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# **Assessing impacts of large scale land transfers: Challenges and opportunities in Malawi's estate sector<sup>1</sup>**

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## **Assessing the impacts of large scale land transfers: Challenges and opportunities in Malawi's estate sector**

**Abstract:** We combine data from complete computerization of all large leases in Malawi with satellite imagery and a geo-coded farm survey to document opportunities and challenges of land-based investment in novel ways. Our focus of analysis is on evolution and status of Malawi's estate sector; type and intensity of land use by different types of estates; and impact of estates on nearby small farmers. We find that, with 1.5 mn. ha (of which some 140,000 ha are registered twice) area under estates is larger than previously estimated. Some 70% of agricultural leases expired, reducing tenure security and public revenue from lease fees. Remotely sensed imagery suggests that only 42% of estate land is under crops and less than 20% of estates crop more than two thirds of their land. Comparing production and yields between estates and smallholders using survey data also suggests that estates are less productive than smallholders. Small farmers cultivating on an estate (encroachers) are less likely to grow a second crop and use less irrigation or inputs, reducing yields but proximity to estates is associated with higher input use, suggesting positive spillovers. To prevent that the option to demarcate customary estates under the new Land Act will further exacerbate tenure insecurity, initiatives to this end will need to be preceded by efforts to clarify boundaries and the status of leases for existing estates.

JEL Classification: C81, O13, Q12, Q15

Keywords: Estate, Computerized data, Encroacher, Spillover effect, Malawi

### **1. Background**

Ever since the 2007/08 commodity price boom, large 'land deals' 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 and how neighboring smallholders are affected has been limited. Such evidence would be of great importance for Governments to be able to manage land demand and transfers in ways that reduce risks and maximize positive socio-economic impacts. While experience from Latin America shows that combining administrative with remotely sensed data for real-time monitoring can have large impact (Assuncao *et al.* 2015) and draw in the private sector (Gibbs *et al.* 2016), use of such methods in Africa is still in its infancy (Lemoine and Rembold 2016).

In this paper we illustrate how computerized data on estate land transfers linked to predicted land use from remotely sensed data as well as geo-coded survey data can help to start closing this gap. We use the case of Malawi, a country where large areas had been transferred to estates in the 1980s and early 1990s (Mandondo and German 2015) and where recent policy developments make this particularly policy relevant. We find that, poor maintenance of both the textual and spatial parts of records on land transfers greatly increases the risks of large land-based investment while significantly reducing potential benefits.

Textual data suggest that, with some 1.35 million ha or some 25% of the country’s arable area, agricultural estates are an important part of Malawi’s rural economy, complemented by 0.14 mn ha of non-agricultural estates. But 70% of agricultural estate leases are expired, greatly reducing potential public revenue from such land transfers and encouraging speculative land holding. While failure to index ground rent to inflation had reduced revenue even for non-expired leases, charging half of the market price for land rental would increase public revenue by US\$ 35 mn. or 5% of total public spending a year. Although we lack (estate) data to quantify the associated effect, the fact that 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- would also be expected to reduce productivity directly. This notion is supported by a low levels of land utilization – based on overlays of recorded estate boundaries with a broad classification of land use from supervised classification of medium-resolution satellite imagery suggests that only about

40% of estate land is used for crop cultivation. 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. Survey data also suggest that for all crops with the exception of sunflower and tea, yields by smallholders are significantly above those by estates. As estates use consistently more inputs than smallholders, this suggests a strong negative relationship between farm size and productivity on the land area actually cultivated, consistent with the recent finding of productivity losses due to land misallocation in Malawi (Restuccia and Santaaulalia-Llopis 2017).

Linking estate boundaries to geocoded farm survey data allows us to show that weak record maintenance also affects smallholders' productive performance. Smallholders who cultivate land within the registered boundaries of an estate -either because they encroached or as a result of informal transfers or subdivision- have significantly lower levels of investment than those on customary land: the incidence of irrigation and cultivation of a second crop are lower by 3percentage points and that of input use by 3-7 points. At the same time we find that, if well managed, estates can increase government revenue directly and contribute to rural economic development indirectly via positive spillovers on neighboring farmers. Input use (seed, manure, and fertilizer) and yield are all lower for smallholders located farther away from the next estate.

In addition to documenting the benefits from linking data across domains that have historically been largely separate, our findings are of relevance for policy. In late 2016, after decades of debate, Malawi passed a series 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 by allowing sporadic registration of customary land under so-called 'customary estates'. The literature suggests that low-cost, participatory, and systematic land tenure reform 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 the scope for lease markets to transfer land to more efficient operators (Ali *et al.* 2014). However, a sporadic approach and a failure to first clarify (i) the boundaries of estate land that is currently utilized; (ii) the status of

rights (including by those who accessed estate land informally via encroachment, succession, or sale) to such land; (iii) and whether estate land that is not utilized will be maintained as government land that can then be transferred to investors or reverts to the traditional domain will be essential. Without clarity in this respect and possibly a systematic process that includes clarification of traditional land management areas' boundaries, on-demand creation of customary estates might -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 and provides background on the evolution of Malawi's land tenure system. Section three discusses administrative, remotely-sensed, and survey-based data sources, using them to describe Malawi's estate and smallholder sectors, as well as patterns of land utilization. Section four provides the methodology to assess spillovers from estates in the Malawian context as well the results from applying it to our data. Section five concludes with implications for policy and research.

## **2. Background and justification**

We argue that a key limitation of the 'land rush' debate has been the methodological challenge of measuring performance by large farms. We then highlight Malawi's land sector, in particular estates as a means to commercialize and distribute political favors, the 1994 moratorium on transfer of land to new estates, the broader land policy debate leading up to the passage of the 2016 Land Bill, and its provisions with respect to the topic at hand. Finally, we discuss existing evidence on Malawi's agricultural sector as well as size, composition, and economic impact of the country's estate sector.

### **2.1 The challenge of assessing large farm performance**

Almost a decade after the 'land rush' first hit the headlines, 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 by providing local smallholders with access to

technology and markets for credit, input, labor, and output. This has often been viewed as providing a rationale for public support and is in fact one of the rationale for agricultural investment promotion agencies all over the world.

To realize this potential, incentives for effective use of transferred land as well as oversight are needed. This would include that (i) the time horizon for which use rights are given is aligned with the useful lifespan of desired investments; (ii) physical boundaries to transferred land are clearly demarcated to reduce the likelihood of disputes and records are kept in a way that eliminates the risk of double registration; (iii) fees allow to recover costs and at least part of the rents accrue to the public in ways (e.g. upfront lease fees, ground rent, or taxes on realized profits) compatible with investors' incentives and invested in ways that benefit the local economy; and (iv) gross violations of contractual commitments, in particular failure to make investments or cultivate land as stipulated, are monitored effectively and promptly dealt with.

In many African countries with supposedly high levels of unutilized land,<sup>2</sup> a combination of low quality of (often manual) records, weak technical capacity, and lack of transparency limit the extent to which these conditions are satisfied (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 (Anseeuw *et al.* 2016; Sitko and Jayne 2014) rather than pioneers. Together with the high risk of such investments (Tyler and Dixie 2013), this often led to high expectations being disappointed. It also created a danger of failed investors using 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.<sup>3</sup>

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<sup>2</sup> 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).

<sup>3</sup> 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).

Yet, although a large number of studies assessing the impact of specific investments now available provides valuable insights regarding potential channels through which effects are transmitted, a system that would be of relevance at national level would need to go beyond these in at least two respects. First, to avoid that results are due to sample or case selection, data on the universe of land transfers is needed. 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 frame, ideally constructed and maintained by the national statistical agency is needed; see Ali *et al.* (2017) for an illustration of how this can work or the case of Ethiopia. Second, to be able to assess how policy affects outcomes, information that is provided at regular intervals will be most useful. 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). That could eventually address many of the issues that have traditionally made monitoring of large investments very difficult.

Malawi is an interesting case due to a number of characteristics that allow assessing longer-term impacts of such investment by often privileged elites. Some 20-25% of its land was leased to commercial farms or local entrepreneurs in the late 1980s, in part to overcome shortcomings in regulatory regimes for customary tenure. The time span elapsed since then allows discerning longer-term impacts and identifying challenges that may not yet be apparent in cases where land transfers have happened more recently. Analyzing this case allows us to make a methodological contribution by highlighting the challenges arising in this context and exploring the extent to which poorly kept records and failure to monitor compliance reduced both the direct and indirect benefits from such investment. The fact that Malawi has just passed new land legislation creates an opening for addressing these issues in a broader context. Efforts to do so that do not resolve pending issues with estate leases or substantially improve the quality of record keeping, however, 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 been traditionally 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:<sup>4</sup> 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). Thereafter, tobacco quotas were gradually extended to smallholders by licensing 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 tenure security by smallholders under the customary tenure regime. As in most of Africa, this tenure regime had historically allowed egalitarian land access and high levels of security by community members (Bruce and Migot-Adholla 1994). Yet there is evidence of high levels of perceived tenure insecurity (Lovo 2016; Place and Otsuka 2001) that negatively affects output, especially by females (Deininger *et al.* 2017). Key underlying factors are population growth, migration, and urban expansion that increased land scarcity (Ricker-Gilbert *et al.* 2014), leading to increases in the frequency of land transactions with outsiders that are liable to challenges *ex post* (van Donge 1999), possibly after long periods of dormancy (Jul-Larsen and Mvula 2007).

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<sup>4</sup> 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).

To boost commercial crop production and provide sufficient tenure security to invest in establishing these, 21-year leases to a large number of estates 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).<sup>5</sup> The process to obtain a lease comprises four steps (van Setten 2016): First, 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 issues an offer with details regarding the length of the lease, permitted land use, assessed fees, and annual ground rent due, ideally accompanied by a survey plan that describes the property’s location more precisely. While the accepted offer constitutes a preliminary lease contract, the lease contract is formalized by a deed that is then formally registered. In practice, the process often remained incomplete or was undertaken in different order.

Such juxtaposition of presumably ‘modern’ freehold or leasehold estates focusing on ‘commercial’ activity with a ‘traditional’ or ‘backward’ customary sector supposedly focused on food crops led to often non-transparent ‘land grabbing’ and exacerbated rather than reduced pre-existing dualism and tenure insecurity in the customary sector. Issuance of leases thus was stopped in 1994, and a more comprehensive land policy reform process was launched.<sup>6</sup> In 2016, this culminated in Parliamentary approval of a series of Land Bills, key provisions of which are briefly discussed below.

The new Land Act limits land rights of non-national and defines land as public (government or unallocated customary land) or private (freehold, leasehold, and customary estates). It defines customary estates 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

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<sup>5</sup> 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.

<sup>6</sup> 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.

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. It mandates systematic participatory identification and recording of parcel boundaries and right adjudication. The Survey Act creates opportunities to use general boundaries and use modern technology, thus opening the door for low-cost (US\$ 5-6 per parcel) approaches as in neighboring countries (Nkurunziza 2015). It also provides for surveying of TLMAs as part of national spatial data infrastructure. The Registration Act aims to eliminate the traditional system's dualism by decentralizing registries to district level, and stipulating filing requirements including provision of registry maps to chiefs while 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.<sup>7</sup> 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 cleared from bush with the remainder having been used as customary land before; in fact a sizeable share of estate owners seem to have converted land they had 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

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<sup>7</sup> These districts are Rumphi, Mzuzu, Kasungu, Dowa, Lilongwe, Nkhoskhota, 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.

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.

### **3. Data and descriptive evidence**

Computerization of key details from all lease contracts provides information on number, area, and currency of estates' leases while digitization of estate boundaries allows creating overlays with satellite imagery to assess the extent to which estate land is cultivated and crop type. Estates drawn from a nationwide list and a large sample of smallholders from the 2006/7 National Census of Agriculture and Livestock (NACAL) provide data on production, yield, and basic socio-economic characteristics. We can thus compare the intensity and productivity of land use between smallholders and estates to assess the long-term impact of land transfers to estates as well as the extent to which rental or sales markets can attenuate dualistic structures and equalize returns between different types of producers. –Moreover, we use the fact that information on smallholders has been geo-coded to compute the straight line distance between smallholder farms and estates and briefly discuss the methodology used for estimates of external effects.

#### **3.1 Describing the universe of estates**

A major reason for the inability to effectively manage estate leases was that all of the relevant data was stored on paper, distributed among three registries, and often very difficult to access. To make data available for analysis, computerization of all documents, supported by a World Bank project,<sup>8</sup> was thus an

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<sup>8</sup> Leases were digitized by a team from 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.

essential first step. Descriptive statistics in tables 1-3 show how, by merely 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, table 1 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.

By highlighting that, for 7,819 agricultural estates with a total area of 404,584 ha, documents lack data on lease duration, computerization also pinpoints governance challenges inherent in existing documentation.<sup>9</sup> For leases with dates, figure 1 illustrates the evolution of agricultural estates. 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 transfer accelerated considerably after independence in three main phases.<sup>10</sup> First, in the period up 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 2626 per year but average size decline to some 25 ha, implying a total transfer to leasehold of some 65,000 ha per year. In the period following the 1994 moratorium, issuance of new agricultural leases dropped sharply to 176 leases or transfer of 7,800 ha per year with the sub-period before 2007 saw slightly more but smaller leases issued with average size of leases increasing but less leases issued after 2006 (see appendix table 2 for data).

Table 1 shows that, while the majority was issued in 1988-95, issuance of leases continued apace for rather sizeable non-agricultural estates. 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

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<sup>9</sup> Bribing officials to omit information on the start date or duration of a lease could allow to de facto obtain a lease of infinite duration.

<sup>10</sup> 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.

interesting details on subsequent transactions. By comparison, agricultural estates measure 39.8 ha on average, with the largest ones located in the South. While the number of agricultural estates is largest 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 the form of legal documentation suggest that 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.<sup>11</sup>

With a mean annual rent of less than US\$ 1/ha for agricultural estates and US\$ 27 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 use 2010/11 Living Standards Measurement Survey data on prices paid for existing leases (US\$ 58/ha) and the price at which respondents would be willing to lease in additional land (> \$50/ha). Even a compliance rate of 50% could generate annual lease revenue of some US\$ 35 mn 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

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<sup>11</sup> 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.

agricultural estates (vs. 41% of non-agricultural ones) had remaining lease terms beyond 10 years. This could affect productive performance via tenure insecurity by undermining investment incentives while also limiting the scope for efficiency-enhancing transfers of land to operators with higher levels of ability. In addition, succession, most likely together with subdivision and encroachment may have led to discrepancies between recorded and actual land use of unknown magnitude. Detailed estate performance data are needed to assess extent and incidence of different types of these as a basis for discussing policy options.

Beyond the textual information discussed above, complete digitization allows us to use *spatial data* to assess record quality by exploring overlaps among records or, by overlaying with imagery, identify double leasing of land and discrepancies between recorded ownership and spatial patterns of use. 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 different owners. Figure 2 illustrates this by displaying (in black lines) recorded boundaries for all estates as per the registry for Mchinji district, in addition to overlaying it with satellite imagery. 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 in table 2 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.<sup>12</sup> The share of double-registration varies widely across districts with figures highest for each of the regions in Balaka (55%), Kasungu (18%), and Mzimba (9%). The table also highlights considerable variation across districts in the share of leased out area that has expired, a figure that is highest in Dowa (84%), Mzimba (70%), and Mangochi (43%), with a national average of 48%. While

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<sup>12</sup> We chose the 20% cutoff to exclude small and non-substantive overlaps that may be due more to the accuracy of mapping. Corresponding figures for all estates are in appendix table 3.

reconciliation of these differences may be easier if leases have expired, ground verification is likely to be needed.

Beyond overlaps, figure 2 also suggests limited correspondence between estates' registered outer estate boundaries and current land use patterns. To assess if registry records allow to be unambiguously identified on the ground and compare their boundaries to those that had been formally registered, we mapped outer boundaries for a sample of 200 estates using Esri ArcCollector.<sup>13</sup> Results for a small area, with registered boundaries in red and actual ones in green, are displayed in figure 3. While most estates could be identified by local people based on their names, non-systematic changes in their size, shape, and location suggest that, at least in this case and the fact that estate land had in many cases been distributed internally among the original owner's heirs, existing boundary descriptions have limited evidentiary value. To the extent that this is representative of the broader universe, combining lease renewal with a comprehensive resurvey will be key. This could not only provide more accurate identification of boundaries and thus increase current land owners' or users tenure security but would also help avoid multiplication of errors and opportunities for dispute via sporadic demarcation of customary estates as provided for by the new Land Bill.

### **3.2 Assessing land use on estates**

A rapidly expanding literature shows the potential of using remotely sensed imagery for crop forecasting and early warning (Basso *et al.* 2013), including 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). Categories used were maize, other crops, grassland, savannah/shrubs, forest, and built up area including bare land and waterbodies. Subjects 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.

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<sup>13</sup> We thank Esri for allowing us to use this product free of charge and for assistance with troubleshooting in the field.

With some 42% of land under crops in the aggregate (table 3), intensity of land use in the estate sector seem to be of an order of magnitude 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 large amounts of ‘idle’ estate land being available. Obtaining a more reliable estimate and identification of the underlying reasons and the scope for either letting previously leased land revert to customary authorities or re-assigning it to new investors will require that boundaries be clarified and multi-year data that adjust for potential fallowing be obtained. The size of the estimates presented here and the fact free access to imagery and computing power have increased the scope for such analysis,<sup>14</sup> suggest that this may be a very worthwhile exercise.

### **3.3 Comparing land use and productivity between smallholders and estates**

While digitization of estate boundaries allows creating overlays with satellite imagery to assess land under crops, it cannot provide detailed information on production and yields. We thereby use survey data from the 2006/07 NACAL implemented by Malawi’s National Statistical Office (NSO) with the Ministry of Agriculture. Beyond household-, individual-, and village-level data collection instruments administered to a sample of smallholders, the survey also includes estates. While estates were drawn from a nationwide list, smallholder farms to be sampled were selected in two stages: In a first stage, enumeration areas (EAs) were randomly selected by district with stratification by agro- ecological zone and a listing conducted in those that had been selected. In the second stage, farm households in each of the selected EAs were randomly drawn with a target of 10 small (< 2 acres) and 5 medium sized ( $\geq$  2 acres) farms each.<sup>15</sup> For a sample of 931 estates and 23,896 smallholder farmers, the survey collected information on

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<sup>14</sup> The use of imagery from more than one growing season may also result in errors though with availability of free imagery (sentinel 1/2) at high temporary and medium levels of spatial resolution, together with algorithms that can be run on platforms such as Google Earth Engine (GEE), this will increasingly be less of an issue.

<sup>15</sup> In EAs with less than 5 small farms, small farms were added to bring the total sample to 15.

household composition, welfare, food security, assets (incl. livestock), marketing, and parcel-level data on land tenure and investment, in the 12-month period starting October 2006. Data gaps reduced the sample to 21,351 smallholders and 868 estates with land and production information.

Comparing smallholders with estate data provides interesting insights in a number of respects. Mean age for the 868 estates with data is 19 years with largest estates the oldest (table 4). Most (68%) are owned by natural persons of Malawian nationality, 16 per cent by ‘others’ -most likely legal persons- and 10 per cent by expatriates. Expatriates’ ownership share peaks at the 100-500 ha size while that of Government and ‘others’ peaks in the greater than 500 category. With about a third of estates having tenants; the share of estates with tenants peaks at close to 50 per cent in the 10-100 size category. Compared to large farms in other countries that produce bulk commodities and often generate little employment (Ali *et al.* 2015), many of Malawi’s estates are quite labor intensive. Permanent or temporary male (female) labor is hired by 60 per cent (25%) and 66 per cent (52%) of estates respectively. For these, 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.

Claims about un- or underused estate land recurred in Malawi’s policy debate (Holden *et al.* 2006). While the sample was not designed to provide conclusive evidence on this, data suggest that for surveyed estates, 15 per cent of allocated land is operated, a share that decreases from 88 per cent in the group below 5 ha to 11 per cent in the above 500 ha group (table 5). While smallholders below 1 ha cultivate more than 88 per cent of their land, mean land use intensity for the few (283) smallholder farmers with more than 10 ha is only 16 per cent.

Comparing production structure between smallholders and estates reveals differences in cropping patterns: for sampled estates, 42 per cent of area is devoted to tobacco, followed by maize (39%), groundnuts (7%), and other crops (table 5). While differences in terms of crop composition somewhat limit the scope for comparing yields, mean values suggest that for all crops with the exception of sunflower and tea, yields

by smallholders are significantly above those by estates. In contrast to smallholders, almost all estates (87%) use fertilizer and close to two thirds (61%) purchased pesticide or seeds, a practice more prevalent for larger sizes in both cases. As estates use consistently more inputs than smallholders, this suggests a strong negative relationship between farm size and productivity on the land area actually cultivated. Non-parametric regressions of maize, rice, tobacco and coffee yields for the pooled sample plotted against the log of farm size in figures 4a-4d graphically illustrate that, although slope varies by crop, the overall relationship is stable and rather tightly estimated.

### **3.4 Characterizing smallholder farmers**

To test if presence of estates affects smallholder productivity either directly or indirectly, we overlay estate boundaries with GPS coordinates for the location of farmers' plots from the 2006/07 NACAL. For the sample of 23,896 smallholders, useable data on GPS coordinates and complete information for all variables of interest is available for 20,927 and 16,339 observations, respectively.

Table 6 presents general descriptive statistics pointing to relatively large household sizes, high levels of female headship (28% overall), limited education (26% each with either no schooling or only primary), and limited non-agricultural opportunities (only 16% with household members who engaged in a wage job). The endowment with assets was also limited and housing conditions quite basic with 74%, 78%, and 63% having a grass roof, mud floor, and mud (compacted earth or mud brick) walls, respectively.

Restricting our attention to estates that had been in place at the time when field work for the NACAL was underway,<sup>16</sup> we use geocoded information on the location of estates and NACAL farmers to compute two measures. First, we identify smallholders whose plots are partially or entirely located within the boundaries of an estate as suffering from potential tenure insecurity, either because they are encroachers or because the estate was informally subdivided.<sup>17</sup> Our assumption is that such overlap may reduce levels

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<sup>16</sup> We dropped estates established after 2006 to match with smallholders surveyed in the 2006/2007 cropping season.

<sup>17</sup> While the data cannot support this type of analysis at this point Collection of data specifically for this purpose would allow to distinguish between these possibilities and possibly also allow within-household analysis for those who cultivated land both within and outside the estate.

of tenure security and productivity of land use. Second, as a proxy for potential spillovers, we compute the straight line distance between smallholders' plots and the centroid of the next (agricultural or non-agricultural) estates to measure the ease of knowledge- technology- or market-based spillovers as discussed below. Results from doing so show that somewhat less than 10% of small farmers are potential encroachers on agricultural estates, a figure that varies between 15% in the Center and 3% in the South. Also, with an average of less than 3 km to the next estate, interaction between estates and smallholders is much closer than what was found in more land abundant countries such as Mozambique (Deininger and Xia 2016).

#### **4. Assessing estates' impacts on smallholders**

Econometric analysis suggests that small farmers who cultivate land that overlaps with an agricultural estate (encroachers) are less likely to grow a second crop and use less irrigation or inputs, reducing yields. At the same time, closer proximity to estates is associated with higher levels of input use that have a positive impact on yields, pointing towards positive spillovers.

##### **4.1 Methodology**

Conceptually, presence of commercial farms can 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). In our case, negative effects would be expected from overlap of smallholders' plots with estates.

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. The fact that smallholder data is often not geo-referenced has prevented quantitative analysis of risks and benefits in an integrated framework. We can conduct such analysis by distinguishing location on an estate, our proxy for tenure insecurity, from the distance to the next estate which may generate positive spillovers. We thus estimate

$$I_{ijk} = \beta_0 + \beta_1 \ln(D_{ijk}) + \beta_2 O_{ijk} + \beta_3 X_{ijk} + \beta_4 V_{jk} + \lambda_k + \varepsilon_{ijk} \quad (1)$$

where  $I_{ijk}$  is our variable of interest, i.e. either input use and intensity of land use by household  $i$  in village  $j$  and district  $k$ .  $D_{ijk}$  measures the distance between the smallholder to the centroid of the next estate. The logarithm of distance is used to capture the notion that spillover effects become insensitive to long distance. A vector of distance variables indicating estates' nature (agriculture vs. non agriculture) is used to capture heterogeneous effects.  $O_{ijk}$  is a vector of indicator variables for smallholders' location on an estate by estates' nature.  $X_{ijk}$  is a vector of household-level variables that may affect input use as well as intensity of land use and thus maize yield with variables from two main groups, namely (i) basic household characteristics such as land size, share of land operated by females, household composition, head's characteristics (gender, age and education), ownership of durable goods, housing conditions, the value of agricultural assets and livestock, and whether or not the household attended extension activities; and (ii) plot topography aggregated with area shares to the household level and plot GPS coordinates to

control for geographic characteristics that may determine estates' choice of location.  $V_{jk}$  is a vector of village-level controls including road access and the prevailing inheritance and marriage regime,  $\lambda_k$  is a vector of district fixed effects,  $\beta_1$  and  $\beta_2$  are parameter vectors to be estimated, and  $\varepsilon_{ijk}$  is an error term allowing correlation between smallholders within the same village.

To quantify spillover effects on productivity, we let  $Q_{ijk}$  denote maize yield attained by household  $i$  in village  $j$  and district  $k$  and  $A_{ijk}$ ,  $L_{ijk}$ , and  $K_{ijk}$  crop area; a vector of labor variables including per hectare number of household members by gender and age participating in land preparation, planting, weeding and harvesting, per hectare number of hired workers, and an indicator of whether the household participated in exchange labor; and a vector of per hectare values of chemical fertilizer, organic manure, seeds used in production as well as agricultural assets. Taking logarithms on both sides yields

$$q_{ijk} = \delta_0 + \delta_1 \ln(D_{ijk}) + \delta_2 O_{ijk} + \delta_3 X_{ijk} + \delta_4 V_{jk} + \lambda_k + \theta_1 a_{ijk} + \theta_2 l_{ijk} + \theta_3 k_{ijk} + \varepsilon_{ijk} \quad (2)$$

where  $q_{ijk}$ ,  $a_{ijk}$ ,  $l_{ijk}$ , and  $k_{ijk}$  are logarithms of  $Q_{ijk}$ ,  $A_{ijk}$ ,  $L_{ijk}$ , and  $K_{ijk}$ , and  $\theta$ s are technical coefficients to be estimated. We include indicator variables for zero values of inputs following Battese (1997).  $D_{ijk}$ ,  $O_{ijk}$ ,  $X_{ijk}$ ,  $V_{jk}$  and  $\lambda_k$  are defined as in equation (1).  $\delta_1$  and  $\delta_2$  are parameters of interest that quantify spillover effects of estates by distance and on encroachers, respectively. To explore whether the spillover effect on productivity was realized through the use of inputs, we estimate two specifications based on (2) with inputs ( $L_{ijk}$  and  $K_{ijk}$ ) either excluded or included.

## 4.2 Results on impact of overlap and spillovers

Table 8 displays results for estimated impacts of being on or close to an estate for smallholder producers on use of improved seed for maize or other crops, use of organic and inorganic fertilizer and intensity of land use as proxied by whether a winter crop had been planted and irrigation investment carried out. For each of these variables we report two specifications, one with only location on or distance to agricultural estates and one with the same variables for non-agricultural estates. To prevent changes in the number of

observations resulting from lack of right-hand side variables from biasing conclusions, results from regressions with and without controls are reported in panels A and B, respectively.

Consistent with the notion that smallholders cultivating estate land will, either due to potentially competing claims or lack of current documentation, have lower levels of tenure security and thus incentives to invest, we find that small farmers located within registered agricultural estate boundaries have significantly lower levels of input use and investment. Table 8 highlights that location on an estate is associated with a 6-8% reduction in the propensity of using maize seed with corresponding reductions for use of other seeds of 4-6% and for manure of 3%. These magnitudes are not insignificant, they imply in each case a 15% increase in the propensity of using the relevant input. Insignificance of coefficients for fertilizer may be due to subsidies (Ricker-Gilbert *et al.* 2011) low returns (Duflo *et al.* 2008; Marenja *et al.* 2014) or limited long-term effects of using fertilizer (Jacoby *et al.* 2002). In line with the notion of negative investment impacts, we also find location on an estate being associated with a reduction in the propensity to practice a second season crop (by 3 points) or irrigation (by 2-3 points).

While overlap of fields with an agricultural estate appears to reduce smallholders' propensity to invest and their level of productivity, spillovers from estates seem largely positive. Proximity to agricultural or -agricultural estates, is associated with higher levels of input use, especially in the case of improved maize and other seed, manure, and fertilizer but appears to have little effect on the likelihood to invest in irrigation or plant winter crops. While this is consistent with the notion of positive spillovers, e.g. via learning, the fact that point estimates of similar and in some cases large magnitude are associated with presence of non-agricultural estates suggests that some of these links may be due to demand-effects or alleviation of cash constraints. Regressions for maize yield in table 9 reinforce the notion of estates having spillover effects. The negative impact of greater distance to estates appears to be due to lower input use rather than technology or other factors. The strong effect of distance to non-agricultural estates is consistent with better access to inputs playing a significant role.

## **5. Conclusion and policy implications**

This paper was motivated by the notion that most existing analyses of large land-based investments are too aggregate to help authorities manage land transfers at farm or investor level. We have shown that making administrative data accessible in digital form and combining them with remotely sensed and survey data can make the debate more evidence-based and policy relevant, yield recommendations that are actionable, and quantify the potential impact of implementing them at very little additional cost.

In light of large land transfers to estates and recent legislative changes, Malawi provides an interesting case to illustrate this. Administrative data highlight not only distinct phases of investment but also illustrate that weak records reduce potential benefits from such investment both directly, by creating tenure insecurity that reduces productivity, and indirectly, by making it more difficult for government to collect revenue that could support public goods. While we lack geo-referenced data on estates production that would allow us to quantify impacts on estates, overall productive performance of estates is inferior to that of smallholders. In the smallholder sector, while proximity to estates has positive impacts on input use, being located within estate boundaries is associated with significantly lower input use and investment by smallholders.

The methodologies used here are of relevance for countries aiming to effectively manage large land transfers and monitor their performance. In Malawi's case, the need to renew, cancel, or renegotiate estate leases arising from the fact that most agricultural estate leases expired creates a unique opportunity 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, 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 land use intensity and investment. This could form a basis for continued real-time monitoring of estate performance using free high frequency remotely sensed data. It would also create the preconditions for systematically implementing recently passed provisions to demarcate customary estates in ways to enhance tenure security and productivity by

small farmers rather than continue the tradition of double allocation of land that is vividly illustrated in our data.

**Table 1: Descriptive statistics of estates by lease status**

	Total	Non-agric. estates					Agric. estates		
		All	North	Center	South.	All	North	Center	South.
<b>Gen. characteristics of lease</b>									
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 in ha	27.10	6.60	15.98	2.54	7.17	39.80	39.49	35.12	76.23
Signed before 1988	0.18	0.28	0.26	0.37	0.20	0.14	0.11	0.14	0.19
Signed between 1988 and 1995	0.56	0.08	0.09	0.07	0.08	0.79	0.81	0.82	0.53
Signed after 1995	0.25	0.65	0.65	0.55	0.72	0.07	0.07	0.04	0.28
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	0.48	0.10	0.06	0.15	0.06	0.74	0.66	0.78	0.55
Lease length >21 years	0.20	0.43	0.35	0.38	0.50	0.04	0.04	0.03	0.12
Size less than 10 ha	0.43	0.98	0.97	0.98	0.98	0.08	0.08	0.06	0.28
Size between 10 and 30 ha	0.46	0.01	0.02	0.01	0.01	0.73	0.72	0.78	0.37
Size between 30 and 50 ha	0.06	0.00	0.00	0.00	0.00	0.09	0.10	0.09	0.12
Size between 50 and 100 ha	0.03	0.00	0.00	0.00	0.00	0.05	0.06	0.04	0.11
Size between 100 and 500 ha	0.02	0.00	0.00	0.00	0.00	0.03	0.04	0.02	0.10
Size above 500 ha	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02
<b>Formal documentation (%)</b>									
Has deed	0.36	0.27	0.19	0.26	0.30	0.42	0.43	0.40	0.54
Has offer	0.65	0.50	0.39	0.49	0.53	0.76	0.69	0.80	0.65
Has offer but no deed	0.34	0.31	0.27	0.33	0.30	0.37	0.28	0.42	0.18
Lease cannot be determined	0.32	0.48	0.59	0.46	0.45	0.22	0.30	0.19	0.32
Sketch plan	0.57	0.66	0.58	0.68	0.66	0.52	0.52	0.53	0.42
SD plan	0.36	0.16	0.23	0.17	0.14	0.46	0.47	0.46	0.50
Deed plan	0.08	0.18	0.19	0.16	0.20	0.02	0.01	0.01	0.08
Annual rent in \$ per ha	10.69	26.66	23.18	23.22	30.35	0.79	0.37	0.53	3.59
<i>Lease term in 2016</i>									
Lease expired	0.45	0.09	0.05	0.15	0.05	0.70	0.63	0.75	0.44
Remaining lease term <= 10 yrs	0.02	0.02	0.03	0.02	0.02	0.03	0.02	0.02	0.06
Remaining lease term > 10 years	0.20	0.41	0.33	0.36	0.48	0.05	0.05	0.04	0.17
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 2: Characteristics of leases for agricultural estates by district**

	Number of leases			Total ha	Area under leases			
	Total	Expired	Overlap >20%		Expired ha	%	Overlap > 20% ha	%
<b>North</b>								
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
<i>Subtotal North</i>	6,181	3,902	1,101	230,633	116,629	50.6	14,758	6.4
<b>Center</b>								
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
<i>Subtotal Center</i>	25,560	19,077	8,148	871,606	467,105	53.6	111,565	12.8
<b>South</b>								
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
<i>Subtotal South</i>	3,399	1,495	427	246,523	60,502	24.5	10,741	4.4
<b>Total Malawi</b>								
<i>Total Malawi</i>	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 3: Land use status for agricultural estates**

	<b>Total area (1,000 ha)</b>	<b>Share of land under crops (%)</b>	<b>Share of estates with at least 70% of area under crops (%)</b>	<b>No. of obs.</b>
Total	683.83	42.07	18.09	24,823
<b>Region</b>				
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
<b>Lease duration/validity</b>				
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
<b>Time of transfer</b>				
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
<b>Size</b>				
<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 4: Estate characteristics**

	All	Size category in ha					
		<=5	5-10	10-50	50-100	100-500	>500
<b>Estate ownership</b>							
Years run by the current owner	19.00	13.14	12.54	15.28	21.13	19.84	30.77
Owner is Malawian	0.68	0.75	0.83	0.92	0.80	0.51	0.30
Owner is expatriate	0.10	0.13	0.00	0.01	0.04	0.29	0.21
Owner is other	0.16	0.13	0.14	0.05	0.06	0.13	0.34
Owner is government	0.02	0.00	0.00	0.00	0.03	0.05	0.05
Owner is NGO	0.03	0.00	0.03	0.02	0.06	0.03	0.07
<b>Labor demand</b>							
Hired perm. male labor	0.60	0.38	0.59	0.52	0.52	0.82	0.92
No. of perm. male labor	28.8	1.5	4.9	3.7	7.2	49.4	108.2
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	0.25	0.25	0.17	0.12	0.24	0.48	0.52
No. of perm. female labor	13.0	0.8	1.0	1.3	1.9	13.7	65.8
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	0.66	0.38	0.66	0.64	0.69	0.77	0.88
No. of temp. male labor	45.1	154.7	7.1	13.1	15.5	72.8	139.9
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	0.52	0.13	0.45	0.47	0.54	0.65	0.79
No. of temp. female labor	23.6	2.0	8.2	6.9	10.9	34.7	79.5
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\$)	131.94	249.74	144.41	133.59	174.60	138.20	77.63
<b>Tenancy</b>							
Have tenants	0.31	0.13	0.10	0.44	0.45	0.24	0.10
Number of tenants	3.70	0.83	0.73	2.40	6.06	4.64	5.77
No. of obs.	868	8	29	422	96	192	121

Source: Own computation from 2006/07 NACAL.

**Table 5: 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
<b>Land use</b>												
Area owned	433.9	4.0	8.5	21.6	74.3	272.4	2,543.5	1.05	0.43	1.70	7.09	33.10
Area operated	67.0	3.5	5.8	10.3	27.4	80.2	294.5	0.64	0.38	1.18	5.32	5.21
<b>Share of area by crop</b>												
Tobacco	0.42	0.32	0.16	0.40	0.42	0.48	0.47	0.01	0.01	0.00	0.00	0.00
Maize	0.39	0.57	0.67	0.44	0.42	0.31	0.23	0.47	0.48	0.46	0.44	0.41
Wheat								0.26	0.26	0.26	0.25	0.36
Rice	0.01	0.00	0.00	0.01	0.00	0.02	0.01	0.08	0.08	0.08	0.13	0.09
Sorghum	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.08	0.08	0.09	0.09	0.07
Sunflower	0.02	0.00	0.01	0.02	0.03	0.02	0.00	0.00	0.00	0.00	0.00	0.00
Groundnut	0.07	0.06	0.13	0.10	0.07	0.03	0.01	0.00	0.00	0.00	0.00	0.00
Soybean	0.01	0.06	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00
Coffee	0.01	0.00	0.00	0.00	0.01	0.03	0.02	0.02	0.02	0.02	0.01	0.03
Tea	0.04	0.00	0.00	0.00	0.00	0.06	0.17	0.00	0.00	0.00	0.00	0.00
Other crops	0.03	0.00	0.02	0.02	0.04	0.04	0.07	0.07	0.07	0.09	0.09	0.05
<b>Yield (kg/ha) by crop</b>												
Tobacco	960	854	1,047	905	1,089	1,010	1,000		1,452	1,513	1,152	
Maize	1,585	1,313	1,874	1,685	1,286	1,385	1,606	1,627	1,753	1,231	623	1,224
Wheat								1,992	2,145	1,595	653	1,373
Rice	1,123			1,310		750	750	1,856	2,011	1,522	527	985
Sorghum								1,861	1,962	1,660	578	1,284
Sunflower	3,058			3,692	1,417	2,140		2,266	2,287	2,264		28
Groundnut	765		440	840	439	783	550	2,790	2,879	2,174		
Soybean	869	700	290	592	4,250	820	988	2,273	2,409	1,906		1,285
Coffee	1,323				45	1,598	1,215	2,759	2,865	2,592	241	1,794
Tea	648					1,537	370	408	379	457		
<b>Purchased inputs</b>												
Share purchased fertilizer	0.87	0.75	0.83	0.96	0.90	0.94	0.93	0.61	0.59	0.69	0.54	0.52
Cost of fertilizer (US\$/ha)	192.07	161.49	118.10	149.67	175.00	270.19	250.14	11.15	13.68	1.27	0.26	0.07
Share purchased pesticides	0.61	0.50	0.38	0.57	0.66	0.78	0.86	0.08	0.07	0.11	0.13	0.12
Cost of pesticides (US\$/ha)	27.70	26.17	3.30	8.48	12.49	60.83	62.44	0.24	0.30	0.04	0.05	0.00
Share purchased seed	0.61	0.50	0.62	0.68	0.71	0.61	0.60	0.45	0.44	0.48	0.44	0.44
Cost of seed (US\$/ha)	9.71	1.79	10.00	5.27	10.32	13.18	19.92	3.46	4.28	0.27	0.08	0.02
Share purchased other inputs	0.19	0.25	0.28	0.14	0.16	0.10	0.07					
Cost of other inputs(US\$/ha)	1.79	0.00	19.47	1.30	1.56	1.66	0.02					
<b>Sample distribution</b>												
North	0.25	0.25	0.03	0.34	0.30	0.13	0.07	0.15	0.15	0.19	0.14	0.05
Center	0.55	0.38	0.72	0.62	0.57	0.49	0.56	0.37	0.35	0.44	0.52	0.50
South	0.20	0.38	0.24	0.05	0.13	0.38	0.37	0.46	0.49	0.35	0.31	0.18
No. obs	868	8	29	422	96	192	121	21,351	16,967	3,907	194	283

Source: Own computation from 2006/07 NACAL. Other crops for estates include beans, cotton, sugar cane. Other crops for smallholders include wheat, millet, beans, velvet beans, ground beans, pigeon peas, cow peas, cassava, sweet potato, irish potato, cotton, and sugar cane.

**Table 6: Smallholders' socio-economic characteristics**

	Total	By region			Located on agric. estate	
		North	Center	South	Yes	No
<b>Household composition and head's characteristics</b>						
Number of children	2.23	2.48	2.26	2.11	2.41	2.21
Number of adults	2.36	2.72	2.37	2.22	2.51	2.35
Number of old people	0.18	0.19	0.18	0.19	0.16	0.19
% of female head	28.06	23.63	25.66	31.58	21.38	28.65
Head's age	43.07	43.85	42.38	43.35	41.34	43.22
% of heads no schooling at all	26.14	11.34	28.42	29.56	22.67	26.45
% of heads with primary 1-5	25.85	19.83	27.25	26.86	25.89	25.85
% of heads with primary 6-8	28.53	37.15	27.78	26.07	32.51	28.17
% of heads with sec.& above	16.92	28.92	14.22	14.83	16.93	16.92
% with hh members did wage job	15.57	17.03	15.44	15.16	11.48	15.94
<b>Household assets</b>						
Value of livestock (2006 US\$)	98.70	238.15	76.39	67.24	110.88	97.61
Value of agric. assets (2006 US\$)	83.51	329.12	44.46	27.69	73.60	84.39
% owned radio	64.12	70.29	61.50	64.05	67.19	63.85
% owned cell phone	12.95	19.80	11.23	11.91	12.77	12.97
% of grass roof	73.96	67.03	80.83	70.87	79.59	73.46
% of iron sheets roof	25.20	32.10	18.34	28.30	19.24	25.73
% of sand floor	4.26	0.87	3.54	6.05	3.71	4.31
% of smoothed mud floor	77.89	73.62	82.48	75.71	80.98	77.62
% of smoothed cement floor	17.61	25.13	13.83	17.98	15.25	17.82
% of mud walls	8.91	10.48	9.92	7.53	6.79	9.10
% of compacted earth walls	17.46	23.64	33.84	1.98	35.18	15.89
% of mud brick walls	33.52	10.95	26.66	47.13	22.20	34.52
% of burnt brick walls	37.49	50.96	27.46	40.82	33.18	37.87
<b>Distance to estates and community characteristics</b>						
Km to the nearest ag. estate	2.73	3.17	2.12	3.06	0.25	2.95
Km to the nearest non ag. estate	2.35	3.54	2.35	1.93	2.54	2.33
% within any estate	8.16	6.31	15.44	2.93	100.00	0.00
% within ag. estate	0.96	1.31	0.60	1.13	0.59	0.99
% with all season road in village	37.88	49.64	40.49	31.65	38.26	37.84
Number of households	20,927	3,440	7,819	9,668	1,707	19,220

Source: Own computation from 2006/07 National Census of Agriculture and Livestock

**Table 7: Characteristics of smallholder production**

	Total	By region			Located on agric. estate	
		North	Center	South	Yes	No
<b>Land endowment and topography</b>						
Land area (ha)	1.08	0.84	1.58	0.77	1.86	1.02
% of mountain slope	15.17	23.25	13.75	13.56	11.73	15.47
% of dregs	7.97	6.03	6.37	9.90	6.35	8.11
% of plain	72.48	64.61	76.66	71.82	79.21	71.89
% of other topography	4.38	6.11	3.21	4.72	2.72	4.53
<b>Land use</b>						
Cultivated area (ha)	0.54	0.48	0.65	0.46	0.75	0.52
Number of crops planted	4.27	5.31	3.94	4.16	3.78	4.31
% of land under maize	47.54	35.44	49.07	50.36	40.45	48.19
% of land under wheat	25.98	31.18	27.26	23.16	31.43	25.48
% of land under rice	8.24	8.16	9.61	7.13	10.68	8.01
% of land under sorghum/millet	8.77	9.44	9.55	7.90	13.00	8.38
% of land under coffee	1.65	6.37	0.95	0.65	0.77	1.74
% of land under other crops	7.82	9.41	3.56	10.81	3.67	8.20
% practiced winter crop	25.65	25.20	29.67	22.55	24.41	25.76
% practiced irrigation	26.55	24.56	30.10	24.37	24.89	26.70
<b>Input and labor use</b>						
% purchased chemical fertilizer	52.20	56.77	55.47	47.92	65.55	51.01
% purchased organic manure	21.16	18.60	28.94	15.78	26.07	20.73
% purchased pestic./herbic./fungic.	7.98	9.48	6.10	8.97	7.85	7.99
% purchased seeds	44.78	47.44	38.80	48.68	41.65	45.06
% purchased improved maize seeds	33.59	39.33	30.30	34.21	32.28	33.70
% attended extension activities	19.11	31.24	17.36	16.17	18.69	19.14
% of land operated by females	34.47	29.94	30.80	38.93	28.05	35.04
% with hh males working own farm	77.86	84.07	79.40	74.40	83.36	77.37
if any, # of hh males per ha	6.92	5.34	6.11	8.19	5.54	7.05
% with hh females working own farm	95.04	96.28	94.21	95.27	95.96	94.96
if any, # of hh females per ha	9.19	7.79	9.03	9.80	8.23	9.28
% with hh children working own farm	32.35	43.40	31.96	28.72	39.07	31.75
if any, # of hh children per ha	7.01	6.22	5.84	8.40	5.43	7.18
% hired permanent employees	10.19	12.94	10.92	8.62	13.18	9.92
if, # permanent employees per ha	96.01	33.25	114.15	100.08	66.86	99.55
% hired temporary employees	32.47	40.93	28.94	32.31	32.57	32.46
if any, # of temp. employees per ha	100.24	36.61	203.53	55.58	55.04	104.16
% used exchange labor	20.44	29.07	24.12	14.38	22.85	20.23
% owned some ag. assets	97.56	98.49	97.11	97.59	98.42	97.48
if, yes, value of ag. assets (2006 US\$/ha)	323.33	1,077	226.32	143.12	207.27	333.66
<b>Maize production</b>						
% planted maize	47.41	47.41	47.90	50.70	41.84	47.90
Maize area (/ha)	0.53	0.49	0.64	0.46	0.69	0.52
Maize yield (kg/ha)	1,586	1,479	1,472	1,694	1,411	1,599
Maize yield (2006 usd/ha)	226.48	211.26	210.26	241.86	201.49	228.40
% used chemical fertilizer	10.83	8.03	6.81	14.42	6.69	11.15
if used, fertilizer value (US\$/ha)	17.09	16.52	17.35	17.07	11.09	17.37
% used organic manure	46.98	60.66	55.74	37.38	53.19	46.51
if used, value of manure (US\$/ha)	61.19	59.78	50.84	72.92	43.56	62.74
% purchased seed	17.72	14.54	22.22	15.22	19.00	17.63
if used, value of seed (US\$/ha)	19.46	22.42	15.38	23.10	14.10	19.90
Number of households	20,927	3,440	7,819	9,668	1,707	19,220

Source: Own computation from 2006/07 National Census of Agriculture and Livestock

Note: Other crops includes cotton, tea, sugarcane, pigeon pea, cowpea, groundnuts, beans, soy beans, velvet beans, ground beans, sun flowers, cassava, sweet potato, Irish potato, and tobacco.

**Table 8: Estimated spillover effects on intensity of input use**

	Used improved maize seed		Used other seed	Used manure	Used fertilizer	Practiced winter crop	Practiced irrigation					
Panel A: With plot/household/community controls												
Loc. on ag. estate	-0.082*** (0.017)	-0.074*** (0.017)	-0.068*** (0.018)	-0.059*** (0.018)	-0.036** (0.016)	-0.034** (0.016)	-0.014 (0.018)	-0.013 (0.018)	-0.031** (0.015)	-0.034** (0.016)	-0.031* (0.016)	-0.033** (0.016)
Dist. next ag. estate (ln km)	-0.010* (0.005)	-0.005 (0.005)	-0.009* (0.006)	-0.004 (0.006)	-0.003 (0.005)	-0.001 (0.005)	-0.025*** (0.006)	-0.025*** (0.006)	0.002 (0.005)	0.000 (0.005)	-0.000 (0.005)	-0.002 (0.005)
Dist. next non-ag. estate (ln km)		-0.015*** (0.005)		-0.016*** (0.005)		-0.006 (0.004)		-0.000 (0.005)		0.007 (0.004)		0.005 (0.004)
Loc. on non-ag. estate		-0.028 (0.050)		-0.033 (0.058)		-0.043 (0.027)		0.048 (0.047)		0.032 (0.039)		0.031 (0.041)
Observations	16,339	16,339	16,339	16,339	16,339	16,339	16,339	16,339	16,339	16,339	16,339	16,339
R-squared	0.130	0.131	0.136	0.137	0.117	0.117	0.216	0.216	0.108	0.108	0.110	0.110
Panel B: Without plot/household/community controls												
Loc. on ag. estate	-0.077*** (0.016)	-0.057*** (0.016)	-0.062*** (0.017)	-0.043** (0.017)	-0.037*** (0.014)	-0.034** (0.014)	0.001 (0.017)	0.010 (0.017)	-0.020 (0.015)	-0.027* (0.015)	-0.016 (0.015)	-0.022 (0.015)
Dist. next ag. estate (ln km)	-0.020*** (0.005)	-0.009* (0.005)	-0.017*** (0.005)	-0.007 (0.005)	-0.007* (0.004)	-0.005 (0.004)	-0.033*** (0.006)	-0.027*** (0.006)	0.005 (0.004)	0.001 (0.005)	0.002 (0.004)	-0.001 (0.005)
Dist. next non-ag. estate (ln km)		-0.032*** (0.004)		-0.030*** (0.004)		-0.005 (0.003)		-0.014*** (0.005)		0.013*** (0.004)		0.011*** (0.004)
Loc. on non-ag. estate		-0.024 (0.044)		-0.037 (0.053)		-0.018 (0.026)		0.073 (0.045)		0.065* (0.036)		0.058 (0.037)
Observations	20,927	20,927	20,927	20,927	20,927	20,927	20,927	20,927	20,270	20,270	20,270	20,270
R-squared	0.075	0.079	0.097	0.101	0.100	0.100	0.156	0.157	0.071	0.072	0.072	0.073

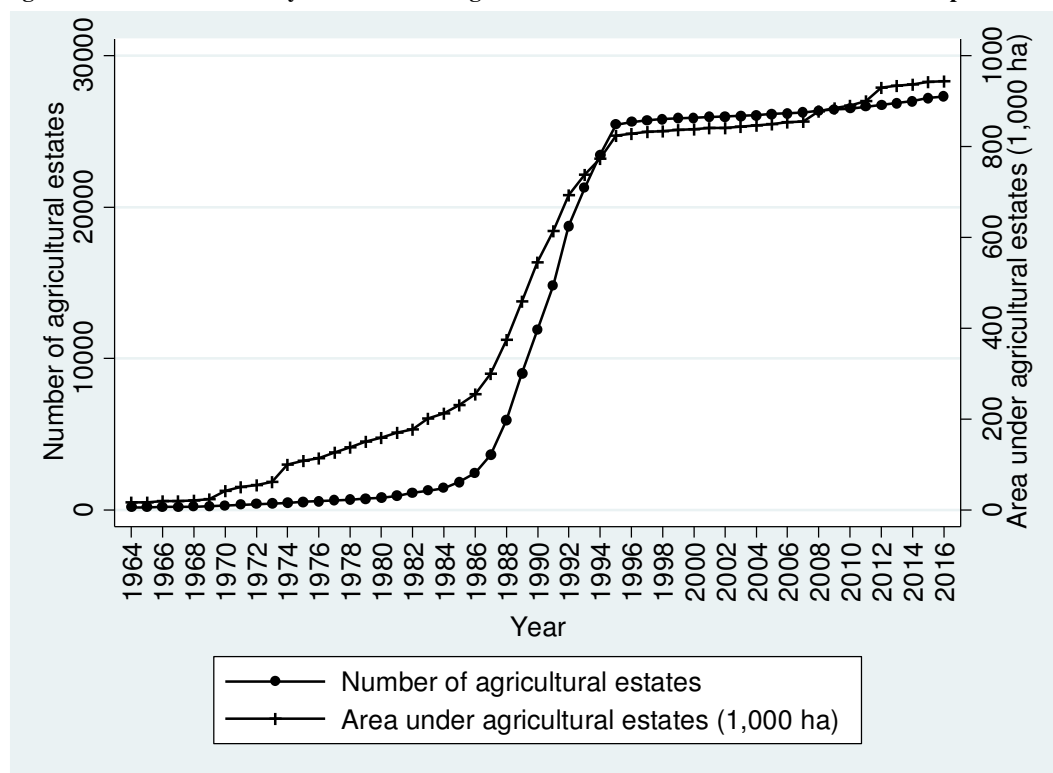
*Note:* Plot controls include topography and geographic locations. Household controls include land size, share of land operated by females, the number of children, adults, and old; head's characteristics (gender, age, education); ownership of durable goods, housing conditions, the value of livestock and agricultural assets, and whether the household attended extension events. Community controls include access to all season road. Robust standard errors in parentheses clustered by village. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

**Table 9: Estimated spillover effects on maize yield**

	Log of maize yield							
	Panel A: With plot/household/community controls				Panel B: Without plot/household/community controls			
Loc. on ag. estate	-0.013 (0.046)	-0.024 (0.044)	0.001 (0.047)	-0.015 (0.044)	-0.042 (0.044)	-0.043 (0.041)	-0.011 (0.045)	-0.028 (0.041)
Dist. next ag. estate (ln km)	-0.025* (0.013)	-0.018 (0.013)	-0.018 (0.014)	-0.013 (0.013)	-0.048*** (0.013)	-0.027** (0.012)	-0.032** (0.014)	-0.019 (0.013)
Dist. next non-ag. estate (ln km)			-0.025** (0.012)	-0.018 (0.012)			-0.045*** (0.011)	-0.023** (0.010)
Loc. on non-ag. estate			0.040 (0.119)	-0.014 (0.106)			0.062 (0.115)	-0.007 (0.101)
Crop area (ln)	-0.559*** (0.016)	-0.397*** (0.035)	-0.558*** (0.016)	-0.396*** (0.035)	-0.529*** (0.015)	-0.339*** (0.027)	-0.527*** (0.015)	-0.339*** (0.027)
Input controls	NO	YES	NO	YES	NO	YES	NO	YES
Observations	7,274	7,274	7,274	7,274	8,730	8,730	8,730	8,730
R-squared	0.350	0.403	0.351	0.403	0.299	0.394	0.301	0.394

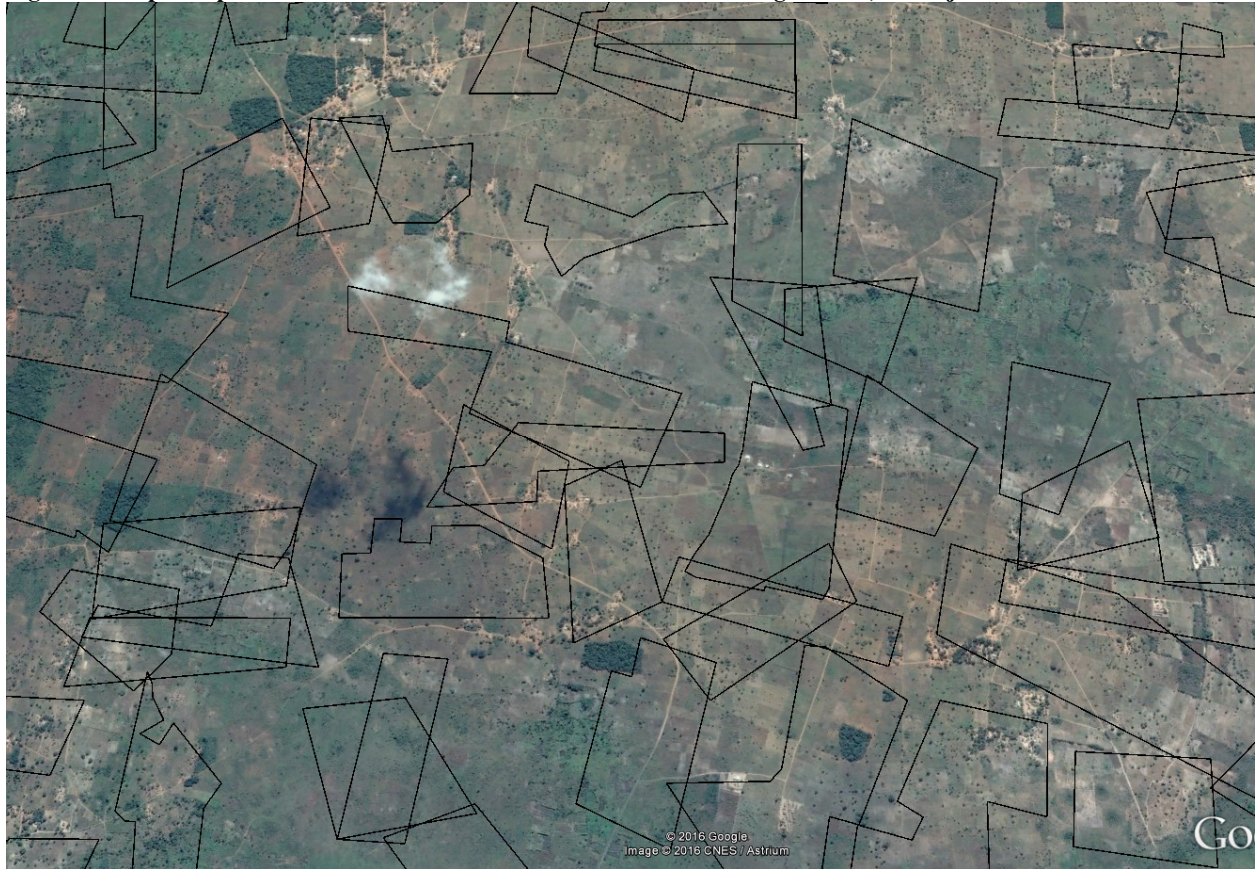
*Note:* Plot controls include topography and geographic locations. Household controls include share of land operated by females, the number of children, the number of adults, the number of old people, head's characteristics (gender, age, and education), ownership of durable goods, housing conditions, the value of livestock, the value of agricultural assets, and whether the household attended extension activities. Community controls include access to the all seasonal road. Robust standard errors in parentheses clustered by village. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

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



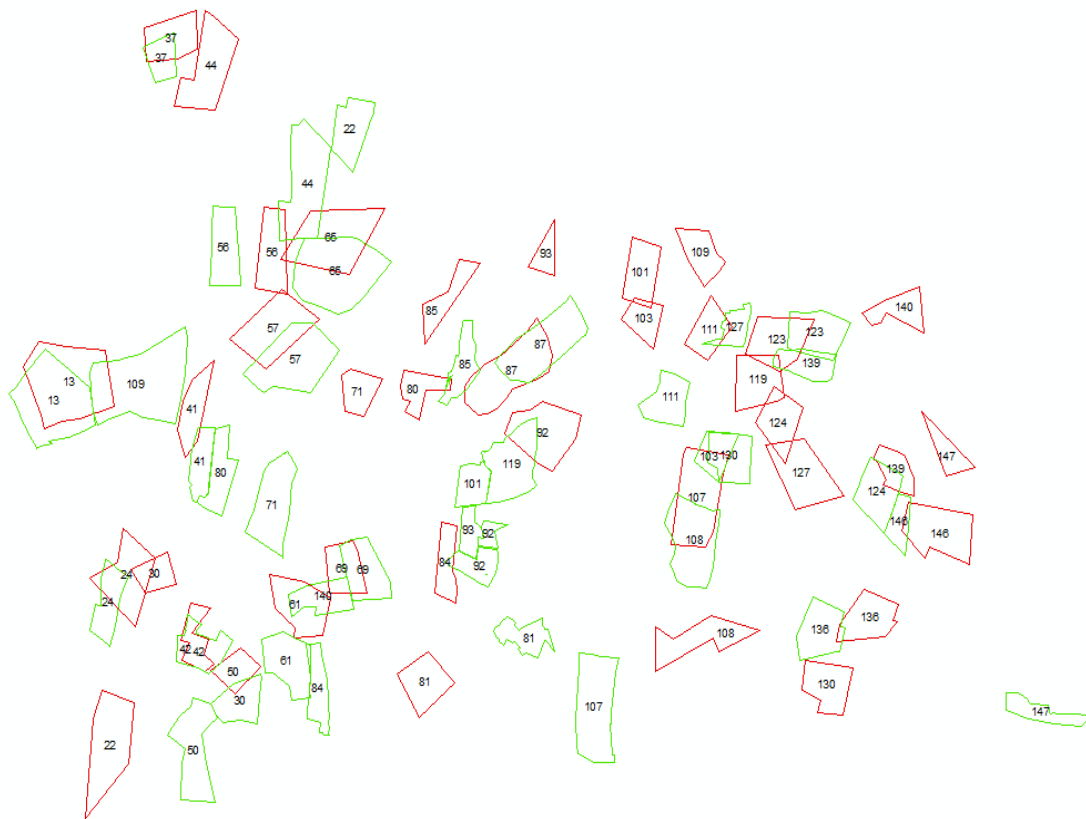
Source: Own computation from the National Geographical Estates Database.

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



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

**Figure 3: Comparing legal description to actual land use based on field verification, \*\*\*\* district**



*Source:* Data from the National Geographical Estates Database (red) complemented by field survey data collected by the authors.

Figure 4: Non-parametric regressions of yield vs. size of cultivated area for maize, rice, tobacco, and coffee

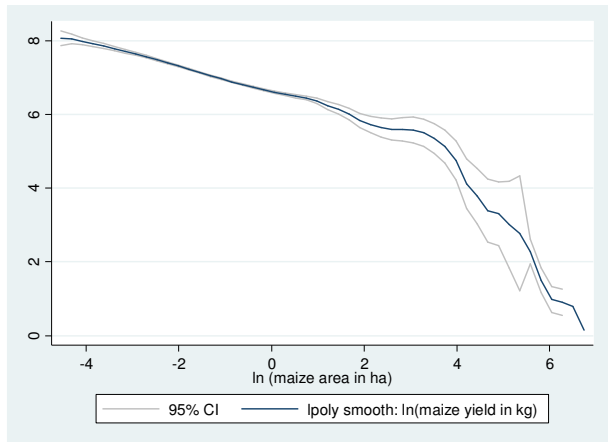


Figure 4a: Maize

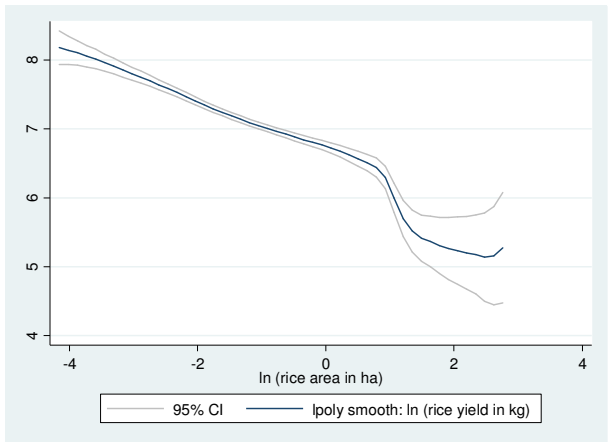


Figure 4b: Rice

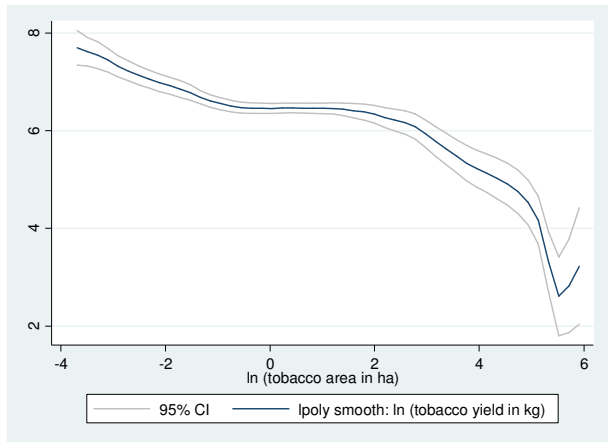


Figure 4c: Tobacco

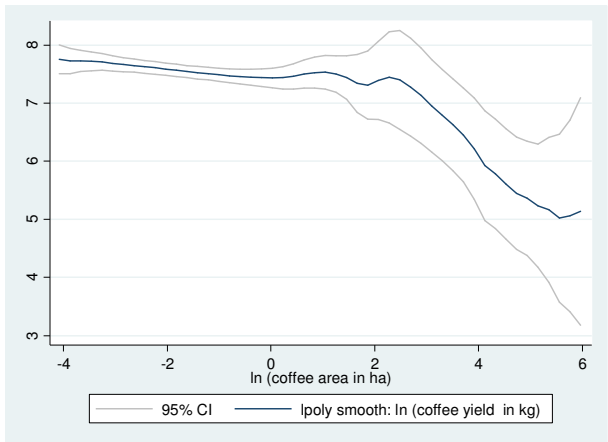
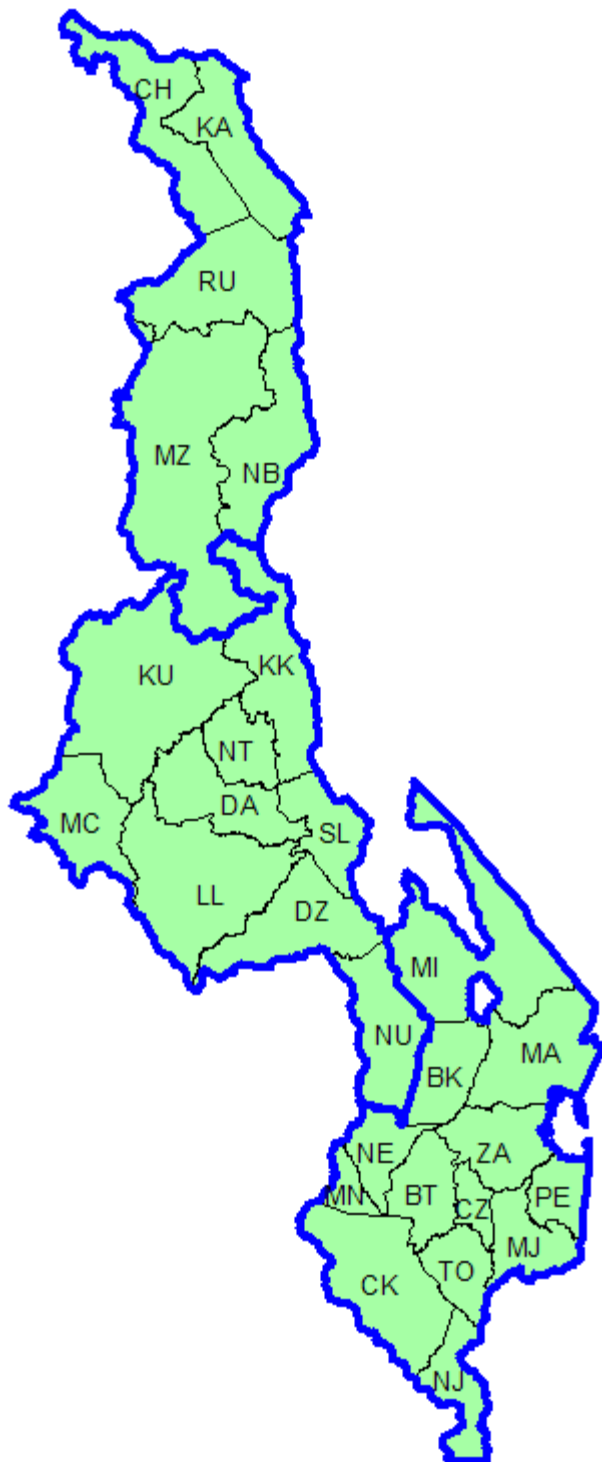


Figure 4d: Coffee

Figure 5: Districts in Malawi



**Appendix table 1: Descriptive statistics of estates by lease status**

	Total	Agriculture			Non-agriculture		
		Expired	Valid	Indet.	Expired	Valid	Indet.
<b>Gen. characteristics of lease</b>							
Total area (1,000 ha)	1,487.44	644.24	299.94	404.58	1.48	14.40	122.79
No. of obs.	58,733	24,474	2,847	7,819	2,160	10,216	11,217

*Source:* Own computation from the National Geographical Estates Database.

**Appendix table 2: Cumulative number of leases**

		1909-64	1965-86	1987-94	1995-2016	1995-2006	2007-16
<i>Panel A: Cumulative figures</i>							
Area transferred	1000 ha	16.73	254.05	772.847	944.18	853.34	944.18
No. of leases	No.	155	2,432	23,439	27,321	26,202	27,321
<i>Panel B: Period increments</i>							
Area transferred	1000 ha	16.73	237.32	518.82	171.33	80.49	90.84
No. of leases	No.	155	2277	21007	3882	2763	1119
Mean lease size	ha	123.90	105.15	24.73	44.13	29.43	81.47
<i>Panel C: Annual increments</i>							
Area/year	1000 ha		10.8	64.9	7.8	6.7	9.1
Leases/year	No.		104	2626	176	230	112

*Source:* Own computation from the National Geographical Estates Database.

**Appendix table 3: Characteristics of leases for all estates by district**

	Number of leases			Area under leases				
	Total	Expired	Overlap >20%	Total ha	Expired		Overlap > 20%	
					ha	%	ha	%
North								
Chitipa (CH)	576	126	39	35,253	3,013	8.5	593	1.7
Karonga (KA)	944	79	41	36,664	1,363	3.7	82	0.2
Mzimba (MZ)	4,998	2,737	856	129,907	89,294	68.7	11,289	8.7
Nkhata Bay (NB)	1,309	139	49	41,621	2,643	6.4	318	0.8
Rumphi (RU)	2,082	1,013	227	32,707	20,497	62.7	2,563	7.8
Subtotal North	9,909	4,094	1,212	276,152	116,811	42.3	14,846	5.4
Center								
Dedza (DZ)	1,165	224	99	13,981	3,183	22.8	1,204	8.6
Dowa (DA)	5,466	3,620	1,649	91,237	75,865	83.2	11,926	13.1
Kasungu (KU)	10,568	7,319	4,319	343,278	182,176	53.1	62,838	18.3
Lilongwe (LL)	3,089	1,053	133	23,960	3,600	15.0	460	1.9
Mchinji (MC)	4,739	3,432	1,304	110,321	66,971	60.7	14,544	13.2
Nkhotakota (KK)	2,952	1,769	698	110,224	63,427	57.5	11,575	10.5
Ntcheu (NU)	1,365	317	228	55,592	5,719	10.3	1,583	2.8
Ntchisi (NT)	2,328	1,591	473	45,364	32,285	71.2	3,371	7.4
Salima (SL)	3,124	1,140	732	97,948	34,431	35.2	5,334	5.4
Subtotal Center	34,796	20,465	9,635	891,904	467,657	52.4	112,834	12.7
South								
Balaka (BK)	412	-	34	1,632	-	-	661	40.5
Blantyre (BT)	2,089	70	265	6,711	330	4.9	96	1.4
Chikwawa (CK)	995	96	106	32,178	390	1.2	257	0.8
Chiradzulu (CZ)	408	57	49	2,196	157	7.2	117	5.3
Machinga (MA)	1,803	314	112	47,034	10,301	21.9	1,176	2.5
Mangochi (MI)	4,031	995	800	119,874	44,952	37.5	8,148	6.8
Mulanje (MJ)	1,038	167	61	26,320	847	3.2	28	0.1
Mwanza (MN)	774	62	97	32,532	1,637	5.0	720	2.2
Neno (NE)	13	-	1	244	-	-	18	7.3
Nsanje (NJ)	499	47	66	8,911	160	1.8	77	0.9
Phalombe (PE)	164	-	17	292	-	-	5	1.6
Thyolo (TO)	697	67	48	9,063	136	1.5	56	0.6
Zomba (ZA)	1,105	200	52	32,394	2,341	7.2	215	0.7
Subtotal South	14,028	2,075	1,708	319,381	61,252	19.2	11,574	3.6
Total Malawi								
Total Malawi	58,733	26,634	12,555	1,487,437	645,720	43.4	139,254	9.4

*Source:* Own computation from the National Geographical Estates Database.

**Appendix table 4: Descriptive statistics of estates' land use**

	Total	Non-agric. estates				All	Agricultural estates		
		All	North	Center	South.		North	Center	South.
Maize	23.00	21.74	16.98	25.64	19.89	23.59	14.00	25.82	21.34
Other crops	21.36	18.86	27.47	20.21	16.27	22.54	23.98	22.80	18.54
Pasture / Grassland	14.29	15.77	18.95	11.80	17.96	13.58	9.90	13.97	16.19
Savannah / Shrub land	18.25	9.40	7.42	8.69	10.27	22.44	25.42	21.64	23.97
Forest / Tree plantations	12.05	8.01	13.26	5.73	8.61	13.96	25.30	11.45	15.73
Water	0.38	1.00	1.47	1.30	0.70	0.09	0.03	0.07	0.30
Bare land / Urban	10.68	25.23	14.46	26.62	26.29	3.79	1.38	4.25	3.93
No. of obs.	58,733	23,593	3,728	9,236	10,629	35,140	6,181	25,560	3,399

*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.

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