997). The fact that records were incomplete and paper-based made drawing a sample difficult. Eventually the study sample was drawn listing all estates in 59 10x10 km blocks in 9 districts which, according to official records, had the highest concentration of estates.[9] On this basis, the universe was estimated to comprise 29,000 estates with an area of 916,815 ha. Some 57% of estate land were found to have been newly cleared with the remainder having been used as customary land before; in fact a sizeable share of estate owners seem to have converted land they previously farmed under customary tenure, either to be able to grow tobacco (the most prevalent reason in the Center) or to increase tenure security (the most prevalent reason given in the North and South). Despite Malawi's relative land scarcity, 75% of estate owners reported to have suitable land that they did not utilize. In tobacco estates, 29% of suitable land was not utilized, a share that varied between 50% in the North and 25% in the Center. Economic performance in terms of yield per ha was best in the size groups below 20 ha or above 500 ha. Interestingly, good performance was strongly positively correlated with land use intensity. With about half of owners absentee and 25% indicating that they rarely visited their estates, encroachment was an issue on 52% of estates above 500 ha, though it affected a much smaller share (5%) of estates below 20 ha. Tenancy was widespread, with some 72% reporting to employ tenants who were estimated to account for 52% of estates' labor force. Finally, public land records were often incomplete or of low quality: in about one third of cases, estates identified in the field could not be located on maps by Ministries of Lands or Agriculture and that 45% had not completed the prescribed process to obtain a registered deed.

women) and chaired by the GVH chair will be supported by a Land Clerk, an employee of the local assembly. The CLC, in collaboration with the TA, can grant individuals customary estates of indefinite duration and register rights to these.

[8] This requires policy decisions on (i) how to define an estate, how to define idle land, and what to do with land that had been leased to estates but is no longer used as an estate (e.g. subsistence farming as a result of sub-division or transfer); (ii) what action to take in case of lessees' failure to comply with lease conditions (either in terms of non-compatible land uses or failure to pay ground rent); (iii) how to adjust estate boundaries in case of imprecise original surveys and expansion or contraction of the originally leased area; and (iv) lease terms including levels of ground rent to be charged for renewal of leases on land that is lawfully occupied by estates; and (v) procedures for re-allocating unused estate land, in particular the role of TAs and other local institutions in this process.

[9] These districts are Rumphi, Mzuzu, Kasungu, Dowa, Lilongwe, Nkhotakhota, Mangochi, Machinga, and Zomba. The listing yielded a total of 3,908 estates out of which some 500 were chosen for a more detailed survey.

3. Using new data to describe land rights and use in Malawi's estate sector

Digitization of lease contracts allows us to trace the evolution of Malawi's estate sector. Contracts' textual components highlight that most leases have expired so that foregone public revenue is large and land may no longer be used as designated. Leases' spatial components point towards significant overlaps that may reduce tenure security, undermine investment incentives, and discourage intensive land use, a notion that is indeed supported by categorization of land sue based on overlays with medium resolution imagery.

3.1 Using textual data to assess the estate sector's evolution and revenue potential

A major reason for the difficulties in effectively managing estate leases was that all of the relevant data was stored on paper, distributed among three registries, and thus very difficult to access. To make data available for analysis, computerization of all documents, supported by a World Bank project,[10] was thus an essential first step. Using the original data of establishment, figure 1 illustrates the changes in estate numbers and the area under agricultural estates. Table 1 illustrates that from a basis of 16,725 ha registered estates in the pre-independence period (155 estates with average size of 124 ha), large scale land transfers accelerated considerably after independence in three main phases.[11] First, in the period to 1986, 2,277 new leases with a total area of 237,322 ha were awarded, i.e. 104 leases with an average of 105 ha implying a total transfer to leasehold of some 10,800 ha each year. A second phase, from 1986 to 1994, saw the number of leases issued each year multiply more than 25 times to 2,626 per year but the average size decline to some 25 ha, implying a total transfer to leasehold of some 65,000 ha per year.[12] In the period following the 1994 moratorium, overall issuance of new agricultural leases dropped sharply to 176 leases or transfer of 7,800 ha per year. The sub-period before 2007 saw issuance of slightly more but smaller leases while after 2006, the average size of leases increased but less new leases were issued. While the majority was issued in 1988-95, issuance of leases continued apace for non-agricultural estates.

Descriptive statistics based on the textual and graphical components of digitized leases show how, by making available administrative data that thus far had been locked up on paper, computerization can expand transparency and opportunities for policy action and analysis. Focusing on textual data only,[13] table 2 shows that, with some 1.5 million ha, (1.35 and 0.14 in agricultural and non-agricultural estates, respectively) in 58,733 leases (35,140 and 23,593 for agricultural and non-agricultural land), total area under estates is larger than had been estimated by ELUS. Agricultural estates measure 39.8 ha on average, with the largest

[10] Leases were digitized by a team from Lilongwe University of Agriculture and Natural Resources (LUANAR). Given the limited number of documents and the lack of staff with the relevant experience, the cost of digitizing textual and spatial data was about US$ 3 per lease.
[11] These figures exclude a limited number of freehold estates that had been established before independence. Records for these are in a separate registry the digitization of which is planned jointly with that of the deeds registry.
[12] With a mean size of 6.6 ha, ranging from 16 ha in the North to 2.5 in the Center, urban leases seem more akin to layouts and computerization of deeds could yield interesting details on subsequent transactions.
[13] We report differences in estate sizes between the lease record and the spatial analysis of mapped boundaries in appendix table 1.

ones in the South (table 2). While most agricultural estates are in the 10-30 ha group, 6% (952,847 ha) and 0.6% (603,705 ha) of estate area is in estates larger than 50 or 500 ha, respectively. Data on legal documentation suggest the prescribed process for obtaining a lease was not always completed; in fact only 36% of all leases (42% of agricultural ones) are supported by a deed. 34% (37% of agricultural ones) have only a letter of offer and 30% (21% of agricultural ones) remained at the application stage. Quality of spatial documentation varies as well; while 2% of leases for agricultural estates (and 18% for non-agricultural ones) are surveyed and accompanied by a deed plan, 52% (and 66% for non-agricultural ones) have not advanced beyond the sketch plan whereas for 46% (and 16% for non-agricultural ones) the sketch was redrawn by the survey department.[14] By highlighting that, for 7,819 agricultural estates with a total area of 404,584 ha, documents lack data on lease duration, computerization also highlights that existing documentation contains gaps that might raise challenges for transparent governance.[15]

With a mean annual rent of less than US$ 1/ha for agricultural estates and US$ 27/ha for non-agricultural ones, the value of public revenue from such rents eroded over time, implying that yield may be below the cost of collection. To illustrate the potential revenue from agricultural leases, we note that, according to the 2010/11 Living Standards Measurement Survey (LSMS-ISA), the mean price of an existing lease is US$ 58/ha and the price at which respondents would be willing to lease in additional land is somewhat above $50/ha. Even a compliance rate of 50% could generate annual lease revenue of some US$ 35 million in addition to providing strong incentives for effective land use.

The potential for collecting ground rent is further eroded by the fact that, in 2016, leases for 70% of agricultural estates had expired and 22% were indeterminate (compared to 9% and 48% for non-agricultural ones, respectively). In fact, with 3% due to expire in less than 10 years, only 5% of agricultural estates (vs. 41% of non-agricultural ones) had remaining lease terms beyond 10 years. This could negatively affect productivity by increasing tenure insecurity and undermining investment incentives and also by limiting the scope for efficiency-enhancing transfers of land to operators with higher levels of ability. Data on estate performance could allow to assess extent and incidence of such insecurity and policy implications.

3.2 Using spatial data to assess overlapping rights and land use

Beyond the textual information discussed above, complete digitization allows us to use spatial data to assess record quality by exploring overlaps among records. The most basic way of doing so is to check for overlaps in the data itself which, if records are correct, would imply that land was simultaneously transferred to two

[14] Sketch Plans are plans that have been validated by a licensed surveyor, mostly of them private companies, but are generally of low quality and accuracy. Survey Drawn (SD) sketch plans normally just involve reproduction of the information provided in application sketch plans by the Survey Department in a homogeneous format without conducting a (re-)survey in the field. Deed plans are resurveyed by the Surveys Department and thus of much higher geographical accuracy.

[15] Discussions suggest that many individuals might have believed that omission of the start date or duration of a lease would imply that their lease was de facto of unlimited duration.

different owners. Figure 2 illustrates this by displaying (in black lines) recorded boundaries for all estates as per the registry in one district. Even cursory inspection reveals a large number of substantial overlaps that are unlikely to be due to limited precision of the survey technology used when issuing leases.

District-level figures from analysis of the spatial part of estate leases in table 3 show that 28% of agricultural estates have at least 20% of their area registered to two different owners. Such double-registration affects 10.2% of the area under agricultural estates or 137,064 ha.[16] The share of double-registration varies across districts: figures are highest in Balaka (55%), Kasungu (18%), and Mzimba (9%). The table also highlights cross-district variation in the share of leased area that has expired, a figure that is highest in Dowa (84%), Mzimba (70%), and Mangochi (43%), with a national average of 48%. Double-registration of agricultural estates by lease validity suggests that the problems are slightly more frequent for expired leases (appendix table 2). If this reduces tenure security and incentives for investment or effective land use, a systematic process of ground verification may be needed.

An expanding literature highlights the potential of using remotely sensed imagery for crop forecasting and early warning (Basso *et al.* 2013), including the assessment of cultivation status and possibly yields at field level based on machine learning (Lobell 2013). Building on these advances, medium resolution SPOT imagery from 2013-14 was used to obtain an estimate of the share of registered estate land under different types of land cover (Van Setten *et al.* 2014).[17] Subject to the caveats regarding quality of spatial data noted earlier, these estimates suggest that a sizeable share of estate land seems to be not used for crop production.

Figures in table 4 show that, with some 42% of land under crops in the aggregate, intensity of land use in the estate sector seem to be similar to what was found by ELUS, suggesting little change since then. Only about 18% of estates are estimated to use 70% or more of their land for crops. Intensity of land use is highest in the size group below 20 ha, lowest in the 50-500 ha group, and then again increases slightly in the above 500 ha group, similar to what was found by ELUS and in line with the narrative of significant amounts of 'idle' estate land. Obtaining a more reliable estimate of the extent to which land currently assigned to estates is un-or underused, though beyond the scope of this paper, would be desirable given the size of estimated economic impacts and the fact that such analysis is no longer too difficult.[18] It would be an important basis for policy decisions, e.g. whether (or when) to let estate land that is not used revert to customary authorities.

[16] We chose the 20% cutoff to exclude small and non-substantive overlaps that may be due more to the accuracy of mapping.
[17] Categories used were maize, other crops, grassland, savannah/shrubs, forest, and built up area including bare land and waterbodies.
[18] Availability of free imagery (sentinel 1/2) at higher temporary and spatial resolution, together with algorithms that can be run on platforms such as Google Earth Engine (GEE) makes analysis much easier.

4. Assessing estates' contribution to agricultural productivity

We use georeferenced survey data from NACAL to assess whether estates help to increase productivity of land use either directly or indirectly. Direct effects are approximated by comparing levels of yield, input use, and land use intensity between estates and smallholders. Indirect effects are identified by exploring if smallholders' location on or in close proximity to estates affects their levels of input use, output, or profit.

4.1 Comparing land use and productivity between smallholders and estates

While administrative data on estate boundaries allows a rough assessment of land under crops via overlays with satellite imagery, information on production and yields requires survey-based information. We use the 2006/07 National Census of Agriculture and Livestock (NACAL) that contains information for the 12-month period starting in October 2006 for both smallholders and estates. Estates were drawn from a nation-wide list and the survey identified smallholder farms in a two-stage process. Enumeration areas (EAs) were first randomly selected by district with stratification by agro-ecological zone. In selected EAs, a listing was then undertaken and farm households drawn randomly from the list aiming for 10 small (< 2 acres) and 5 medium sized (≥ 2 acres) farms per EA.[19]

For smallholders, information on household composition, assets, and plot-level production as well as GPS coordinates was collected. Useable data on GPS coordinates and complete information for all variables of interest is available for 20,677 observations. Information on socio-economic characteristics and production in appendix tables 3 and 4 shows that nationally about 9% -from 16% in the Center to 3% in the South- live as tenants or squatters on an estate. Compared to the rest, the latter cultivate a slightly larger area (1.05 vs. 0.67 ha) and devote a higher share of their land to tobacco but there is little evidence of differences in terms of intensity of input use for maize for which profits are actually slightly lower.

Table 5 illustrates that on average the 868 estates in the sample had an age of 19 years with largest estates the oldest. Most (73%) are owned by Malawian persons, 11% by 'others' -most likely legal entities- and 10% by expatriates. The ownership share of expatriates and government peaks at 100-500 ha and that of 'others' in the > 500 ha group. About a third of estates have tenants; the share of estates with tenants peaks at close to 50% in the 10-100 size category. In contrast to other countries where large farms produce bulk commodities and often generate little employment (Ali *et al.* 2015), many of Malawi's estates are labor intensive. Permanent or temporary male (female) labor is hired by 64% (27%) and 70% (56%) of estates respectively. Demand for permanent labor per ha cultivated is almost equal to the amount of labor spent by smallholders based on the 2010/11 LSMS-ISA survey (Deininger *et al.* 2015). It increases with size to about 0.9 males and 0.6 females in the largest category though the pattern for temporary labor is more volatile.

[19] In EAs with less than 5 medium-sized farms, small farms were added to bring the total sample to 15.

Comparing smallholders to estates provides interesting insights in a number of respects. First, for estates, 15% of allocated land is operated, a share that decreases from 88% in the group below 5 ha, a figure that is comparable to the intensity of land utilization by smallholders, to 12% in the above 500 ha group (table 6). *Prima facie* this provides some support for claims about un- or underused estate land that have been a recurrent theme in Malawi's policy debate (Holden *et al.* 2006). Second, production structure and cropping patterns differ between smallholders and estates: 42% of estate area is devoted to tobacco, followed by maize (39%), groundnuts (7%), and other crops (table 5).

The data also suggest that for all crops except cassava smallholders' yields are significantly above those by estates. Non-parametric regressions for yields of tobacco, maize, groundnuts and cassava against the log of farm size using the pooled sample of smallholders and estates in figure 3graphically illustrate that, with the possible exception of cassava, adding large farms to the sample of smallholders does not lead to a reversal of the negative relationship between farm size and yields on land area actually cultivated; to the contrary the relationship is robust and rather tightly estimated. While these are yields rather than profits, the fact that the share of estates using purchased inputs and the mean per hectare value of such inputs by those who use them is significantly above the equivalent figure for smallholders, this suggests that the relationship between farm size and profits is unlikely to be positive. Non-parametric regressions for profits in maize and tobacco (the only crops for which price data are available) in figure 4 support this notion although wide confidence intervals imply that there is considerable heterogeneity in this variable among large producers. It would be of great interest to explore possible if profits or land use intensity (by the estate owner or tenants) are higher on estates with no overlapping registered claims or valid lease documents to explore if, say, tenure insecurity reduced productivity or prevented estates from enhancing income and overall production by leasing out part of their land to smallholders or increasing the number of tenants they employ. Unfortunately, estate data are not georeferenced, making overlays with administrative records that would be needed to conduct such analysis impossible.

4.2 Assessing impacts of estates on nearby smallholders

If access to modern technology is limited or factor markets imperfect, commercial farm establishment may benefit neighboring smallholders by improving their knowledge of improved techniques and allowing easier access to factor and output markets. The rationale for the latter is that if the volume of potential transactions in any given location is limited, high transaction costs may well ration smallholders out of such markets (Key et al. 2000) even if they had working capital and would not depend on credit. To the extent that they use certain inputs or produce outputs for the market, estates can then provide market access to neighboring smallholders, potentially on implicit credit. An additional source of positive spillovers is through employment on estates that can increase smallholders' demand and potentially relieve their

borrowing constraints (Mano and Suzuki 2013). Small farmers who work on estates as casual workers may also acquire knowledge about new techniques or pick up specific skills that will be useful on their own farms. Beyond such beneficial effects, the literature has long pointed out that large farms may compete with local smallholders for resources, most prominently land (German et al. 2013 ; Schoneveld 2014) but also water (Braun and Meinzen-Dick 2009; Rulli et al. 2013).

Spatial proximity as a channel for transmission of spillover effects between investors and neighboring households has been used to investigate economic and social impacts of mine openings or closings (Chuhan-Pole *et al.* 2015), including on female empowerment (Kotsadam and Tolonen 2015). Although more limited, evidence from Zambia (Ahlerup and Tengstam 2015), Nigeria (Adewumi *et al.* 2013), Mozambique (Deininger and Xia 2016) and to some extent Ethiopia (Ali *et al.* 2016b) suggests that a similar framework can be used to assess the impacts of large farms investment on neighboring small farmers. While for the case at hand lack of panel data on smallholders makes it impossible to identify causal impacts, we can use simple regressions as a descriptive device to assess whether, after controlling for other factors, location on or distance to an estate, with or without a valid lease, affects smallholders' production outcomes. To do so, we estimate

$$Y_{ijk} = \alpha_k + \beta S_{ijk} + \gamma D_{ijk} + \varepsilon_{ijk} \qquad (1)$$

where Y_{ijk} is the variable of interest, i.e. either the quantity of inputs used or crop yield and profit by household i in village j of district k; α_k is a vector of district effects; S_{ijk} is an indicator variables for smallholders located within an agricultural estate; D_{ijk} is the distance to the boundary of the next agricultural estate for those not located within an estate. To distinguish by validity of estates' leases, we further add interactions between indicator variables for validity of leases and S_{ijk} and D_{ijk}. β and γ are the parameters to be estimated. ε_{ij} is an error term clustered by the closest agricultural estate.

Results in table 7 suggest that, largely as a result of larger area cultivated, location on or proximity to an agricultural estate is associated with higher levels of output (col. 6). This does, however, not translate into higher levels of productivity; in fact for squatters on agricultural estates, output and profit per hectare are negative and significant and per-hectare profits are higher only for smallholders in closer proximity to the boundary of estates with non-expired leases. While further exploration of this issue with better data would be warranted, this suggests that any indirect benefits from estates will be quite limited.

5. Conclusion and policy implications

A decade after the emergence of high demand for large scale agricultural land acquisition, many target countries still find it difficult to harness the benefits they expected to materialize from this phenomenon. While part of this is due to unrealistic expectations, our analysis suggests that failure to maintain and make

the most of administrative data is a key contributing factor. It reduces public revenue, fails to encourage effective land use, and undermines the scope for performance monitoring that would allow taking measures to improve performance as needed. We show how combining administrative data with remotely sensed imagery and survey data can result in a more evidence-based debate and policy relevant recommendations.

The methodologies used here are of broader relevance, for the case of Malawi, such data allow us to discern distinct phases of investment and illustrate how weak records reduce potential benefits from such investment both directly, by making it more difficult for government to collect revenue to support public goods and encouraging speculative instead of productive land use, and indirectly, by creating tenure insecurity that may reduce intensity of land use and productivity. In Malawi, he need to renew, cancel, or renegotiate estate leases arising from the fact that most agricultural estate leases expired creates a unique opportunity to act on some of the issues identified here, in particular to set lease rates at more realistic levels and to adjudicate rights and boundaries in line with actual use. If built on a clear policy framework that clarifies the hierarchy of evidence among competing claims and procedures to deal with unused estate land, a field based process to produce an index map of existing estates could be implemented at a cost well below the potential gains in terms of increased public revenue and higher levels of land use intensity and productivity. Resulting data on estate rights and boundaries could not only create the preconditions for systematically implementing recently passed provisions to demarcate customary estates in ways to avoid the tradition of double allocation of land that is vividly illustrated in our data. It could also form a basis for continued real-time monitoring of estate performance that would allow to realize some of the potential, in terms of access to technology and markets, that could help contribute to much-needed diversification of Malawi's rural sector.

Table 1: Evolution of number and area under agric. and non-agric. estate leases

		1909-64	1965-86	1987-94	1995-2016	By sub-period	
						1995-2006	2007-16
Panel A: Cumulative figures							
Total							
Area transferred	1000 ha	17.95	259.12	779.05	960.06	864.62	960.06
No. of leases	No.	648	5,281	27,282	39,695	33,252	39,695
Agric.							
Area transferred	1000 ha	16.73	254.05	772.85	944.18	853.34	944.18
No. of leases	No.	155	2,432	23,439	27,321	26,202	27,321
Non-agric.							
Area transferred	1000 ha	1.23	5.08	6.21	15.89	11.29	15.89
No. of leases	No.	493	2,849	3,843	12,374	7,050	12,374
Panel B: Period increments							
Total							
Area transferred	1000 ha	17.95	241.17	519.93	181.01	85.57	95.44
No. of leases	No.	648	4,633	22,001	12,413	5,970	6,443
Mean lease size	ha	29.24	52.80	23.79	14.87	14.84	14.89
Agric.							
Area transferred	1000 ha	16.73	237.32	518.82	171.33	80.49	90.84
No. of leases	No.	155	2,277	21,007	3,882	2,763	1,119
Mean lease size	ha	123.90	105.15	24.73	44.13	29.43	81.47
Non-agric.							
Area transferred	1000 ha	1.23	3.85	1.13	9.68	5.08	4.60
No. of leases	No.	493	2,356	994	8,531	3,207	5,324
Mean lease size	ha	2.56	1.67	1.30	1.16	1.67	0.87
Panel C: Annual increments							
Total							
Area/year	1000 ha	0.32	10.96	64.99	8.23	7.13	9.54
Leases/year	No.	12	211	2,750	564	498	644
Agric.							
Area/year	1000 ha	0.30	10.79	64.85	7.79	6.71	9.08
Leases/year	No.	3	104	2,626	176	230	112
Non-agric.							
Area/year	1000 ha	0.02	0.18	0.14	0.44	0.42	0.46
Leases/year	No.	9	107	124	388	267	532

Source: Own computation from the National Geographical Estates Database.

Table 2: Descriptive statistics of estates by lease status

	Total	Non-agric. estates				Agric. estates			
		All	North	Center	South	All	North	Center	South
General characteristics									
Total area (1,000 ha)	1,487.44	138.68	45.52	20.30	72.86	1,348.76	230.63	871.61	246.52
Mean area (ha)	27.10	6.60	15.98	2.54	7.17	39.80	39.49	35.12	76.23
Signed before 1988 (%)	18.29	27.71	26.48	37.46	20.03	13.82	11.30	13.74	18.91
Signed 1988 to 1995 (%)	56.25	7.59	8.79	7.14	7.66	79.31	81.39	81.99	52.67
Signed after 1995 (%)	25.47	64.70	64.74	55.40	72.32	6.88	7.31	4.27	28.41
Length of lease (years)	40.71	76.77	81.09	64.19	86.24	24.35	24.52	23.41	32.46
Lease length <=21 years (%)	47.88	9.55	5.85	15.35	5.80	73.62	65.85	77.92	55.40
Lease length >21 years (%)	19.79	43.04	35.27	38.47	49.73	4.19	3.67	3.24	12.27
Size less than 10 ha (%)	42.60	97.83	97.05	98.44	97.57	8.37	7.98	5.86	28.29
Size 10 - 30 ha (%)	45.62	1.09	1.72	0.90	1.05	73.22	71.92	78.21	37.20
Size 30 - 50 ha (%)	5.90	0.25	0.28	0.16	0.31	9.40	9.81	8.98	11.90
Size 50 - 100 ha (%)	3.21	0.26	0.32	0.18	0.32	5.04	5.91	4.11	10.58
Size 100 - 500 ha (%)	2.12	0.33	0.14	0.24	0.45	3.24	3.65	2.22	10.30
Size above 500 ha (%)	0.55	0.25	0.49	0.09	0.31	0.74	0.74	0.61	1.73
Formal documentation									
Has deed (%)	35.80	26.51	18.72	25.66	29.97	42.03	43.33	40.07	54.49
Has offer (%)	65.49	49.51	39.06	49.33	53.34	76.22	68.76	79.53	64.93
Has offer but no deed (%)	34.47	30.56	26.61	33.09	29.76	37.09	27.70	41.91	17.86
Lease indeterminate (%)	32.41	47.54	58.91	46.38	44.57	22.25	30.50	18.90	32.45
Sketch plan (%)	56.76	65.81	58.18	67.65	65.81	51.65	52.07	52.85	41.94
SD plan (%)	35.53	16.14	23.08	16.73	14.42	46.47	46.61	45.94	50.23
Deed plan (%)	7.71	18.05	18.74	15.63	19.77	1.87	1.32	1.21	7.83
Annual rent (US$/ha)	10.69	26.66	23.18	23.22	30.35	0.79	0.37	0.53	3.59
Lease term in 2016									
Lease expired (%)	45.35	9.16	5.15	15.03	5.46	69.65	63.13	74.64	43.98
Lease term <= 10 a (%)	2.42	2.09	2.66	2.46	1.57	2.64	1.55	2.43	6.27
Lease term > 10 a (%)	19.82	41.21	33.29	36.13	48.41	5.46	4.82	4.04	17.30
No. of obs.	58,733	23,593	3,728	9,236	10,629	35,140	6,181	25,560	3,399

Source: Own computation from the National Geographical Estates Database.

Table 3: Extent, expiration status, and double registration for agricultural estates by district

	Number of leases			Area under leases				
	Total	Expired	Overlap >20%	Total ha	Expired ha	%	Overlap > 20% ha	%
North								
Chitipa (CH)	219	93	29	6,825	3,009	44.1	584	8.6
Karonga (KA)	245	49	7	23,433	1,331	5.7	49	0.2
Mzimba (MZ)	3,886	2,689	824	128,002	89,229	69.7	11,274	8.8
Nkhata Bay (NB)	418	98	26	40,588	2,567	6.3	302	0.7
Rumphi (RU)	1,413	973	215	31,785	20,491	64.5	2,549	8.0
Subtotal North	6,181	3,902	1,101	230,633	116,629	50.6	14,758	6.4
Center								
Dedza (DZ)	224	88	19	10,815	3,061	28.3	1,121	10.4
Dowa (DA)	4,563	3,535	1,361	90,638	75,835	83.7	11,346	12.5
Kasungu (KU)	9,521	7,266	4,129	339,668	182,148	53.6	62,634	18.4
Lilongwe (LL)	540	224	69	20,780	3,451	16.6	427	2.1
Mchinji (MC)	4,223	3,397	1,200	109,948	66,957	60.9	14,460	13.2
Nkhotakota (KK)	2,389	1,748	611	109,932	63,401	57.7	11,518	10.5
Ntcheu (NU)	363	179	43	49,800	5,570	11.2	1,521	3.1
Ntchisi (NT)	1,991	1,564	371	43,621	32,271	74.0	3,320	7.6
Salima (SL)	1,746	1,076	345	96,405	34,410	35.7	5,217	5.4
Subtotal Center	25,560	19,077	8,148	871,606	467,105	53.6	111,565	12.8
South								
Balaka (BK)	50	-	9	1,190	-	-	656	55.1
Blantyre (BT)	215	31	16	2,317	314	13.5	31	1.3
Chikwawa (CK)	200	15	27	29,806	364	1.2	166	0.6
Chiradzulu (CZ)	51	15	4	768	101	13.2	19	2.4
Machinga (MA)	503	292	63	42,307	10,261	24.3	1,144	2.7
Mangochi (MI)	1,530	878	242	104,871	44,607	42.5	7,729	7.4
Mulanje (MJ)	165	49	5	23,833	760	3.2	8	-
Mwanza (MN)	148	30	25	10,709	1,569	14.7	705	6.6
Neno (NE)	10	-	1	232	-	-	18	7.6
Nsanje (NJ)	68	5	9	5,198	140	2.7	40	0.8
Phalombe (PE)	9	-	-	87	-	-	-	-
Thyolo (TO)	111	19	7	4,390	118	2.7	35	0.8
Zomba (ZA)	339	161	19	20,813	2,267	10.9	192	0.9
Subtotal South	3,399	1,495	427	246,523	60,502	24.5	10,741	4.4
Total Malawi								
Total Malawi	35,140	24,474	9,676	1,348,763	644,236	47.8	137,064	10.2

Source: Own computation from the National Geographical Estates Database.

Table 4: Land use status for agricultural estates

	Total area (1,000 ha)	Share of land under crops (%)	Share of estates with at least 70% of area under crops (%)	No. of obs.
Total	683.83	42.07	18.09	24,823
Region				
North	101.04	34.97	11.34	3,758
Center	455.38	44.51	20.59	18,526
South	127.41	38.99	9.85	2,539
Lease duration/validity				
Expired/indet. lease	569.86	42.36	18.24	23,034
Valid lease	113.97	40.65	16.21	1,789
Valid lease > 10 years	102.20	40.28	15.37	1,171
Has deed	400.49	41.22	17.02	12,259
Has SD plan	382.79	41.89	17.58	12,637
Time of transfer				
Before independence	0.43	45.88	8.33	12
1964-1985	76.52	40.02	17.44	1,193
After 1985	502.53	43.96	18.23	19,814
Size				
<10 ha	9.04	51.10	23.56	1,957
10-20 ha	205.42	48.32	21.77	15,224
20-50 ha	169.06	40.57	10.83	5,828
50-100 ha	77.82	34.96	4.78	1,151
100-500	108.68	35.50	4.24	590
>= 500 ha	113.82	43.43	6.85	73

Source: Own computation National Geographical Estates Database overlaid with SPOT imagery.
Note: Crop use is defined as maize and other crops. Figures are reported only for estates for which satellite imagery is available.

Table 5: Estate characteristics by size

	All	Size category in ha					
		<=5	5-10	10-50	50-100	100-500	>500
Estate ownership							
Years run by the current owner	18.99	13.14	12.54	15.28	21.13	19.84	30.77
Owner is Malawian (%)	72.58	75.00	82.76	92.42	80.21	50.52	29.75
Owner is expatriate (%)	10.48	12.50	0.00	1.18	4.17	29.17	20.66
Owner is other (%)	10.94	12.50	13.79	4.50	6.25	12.50	33.88
Owner is government (%)	2.19	0.00	0.00	0.00	3.13	5.21	4.96
Owner is NGO (%)	3.23	0.00	3.45	1.90	6.25	2.60	6.61
Labor demand							
Hired perm. male labor (%)	64.40	37.50	58.62	52.13	52.08	82.29	91.74
No. of perm. male labor	28.76	1.50	4.92	3.66	7.17	49.43	108.24
No. of perm. male labor per ha	0.60	0.50	0.93	0.40	0.45	0.89	0.88
Hired perm. female labor (%)	27.19	25.00	17.24	12.09	23.96	47.92	52.07
No. of perm. female labor	13.05	0.83	0.96	1.26	1.87	13.67	65.84
No. of perm. female labor per ha	0.19	0.28	0.19	0.11	0.05	0.19	0.58
Hired temp. male labor (%)	70.28	37.50	65.52	63.51	68.75	76.56	88.43
No. of temp. male labor	45.05	154.67	7.08	13.06	15.48	72.80	139.95
No. of temp. male labor per ha	1.51	31.28	1.96	1.48	0.96	1.14	1.03
Hired temp. female labor (%)	55.76	12.50	44.83	46.92	54.17	64.58	79.34
No. of temp. female labor	23.58	2.00	8.15	6.86	10.91	34.73	79.53
No. of temp. female labor per ha	0.71	0.50	1.65	0.86	0.50	0.54	0.45
Total wage bill per ha (US$)	131.95	249.76	144.42	133.60	174.62	138.21	77.64
Tenancy							
Have tenants (%)	33.64	12.50	10.34	43.84	44.79	25.00	9.92
Number of tenants	4.98	0.63	1.03	4.65	6.36	4.90	6.36
No. of obs.	868	8	29	422	96	192	121

Source: Own computation from 2006/07 NACAL.

Table 6: Comparing production and yields between estates and smallholders

	Estates by size in ha							Smallholders by size in ha				
	All	**<=5**	**5-10**	**10-50**	**50-100**	**100-500**	**>500**	**All**	**<=1**	**1-5**	**5-10**	**>10**
Land use												
Area owned	433.86	4.00	8.52	21.61	74.28	272.36	2,544	1.06	0.43	1.72	7.07	29.34
Area operated	66.98	3.50	5.77	10.27	27.42	80.21	294.53	0.70	0.38	1.35	5.10	8.07
Share of area by crop												
Tobacco (%)	42.07	31.94	15.89	39.71	42.48	47.93	47.15	1.77	1.22	3.65	4.55	2.36
Maize (%)	38.86	56.94	66.95	44.30	41.75	30.83	22.93	60.06	60.51	58.90	60.13	49.55
Beans (%)	0.73	0.00	1.28	0.76	1.68	0.28	0.51	1.86	1.94	1.62	1.40	1.44
Rice (%)	1.08	0.00	0.00	1.13	0.07	1.75	0.89	2.34	2.27	2.65	3.40	0.53
Cassava (%)	1.84	0.00	0.64	1.80	3.46	2.48	0.10	4.65	4.28	5.88	2.37	9.40
Ground nuts (%)	7.02	5.56	12.99	9.95	6.78	3.38	1.38	4.86	4.06	7.46	5.69	11.20
Tea (%)	3.67	0.00	0.00	0.00	0.00	5.92	16.97	0.02	0.01	0.07	0.00	0.00
Other crops (%)	4.73	5.56	2.24	2.35	3.79	7.43	10.07	12.87	12.86	13.11	9.06	11.95
Yield (kg/ha) by crop												
Tobacco	960	854	1,047	905	1,089	1,010	1,000	1,129	1,233	1,073	674	491
Maize	1,585	1,313	1,874	1,685	1,286	,1385	1,606	1,765	1,911	1,367	505	1,199
Beans	355		75	207	432	1,200	615	427	455	334	115	1,043
Rice	1,123			1,310		750	750	2,143	2,333	1,835	188	673
Cassava	3,058			3,692	1,417	2,140		2,742	2,914	2,366	1,681	3,200
Ground nuts	765		440	840	439	783	550	1,199	1,298	1,087	720	821
Tea	648					1,537	370	2,992	1,004	3,489		
Purchased inputs												
Purchased fertilizer (%)	93.66	75.00	82.76	95.73	89.58	93.75	93.39	60.91	58.69	70.03	56.32	53.27
Cost of fertilizer (US$/ha)	192.09	161.50	118.11	149.68	175.01	270.21	250.15	41.05	48.54	17.09	3.97	1.07
Purchased pesticides (%)	65.78	50.00	37.93	56.64	65.63	78.13	85.95	7.98	7.06	11.07	11.05	11.21
Cost of pesticides (US$/ha)	27.70	26.17	3.30	8.48	12.49	60.84	62.45	1.74	2.13	0.47	0.30	0.04
Purchased seed (%)	65.09	50.00	62.07	67.77	70.83	60.94	59.50	44.82	44.02	48.07	44.21	44.39
Cost of seed (US$/ha)	9.71	1.79	10.00	5.27	10.32	13.19	19.92	15.42	19.01	3.71	1.29	0.28
Purchased other inputs (%)	13.13	25.00	27.59	14.45	15.63	10.42	6.61					
Cost of other inputs (US$/ha)	1.79	0.00	19.47	1.30	1.56	1.66	0.02					
Sample distribution												
North (%)	23.96	25.00	3.45	33.89	30.21	13.02	6.61	16.46	15.64	19.83	8.95	4.67
Center (%)	57.83	37.50	72.41	61.61	57.29	49.48	56.20	37.35	34.03	47.22	60.00	69.63
South (%)	18.20	37.50	24.14	4.50	12.50	37.50	37.19	46.20	50.33	32.96	31.05	25.70
No. obs	868	8	29	422	96	192	121	20,677	15,946	4,327	190	214

Source: Own computation from 2006/07 NACAL.

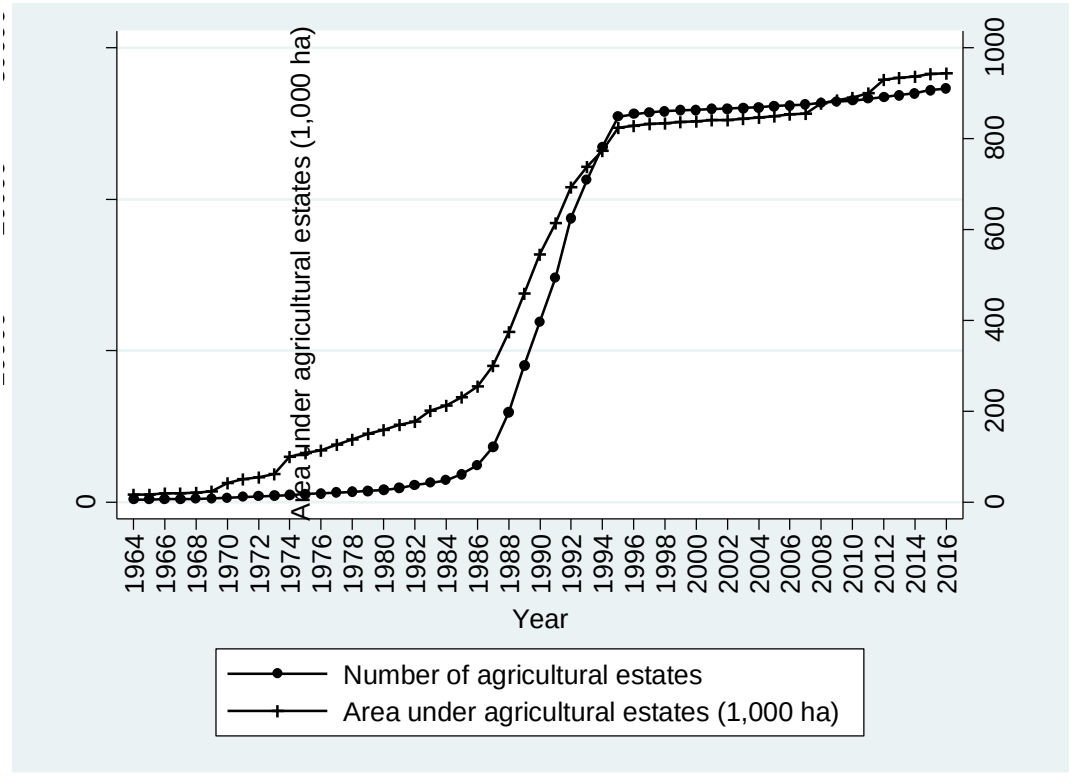
Note: Other crops for estates include cotton, paprika, soya beans, coffee, macadamia nut, sugar cane, sorghum, peas, and grams. Other crops for smallholders include sorghum, millet, soya beans, ground beans, pigeon peas, cow peas, sun flower, sweet potato, irish potato, cotton, sugar cane, and coffee.

Table 7: Smallholders' profits, output, and input use relative to their location to agricultural estates

	Profit (US$/ha)	Output val. (US$/ha)	Fertilizer (US$/ha)	Manure (US$/ha)	Seed (US$/ha)	Output (US$)
Panel A: No controls						
Squatter	-9.612	-6.170	-1.628	-2.159***	-3.076	47.456***
	(7.236)	(7.275)	(5.181)	(0.807)	(3.068)	(14.504)
Non-squatter * dist. to	-1.107	-1.281	-0.915**	-0.060	0.557*	-4.706***
next agric. estate	(1.382)	(1.278)	(0.452)	(0.065)	(0.284)	(1.008)
Observations	16,439	17,568	20,225	17,124	19,568	17,568
R-squared	0.031	0.031	0.146	0.022	0.075	0.020
Panel B: With controls						
Squatter	-15.871*	-9.795	-1.639	-2.463**	-5.719***	48.675***
	(8.290)	(7.997)	(3.353)	(0.992)	(1.535)	(14.647)
Non-squatter * dist. to	-2.016	-0.362	-0.108	-0.028	0.789**	-3.723***
next agric. estate	(1.550)	(1.305)	(0.471)	(0.098)	(0.333)	(0.924)
Observations	13,100	14,074	16,155	13,714	15,596	14,074
R-squared	0.047	0.054	0.160	0.035	0.088	0.061
Panel C: Distinguishing lease validity						
Squatter (β_0)	-41.057*	-39.113**	1.718	-2.306	-3.448	-5.440
	(21.187)	(19.171)	(10.263)	(1.412)	(4.286)	(17.158)
Squatter	28.090	32.673	-3.946	-0.184	-2.618	60.890**
* ag. estate w/ invalid lease (β_1)	(22.546)	(20.555)	(10.699)	(1.532)	(4.541)	(23.902)
Non-squatter * dist. to next ag. estate (γ_0)	-8.244***	-3.527	-0.132	0.113	0.968*	-3.000
	(3.147)	(3.451)	(0.794)	(0.163)	(0.511)	(1.953)
Non-squatter * dist. to next ag. estate	7.321**	3.744	0.059	-0.169	-0.207	-0.957
* ag. estate w/ invalid lease (γ_1)	(3.386)	(3.703)	(0.954)	(0.203)	(0.594)	(2.262)
Ag. estate w/ invalid lease	-12.616	-18.185	-5.368	0.121	-1.391	6.223
	(14.968)	(12.779)	(5.174)	(1.120)	(2.509)	(9.816)
Observations	13,100	14,074	16,155	13,714	15,596	14,074
R-squared	0.048	0.054	0.160	0.035	0.088	0.061
Tests:						
Test $\beta_0 + \beta_1 = 0$	2.17	0.57	0.41	5.46**	13.89***	11.51***
Test $\gamma_0 + \gamma_1 = 0$	0.35	0.03	0.02	0.23	4.15**	14.23***

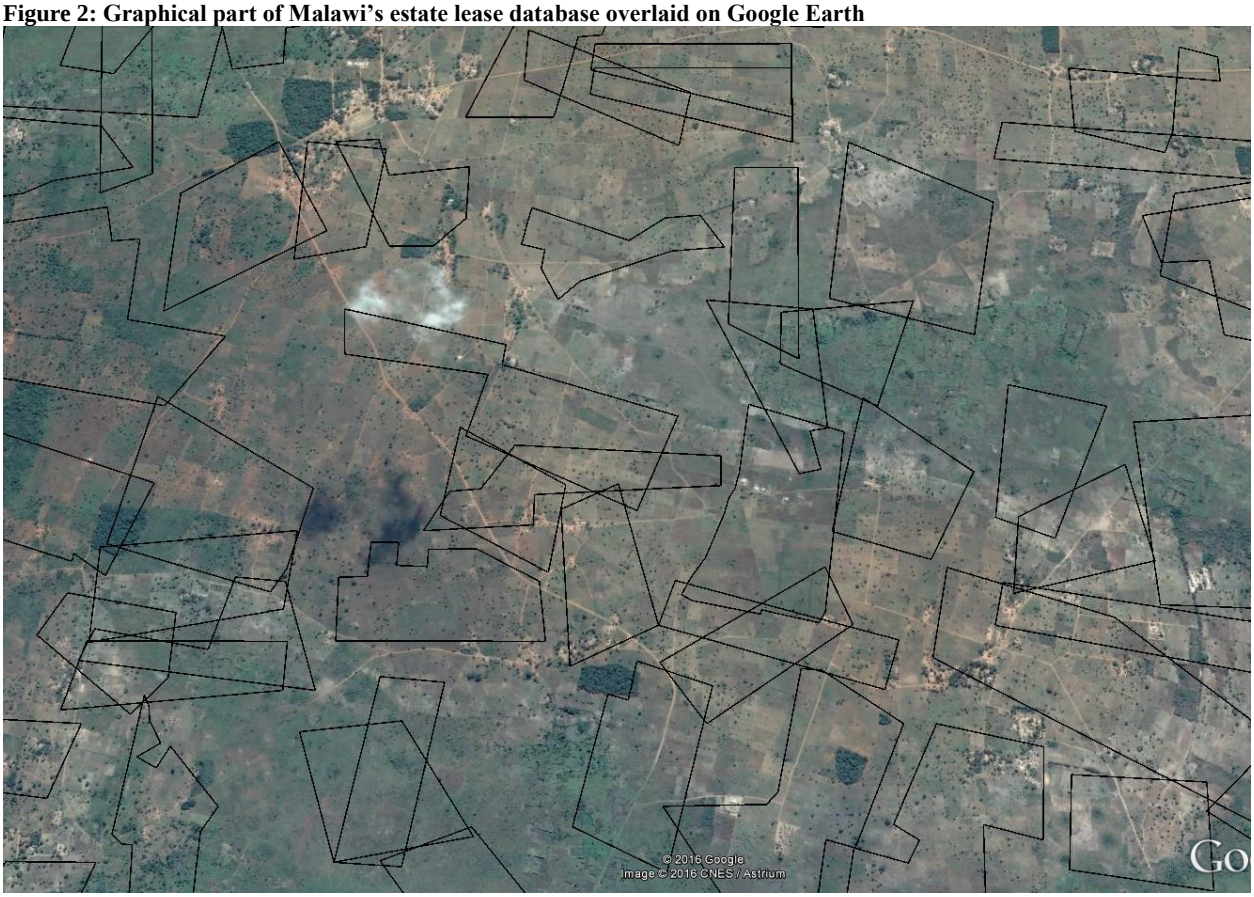
Note: Profits are for maize, rice & tobacco. Regressions in panels B and C include village-, household-, and parcel level controls. Village controls include access to all season road and inheritance regimes; household controls include the number of children, adults, and old; head's characteristics (gender, age, education, birth place); ownership of durable goods, housing conditions, the value of livestock and agricultural assets; parcel controls include topography and district fixed effects are included throughout.
In panel C, β_0 (γ_0) is the estimated coefficient for squatters (non-squatters) for agricultural estates with valid leases and the sum of β_0 and β_1 (γ_0 and γ_1) tests effects on squatters (non-squatters) for agricultural estates with invalid lease whereas β_1 (γ_1) tests for the difference of effects for squatters (non-squatters) on estates with invalid leases.
Standard errors in parentheses are clustered by the closest agricultural estate. *** p<0.01, ** p<0.05, * p<0.1.

Figure 1: Cumulative density of the number agricultural leases issued and covered after independence



Source: Own computation from the National Geographical Estates Database.

Figure 2: Graphical part of Malawi's estate lease database overlaid on Google Earth



Source: Spatial data from the National Geographical Estates Database overlaid with google earth.

Figure 3: Non-parametric regressions of yield for main crops for smallholders and estates

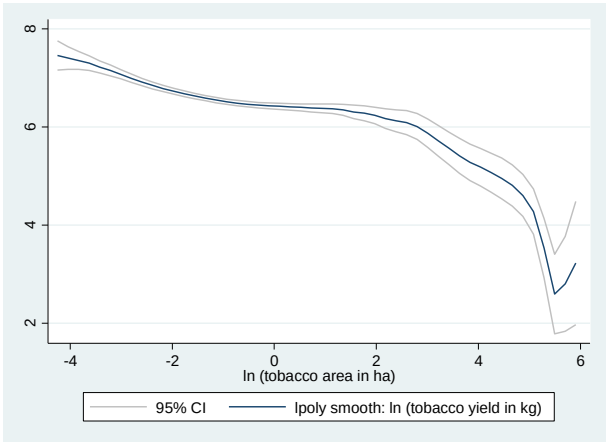


Figure 3a: Tobacco

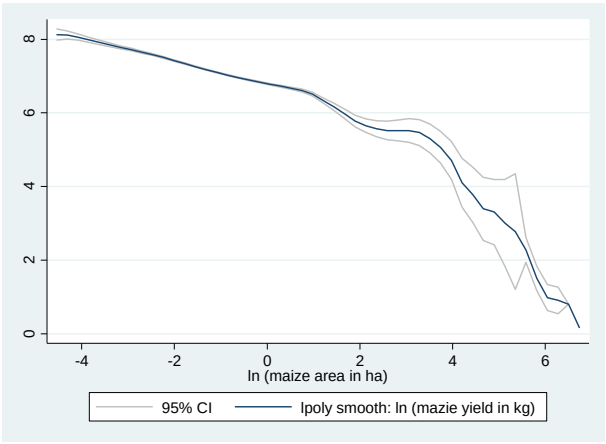


Figure 3b: Maize

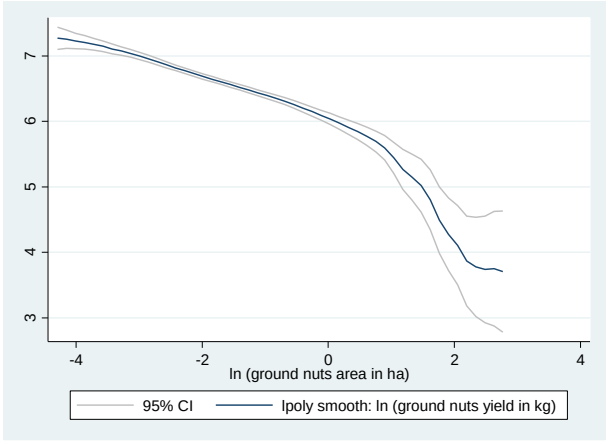


Figure 3c: Ground nuts

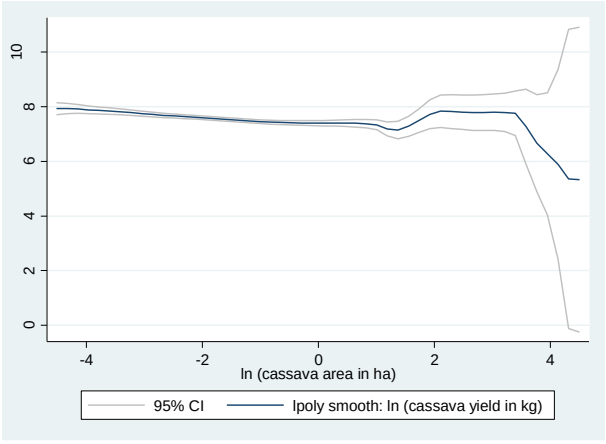


Figure 3d: Cassava

Source: Own computation from 2006/07 NACAL.
Note: As explained in the text, both smallholder and estate samples are included.

Figure 4: Non-parametric regressions of profit for maize, rice and tobacco

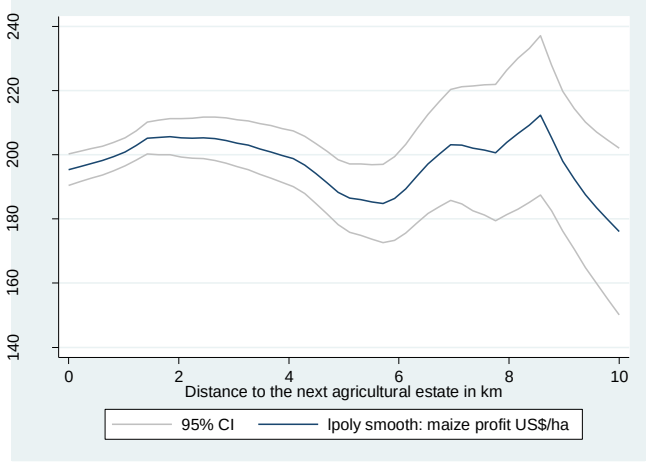


Figure 4a: Maize

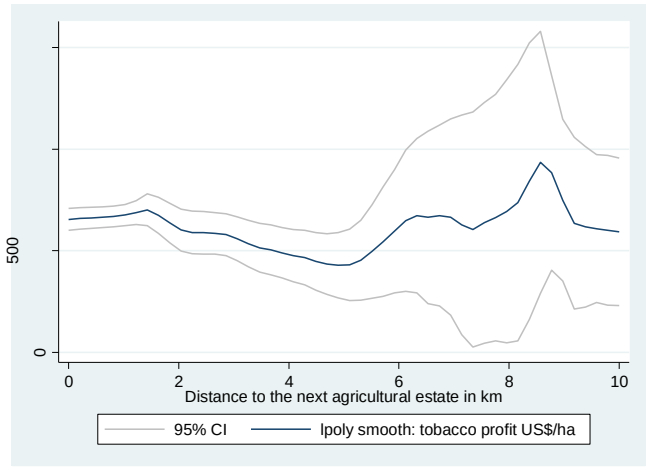


Figure 4b: Tobacco

Source: Own computation from 2006/07 NACAL.

Appendix table 1: Discrepancy in agricultural estate sizes between lease records and calculation from mapped boundaries

	% of leases with discrepancy between				
	-1% to 1%	**-5% to 5%**	**-10% to 10%**	**-20% to 20%**	**-50% to 50%**
Total Malawi					
Valid leases	32.44	60.63	74.70	85.23	93.01
Expired leases	23.22	68.18	81.76	90.80	97.58
Indeterminate leases	16.08	47.31	62.35	74.71	86.60
North					
Valid leases	33.05	57.63	71.19	80.93	91.95
Expired leases	16.77	52.80	68.11	83.03	96.37
Indeterminate leases	9.27	31.14	46.90	67.93	90.27
Center					
Valid leases	31.70	59.52	73.82	84.15	92.16
Expired leases	24.02	70.54	84.13	92.27	97.94
Indeterminate leases	16.92	50.84	66.10	76.09	85.31
South					
Valid leases	33.61	63.92	77.76	88.96	95.06
Expired leases	29.86	78.78	87.84	92.81	96.26
Indeterminate leases	23.10	56.78	69.60	79.14	86.74

Source: Own computation from the National Geographical Estates Database.

Appendix table 2: Extent of double registration for agricultural leases by lease validity

	Number of leases	% of overlap >20% with			Area under leases (1000 ha)	% of overlap >20% with		
		Valid	Expired	Indet.		Valid	Expired	Indet.
Total Malawi								
Valid leases	2,847	6.25	14.01	6.32	300	2.80	3.65	1.30
Expired leases	2,4474	2.93	22.02	6.51	644	1.73	9.93	3.05
Indeterminate leases	7,819	2.66	18.75	6.46	405	0.96	5.25	2.28
North								
Valid leases	394	3.30	5.58	1.52	32	0.39	0.83	0.18
Expired leases	3,902	0.90	14.81	4.25	117	0.31	7.99	1.80
Indeterminate leases	1,885	0.74	10.77	4.88	82	0.09	2.99	1.15
Center								
Valid leases	1,652	6.78	20.94	8.54	176	4.33	5.63	1.32
Expired leases	19,077	3.31	24.90	7.13	467	2.09	11.53	3.41
Indeterminate leases	4,831	3.35	25.05	6.89	229	1.00	7.48	2.41
South								
Valid leases	801	6.62	3.87	4.12	92	0.73	0.86	1.66
Expired leases	1,495	3.28	4.14	4.48	61	1.71	1.31	2.71
Indeterminate leases	1,103	2.90	4.81	7.25	94	1.64	1.75	2.95

Source: Own computation from the National Geographical Estates Database.

Appendix table 3: Smallholders' socio-economic characteristics

	Total	By region		
		North	Center	South
Household composition and head's characteristics				
Number of children	2.23	2.48	2.26	2.12
Number of adults	2.36	2.72	2.38	2.23
Number of old people	0.18	0.19	0.18	0.19
% of female head	28.07	23.73	25.63	31.58
Head's age	43.09	43.84	42.42	43.36
% of heads no schooling at all	26.12	11.33	28.38	29.52
% of heads with primary 1-5	25.99	20.04	27.37	26.98
% of heads with primary 6-8	28.56	37.41	27.83	26.02
% of heads with sec.& above	16.79	28.53	14.08	14.82
% of head born in own village	52.73	55.28	55.56	49.53
% with hh members did wage job	15.48	16.63	15.40	15.14
Household assets				
Value of livestock (2006 US$)	99.00	241.30	76.17	67.32
Value of agric. assets (2006 US$)	84.14	333.72	44.78	27.79
% owned radio	64.11	70.32	61.45	64.06
% owned cell phone	12.87	19.53	11.19	11.89
% of grass roof	74.11	67.41	80.95	70.93
% of iron sheets roof	25.05	31.70	18.21	28.24
% of sand floor	4.26	0.89	3.46	6.10
% of smoothed mud floor	78.07	74.06	82.67	75.76
% of smoothed cement floor	17.43	24.67	13.71	17.88
% of mud walls	8.95	10.58	9.97	7.55
% of compacted earth walls	17.47	23.95	33.86	1.91
% of mud brick walls	33.48	10.46	26.66	47.16
% of burnt brick walls	37.50	51.10	27.42	40.86
Distance to estates and community characteristics				
Km to the nearest ag. estate	2.10	2.16	1.44	2.61
% within ag. estate	8.72	7.61	16.26	3.03
No. of obs.	20,677	3,379	7,732	9,566

Source: Own computation from 2006/07 NACAL.

Appendix table 4: Characteristics of smallholder production

	Total	By region			Locate on ag. estate		
		North	Center	South	No	Yes	T test
Land endowment and topography							
Land area (ha)	1.06	0.86	1.52	0.76	0.99	1.78	***
% of mountain slope	15.16	23.23	13.74	13.56	15.52	11.37	***
% of dregs	8.00	6.02	6.42	9.91	8.16	6.25	***
% of plain	72.47	64.69	76.62	71.80	71.79	79.71	***
% of other topography	4.37	6.06	3.22	4.72	4.53	2.67	***
Land use							
Cultivated area (ha)	0.70	0.65	0.90	0.56	0.67	1.05	***
% of land under maize	69.25	60.01	72.05	70.25	69.18	69.90	
% of land under rice	2.70	5.63	1.40	2.73	2.74	2.31	
% of land under sorghum	1.90	0.04	0.11	4.10	2.05	0.32	***
% of land under beans	2.14	1.81	3.06	1.49	2.25	1.05	***
% of land under pigeon peas	3.63	0.09	0.06	7.95	3.89	0.97	***
% of land under ground nuts	5.60	3.74	8.84	3.54	5.32	8.51	***
% of land under cassava	5.36	18.85	4.05	1.54	5.46	4.40	**
% of land under tobacco	2.04	3.79	2.92	0.66	1.63	6.15	***
% of land under other crops	7.37	6.04	7.51	7.74	7.47	6.40	**
Input and labor use							
Value of fertilizer (2006 US$/ha)	39.44	62.22	50.50	47.24	50.75	52.83	
Value of improved maize seeds (2006 US$/ha)	11.07	11.15	17.17	14.26	15.19	11.25	
Value of manure (2006 US$/ha)	2.78	1.20	5.97	1.63	3.21	1.45	
Value of other seeds (2006 US$/ha)	4.33	3.64	4.77	6.18	5.46	2.75	*
% attended extension activities	19.19	31.48	17.44	16.23	19.20	19.08	
% used exchange labor	20.54	29.45	24.18	14.43	20.31	22.92	***
Value of ag. assets (2006 US$/ha)	318	996	233	144	327	223	
Output and profit							
Total crop yield (2006 US$/ha)	253	263	247	254	253	252	
Maize profit (2006 US$/maize ha)	199	171	187	218	201	179	***
Rice profit (2006 US$/rice ha)	397	368	404	409	403	329	*
Tobacco profit (2006 US$/tobacco ha)	636	749	553	737	646	606	
No. of obs	20,677	3,379	7,732	9,566	18,873	1,804	

Source: Own computation from 2006/07 NACAL.

Note: Other crops includes millet, soya beans, ground beans, cow peas, sun flower, sweet potato, irish potato, cotton, tea, sugar cane, and coffee.

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