Agricultural Commodity Prices and the Demand for Land Titles: Evidence from Uganda

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Abstract

In this paper, I investigate how agricultural commodity prices affect individual demand for land registration in a developing country, using panel data information on the tenure of land harvested by Ugandan households. I build a price index weighting international prices of agricultural commodities by the structure of land use at the sub-county level, and study its interaction with the land market activities of Ugandan farmers. I find that commodity prices encourage land registration and land market activity. I hypothesise that the impact of prices on individual demand for land property rights results from the interaction of an income effect, a composite incentive effect, and unbalanced opportunities created by the social context where farmers operate. The claim is supported by evidence of a positive impact of prices on sales revenues, and by observing that results on land certification are stronger for the prices of cash and tree crops, which (i) are more highly valued on local and international markets; (ii) represent a fixed investment on land that is best internalised when the plot is registered and property rights formalised; and (iii) are therefore more subject to the threat of expropriation and land grabbing. I also document some asymmetries in how different groups in the population respond to crop prices: wealthy households benefit disproportionately from an increase in prices, as well as households belonging to predominant ethnicities in ethnically concentrated areas. Finally, the extent of social capital in the area where farmers reside substantially influences the strength of the observed results.

JEL classification: O12, O13, O18, O19, O55, Q12, Q15.

Keywords: land, property rights, crop prices, inequality, social capital.

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1 Introduction

This paper explores how prices of agricultural commodities affect the individual demand for land property rights, studying the land market activities of farmers in Uganda.

Given its focus on the rural context, the paper sheds light on some of the mechanisms driving the large productivity differences between richer and poorer countries, which tend to be largely concentrated in agriculture (Caselli, 2005). In particular, in light of extensive evidence on the impact of property rights on individual productivity, investment, and labour supply, identifying the channels that affect the diffusion of land titles is crucial to the study of development economics. The literature generally posits that where titles are missing or imperfectly enforced, individuals lack the incentives to efficiently use the land they are cultivating: this owes mainly to fear of expropriation (Demsetz, 1967; Feder and Feeny, 1991; Field, 2007; Goldstein and Udry, 2008), which makes the farmer only partially internalise the benefit of productivity-enhancing investment on their land (Demsetz, 1967; Omura, 2008), but may also be determined by behavioural responses to the lack of ownership and title security (Banerjee et al., 2002). Moreover, as titled land can be more easily sold thanks to better transfer rights, land improvements made through investment can be better realised, thereby again enhancing investment incentives (Besley, 1995; Brasselle et al., 2002; Platteau, 1996). Ownership security is also found to affect the availability of resources to finance investment, as the supply of credit frequently depends on the borrower's actual control on the land they pledge as collateral (De Soto, 2000; Feder and Nishio, 1999; Feder and Onchan, 1987).

As is typical in many developing countries, Uganda combines a heavy reliance on primary sector production and arguably weak institutions governing land market activity. 83 percent of the Ugandan population currently live in rural areas, and agriculture consistently accounts for almost three quarters of employment and one third of total value added (data from the Food and Agriculture Organization, 2015, and the World Development Indicators, 2013). In recent years, the Ugandan government has also been quite active in promoting innovation and technological improvement in the sector, in an attempt to shift production from predominantly subsistence to more market-oriented activities. At the same time however, the system of land property rights in the country has historically been quite complex, and, despite the formal legal provision of various forms of land certificates, only 15-20 percent of land is actually certified (USAid, 2010). As a result, both political controversy and land-related conflicts are far from uncommon (see e.g. Rugadya 1999; Deininger and Castagnini 2006; Schwartz 2008).

I use recent panel data on Ugandan farmers to investigate the effect of crop prices on various outcomes related to land tenure and land market activity. To abstract from potential endogeneity of local farm-gate prices, I focus on the price of agricultural commodities on world markets. My main regressor of interest is an index that aggregates international crop prices, weighted by a fixed measure of the structure of agricultural production in the sub-county where each household resides. I find that agricultural prices spur land registration and land market activity: a 10 percent increase in aggregate prices increases farmers' share of titled landholdings by almost 6 percent of the outcome mean, and raises their share of purchased land

by around 1 percent.

I interpret my findings as evidence of a combination of an income and an incentive effect. In Uganda, land authorities are the country's most corrupt commercial justice institution (Mwebaza and Gaynor, 2002), and administrative procedures can easily turn into a bureaucratic nightmare (the World Bank estimates that in 2009 in Uganda there were 13 steps to registering property, which took 227 days on average and cost more than ten times the monthly income of the average Ugandan household[1]). In such a context, it is not implausible that farmers may generally feel deterred from acquiring titles on their land – or more simply may not be endowed with the extra time and money required for the process. At the same time however, the developing world abounds with examples in which the land of the weaker is vulnerable to outright takings or damages by the stronger ones, especially when business interests are involved (Glaeser et al., 2016). The effect of an appreciation of agricultural commodities could thus be twofold. On the one hand, an increase in the price of farmers' produce might relax their budget constraint, allowing them to obtain the titles they wished they could have acquired earlier but were not able to afford. On the other hand, as price shocks result in land rent booms, substantially increasing the scope for rent-seeking and land grabbing, the need to protect one's property becomes a much more compelling one, making it worth the bother of long procedures and waits.

To test for these mechanisms, I propose a theoretical framework in which individual demand for land certificates responds to prices through an income as well as an incentive effect, which is in turn driven by the current and future profitability of the harvested crops, the amount of existing investment on the land, and fear of losing the land due to eviction or rent-seeking. I also posit that the strength of these effects is a function of the relative position of farmer households in their social context of reference, and that this reinforcing effect in turn depends on existing levels of social capital.

My results broadly confirm my hypotheses: I find that the value of farmers' sales responds positively to an increase in agricultural prices, and that individual demand for land titles is especially responsive to changes in the prices of tree crops like coffee and bananas, which are both more lucrative and represent a sunk investment on farmers' land. At the same time, farmers tend to display higher levels of insecurity in response to changes in the price of these crops, being more concerned that somebody may challenge their access to the land. Next, I present evidence that higher levels of social capital decrease the extent of land insecurity, and have an equalising effect that attenuates the unbalanced responses of different groups in the population to increasing crop prices.

The rest of the paper is organised as follows: Section 2 summarises existing research on the effect of land property rights, institutional change, and demand for land certification; Section 3 provides an account of the agricultural sector and system of land property rights in Uganda; Sections 4 and 5 respectively outline the empirical strategy of the analysis and de-

[1]Today the situation appears to have surprisingly improved, with a reduced number of steps required to complete the registration (10), which now take only 42 days and cost 2.6 percent of the value of the property, in line with the average for Europe and Central Asia

scribe the data, while Section 6 reports the main results and some robustness checks; Section 7 provides a simple theoretical framework that could account for the observed results, which is then brought to the data in Section 8; finally, Section 9 concludes.

2 Related literature

The paper can firstly be ascribed to the literature on the demand-driven evolution of land property rights and land registration. According to what has been called (Platteau, 1996) the "evolutionary theory" of land rights, when the gains from internalisation exceed its cost, economic efficiency justifies the replacement of communal land by private ownership rights (Demsetz, 1967). In practice, this could happen through either a reduction in the cost of measuring and enforcing property rights or an increase in the value of land and an intensification of the competitive pressures over it. The latter mechanism may be for example the result of sustained population growth, or, more relevant to the current paper, the commercialisation of agriculture: as labour and capital are imperfect substitutes for land, land rents are bid up as the agricultural sector expands. This in turn increases the gains of internalisation of the now valuable resource (Demsetz, 1967), which eventually leads to higher incentives towards the achievement of secure property rights. This is even more true in the context of an open economy, when a country's comparative advantage lies in agriculture.[2]

The potential benefits stemming from these patterns are both static and dynamic (Demsetz, 1967; Platteau, 1996): once titles on land are established, the right to sell and mortgage one's property will result in more allocative efficiency and higher investment, owing to both increased investment incentives and greater access to formal credit when land can be pledged as collateral.

The literature lends ample empirical support to the claim that land registration leads to better access to formal credit (Binswanger and Rosenzweig, 1986; De Soto, 2000; Feder et al., 1988; Carter and Olinto, 1996), higher land values (Alston et al., 1996; Feder et al., 1988; Jimenez, 1982; Dowall and Leaf, 1991; Pender and Kerr, 1999), increased investment (Alston et al., 1996; Carter and Olinto, 1996; Field, 2005; López, 1997) and higher output and income (Feder et al., 1988; López, 1997) in various parts of the world. In addition, Galiani and Schargrodsky (2011) provide a detailed account of how the existence of secure land rights may have additional long-term consequences on overall productivity and poverty alleviation, via effects on the intra-household allocation of resources and on household labour, fertility, and health decisions. As regards Sub-Saharan Africa more specifically though, the evidence is slightly more nuanced: if on the one hand Moor and Nieuwoudt (1998) and Roth et al. (1994a) conclude that tenure security has a significant and positive effect on certain types of investment and yield

[2]Theoretically, in a simple specific factors model of trade with two sectors (agriculture and manufacturing) and three factors of production (capital, labour and land; cf. e.g. Jones, 1971, or Hueckel, 1973), if land is specific to agriculture and the home economy specialises in the production of the agricultural good, any improvement in its terms of trade (an increase in the world price of the agricultural product relative to that of the manufactured good) results in resources flowing from manufacturing into agriculture.

in Zimbabwe and Uganda, respectively, other authors find no relationship between land tenure and land improvement, output, or access to credit in Kenya and Somalia (Migot-Adholla et al., 1991; Pinckney and Kimuyu, 1994; Roth et al., 1994b). Well-known evidence from Ghana by Besley (1995) in turn supports the idea that better land rights facilitate investment in certain areas but not in others, depending on the varying underlying socio-economic and demographic conditions in different regions. Furthermore, many scholars emphasise the potential for increased inequality following episodes of intense land appreciation or land reform, as certain vulnerable groups (most notably women and nomadic farmers) may be dispossessed of the use rights they formerly held under customary law, or as the wealthier, better educated, politicised elite exploit their financial means, connections, and information advantage to obtain rights for themselves to the detriment of the poor (Feder and Nishio, 1999; Feder and Noronha, 1987; Platteau, 1996).

My paper lends evidence to the "evolutionary" theory of land rights, as well as to the inequality effects of land tenure. At the same time however, it complements the literature addressing the link between the pressure exerted by commodity prices and an increase in land registration, whereas existing research mostly takes this step as a given to analyse the effect of land tenure on other outcomes.

Evidence on the establishment of land property rights and on its drivers is, in fact, surprisingly limited. The issue has been explored from a historical perspective by Feeny (1979; 1988) and Leacock (1954), who provide evidence on the geographical and chronological relationship between commodity booms on international markets and the creation of a more efficient institutional framework and system of property rights in Thailand, Burma, the Philippines and Québec in the late XIX and early XX centuries. For Sub-Saharan Africa, Fenske (2014) documents how the rubber trade transformed land rights and land disputes in Nigeria during the colonial period, increasing farm sizes and enhancing both sale and rental markets. Bruce (1986) also reports on how the introduction of commercial crops in colonial Sub-Saharan Africa was conducive to the individualisation of tenure and land sale transactions. None of these works, however, goes beyond a descriptive historical account of the co-evolution of commercialised agriculture and property rights.

My paper, on the contrary, provides an empirical test of the link, and it is among the few to undertake a more formal study of the determinants of individual demand for land registration: existing evidence on the subject, using recent data rather than long-run historical descriptives, is rather scarce.[3] Bezu and Holden (2014) study the willingness to pay for land registration in the context of land reform in Ethiopia, and find that demand for certification depends on existing levels of tenure security, which is in turn a product of the effective implementation of previous rounds of land certification. In this sense, the focus of their research is more on reactions to the efficient *supply* of land titles and on policy reform, whereas my paper is rather

[3] As regards Uganda in particular, although the connection between trade, land appreciation, and modifications in the structure of land property is often mentioned in both academic papers and technical reports on the country (see e.g. Deininger and Castagnini, 2006; Deininger et al., 2011; Bomuhangi et al., 2011; Schwartz, 2008), the link has not yet been empirically tested.

concerned with the incentives of individual farmers to obtain a title on their land, in a setting where property rights *do* formally already exist and no major systemic change is being implemented.[4] Closer in spirit to mine is the work of Alston et al. (1996) and Miceli et al. (2001), who also perform a "status quo" analysis on how land registration demand responds to land value in Brazil and Kenya, respectively. While Alston et al. proxy land value with distance from a market centre, Miceli et al. employ an estimate of the potential productivity of land measured in terms of annual average rainfall: my paper then differs from both in that it provides a detailed account of how market forces affect various determinants of demand, rather than of the effect of the intrinsic, immutable quality and profitability of land itself. In this sense, my work is more similar to a study by Collin et al. (2012), who analyse the demand for formal land titles in unplanned urban settlements in Tanzania, and disentangle the effect of increased property values and a higher perceived risk of expropriation. The main difference between their paper and mine is their focus on the urban housing market rather than the rural agricultural sector, which makes the underlying mechanisms driving the results quite different in the two settings. In particular, Collin et al. are concerned with the relationship between the provision of public infrastructure and the uptake of land tenure formalisation as a policy response to the rapid urbanisation and the unchecked growth of unplanned, informal urban settlements. My paper instead is centred on farming activities, and on how different structures of local production and varying social contexts affect the response of individual demand for titles on harvested land to more favourable conditions on agricultural markets.

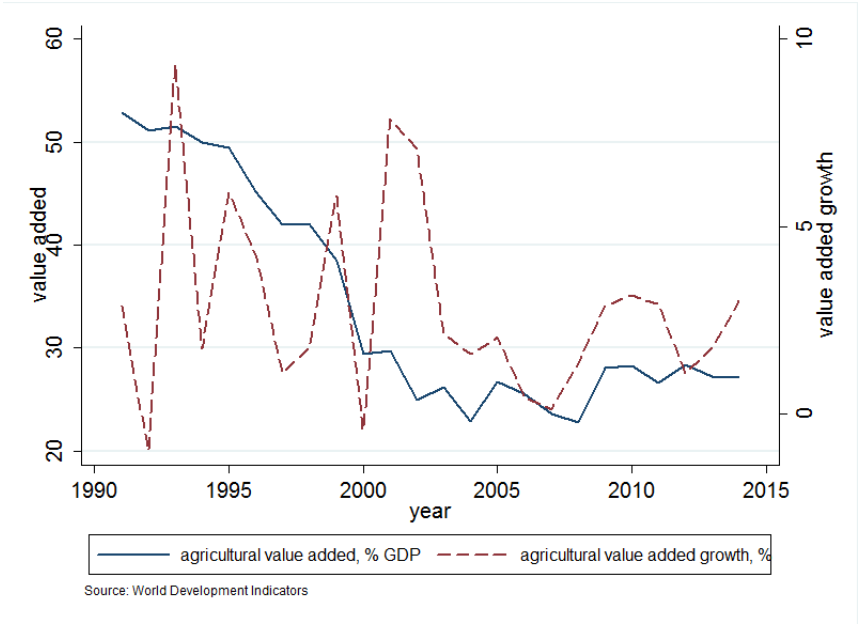
3 Uganda

Uganda represents a good example of a low-income small economy, characterised by a strong specialisation in agriculture. As shown in Figure 1, the share of agriculture in total Ugandan GDP has declined over the years from over 50 percent in 1991 to around 27 percent in 2014, suggesting a certain extent of structural transformation in the economy. The growth rate of the agricultural sector has instead been fluctuating substantially during the same period, around an average of about 3 percent. The sector remains nevertheless the main employer of labour, with agriculture consistently accounting for around 70 percent of the labour force in the last decade (World Development Indicators).

In the recent past, the Ugandan government has put in place a number of policies and programmes targeting the primary sector, to induce a transition from predominantly subsistence to commercial agriculture. In the last decade, the government's efforts have focussed on research for technology development and scaling up, especially in the areas of seeds and planting materials, fertilisers, labour saving technology and mechanisation, and water distribution. Moreover, actions have been promoted with the objective of integrating smallholders in agricultural value chains, by supporting collaboration between agribusiness, farmers, advisers,

[4]The "status quo" nature of the analysis is also especially relevant for my case study, to the extent that past research on the country (Roth et al., 1994a) showed that the positive effect of land tenure on investment tends to be stronger when registration is a voluntary act than when it is imposed by the government.

Figure 1: The performance of the agricultural sector, Uganda 1991-2014



and researchers.

As regards international trade, imports of capital equipment for agricultural production have been made duty-free, to boost productivity and investment (MAFAP, 2014). Since the early 1990s, moreover, Uganda has been pursuing a liberalised economic policy and an active export promotion strategy, based on minimum government intervention in commodity pricing, elimination of export taxes, exchange rate liberalisation, zero-rated duty and VAT exemption on exports, and no additional charges or levies. Uganda's exports, mostly composed of agricultural products,[5] are duty- and quota-free in the European Union and US markets, and qualify for preferential tariff rates in the East African Community (EAC) and Common Market for Eastern and Southern Africa (COMESA).

The liberalisation of Uganda's economy has induced a progressive reduction in the influence of the government on agricultural prices. On the one hand, there are no more public trading companies competing against the private sector or acting as major buyers and guarantors of a minimum producer price. On the other hand, international trade liberalisation has entailed the abolition of both export duties on agricultural products and of any bans or other restrictions on trade in food commodities. As such, the FAO claims that both domestic and international trade in all agricultural products is now entirely privately managed, and that all agricultural prices are completely determined by the market (MAFAP, 2014). For the purpose of my study, this means that prices in world markets are able to reach farmers in Uganda, affecting the value of their production and of their land.

As regards the distribution of land among the population, the country has long been characterised by sluggish land markets and a weak de facto enforcement of land property rights,

[5]The Food and Agriculture Organization estimates that the comparative advantage of the country lies in the production of fish, cotton, tea, and coffee (MAFAP, 2013).

which results in a delay of innovations in agricultural production and widespread land-related disputes – in general, land markets in Uganda are plagued by growing tensions between landlords and tenants, government displacements, and ethno-political and intra-family conflict (Rugadya, 2009). The correct functioning of land markets has become even more crucial in the aftermath of the world food price boom of 2007-2008, when both domestic and foreign investors started pursuing large-scale land deals to engage in commercial agriculture (Bomuhangi et al., 2011). On the one hand, smooth land markets would ease transactions and allow the economy to better reap the benefits of a move away from subsistence agriculture. On the other hand, as long as large power imbalances exist between purchasers and current landholders, and as undocumented land rights are especially vulnerable to expropriation, better-defined rights are a means to safeguard the livelihood of small farmers whose subsistence relies on their landholdings. The next subsection provides a more detailed account of the system of land rights prevalent in the country.

3.1 Land tenure

The Ugandan law recognises five main land tenure regimes: public land, customary tenure, *mailo*, freehold, leasehold.

Public tenure applies to lands for public use, including all designated wetlands, even if these fall within otherwise designated lands. These lands have restrictions on use, such as prohibitions against cultivation and other uses of wetlands.

Turning to private rights, the land market in Uganda is characterised by a vast prevalence of customary rights over other forms of tenure. According to World Bank estimates, 80 percent of the land is under unregistered customary ownership (Goldstein et al., 2016), which is governed by customs, rules, and regulations of the community (Ugandan Ministry of Lands, Housing and Urban Development, 1998). Historically, customary land in Uganda has been divided among clans, with clan leaders in turn allocating it to households, regulating transfers, and occasionally even controlling land investments (Goldstein et al., 2016). Although customary landholders initially did not have a formal title on the land they used, the 1995 Ugandan Constitution recognised and provided some degree of legal protection to unregistered land under customary tenure. The process was eventually completed with the 1998 Land Act, which formally recognised customary ownership and converted former occupants on customary land into owners. Customary owners can obtain a certificate of customary ownership that can be transferred through sale, rent, gift, or mortgage, and can be converted into a freehold title (cf. *infra*) through a well-defined process (Deininger et al., 2008).

Mailo tenure was established in the beginning of the XX century by the British colonial government in the Central region and parts of Central Western Uganda. The British allocated mile-square blocks of land, together with any smallholders occupying them, to the royal family and high-ranking officials of the Buganda kingdom in exchange for political cooperation, whereas the original occupants were converted into tenants. After decades of social unrest, in 1928 the *busuulu* (ground rent) and *envujju* (tribute) laws eventually specified the rights of

the *mailo* owners and tenants: tenants do not hold full ownership rights on the land, must pay a nominal rent to the *mailo* owner and face some restrictions on what they can do on the land (Bomuhangi et al., 2011). However, more recent reform has made it more difficult for *mailo* owners to evict the tenants, who may hold their user rights (*kibanja* tenancy) indefinitely. Starting from the 1998 Land Act, bona fide tenants who have peacefully occupied and used or developed unchallenged by the owner a piece of land for at least twelve years can apply for certificates of occupancy upon payment of an annual nominal rent of USh 1,000 (USD 0.6 approximately). A tenancy by occupancy may be inherited and, with the agreement of the landowner, even be turned into a freehold title. Once issued, the certificate entitles the tenant to undertake any lawful transaction on the occupied land, subject to the consent of the landowner (Hunt, 2004).

Freehold tenure was originally peculiar to the Kingdoms of Toro and Ankole in Western Uganda, and was set up by an agreement between these Kingdoms and the British, who also issued adjudicated freehold to a small number of people and churches or religious institutions (Rugadya, 1999). The owner of a freehold title can hold the land for an unlimited period, may pass it on to their heirs upon their death, and has full powers to use and dispose of it in any way that is not prohibited by the law. The terms of the tenancy between the tenants and the titleholders are not negotiable and were fixed by law in 1937. The main difference between freehold and *mailo* is that tenants on *mailo* land have security of tenure, whereas the same is not automatically true for freehold.

Finally, in the leasehold system, the owner of freehold, customary or *mailo* land (or the Uganda Land Commission in case of public land) grants the tenant exclusive use of the land for a specific lease period, usually of 5, 45, or 99 years, in return of an annual rent or service and under specified terms and conditions. The lessee is entitled to a certificate of title (USAid, 2010). Moreover, while other forms of tenure are reserved to Ugandan citizens, leaseholders may be non-Ugandans.

Despite the legal provision of measures to facilitate the titling and registration of customary land documented above, only around 15-20 percent of the land in Uganda is registered (USAid, 2010). In practice, many have expressed doubts on the extent to which improved land regulations have been adequately publicised throughout the country (Rugadya, 1999), so that a significant portion of landholders might still be unaware of the possibility of registering their land. Moreover, the process for registering land is often onerous in terms of time and expenditures, and many landholders lack the capacity and resources needed to successfully complete it. Mwebaza and Gaynor (2002), in a study conducted on land markets in three Ugandan districts, also argue that landholders may not perceive titling as a significant benefit, in light of widespread corruption and of the additional costs for processing documentation of transactions on land attributable to extra payments demanded by officials when dealing with titled land. Although there seems to be evidence that those who purchase untitled land feel secure on their land (Mwebaza and Gaynor, 2002; Troutt, 1994), tenure insecurity appears to still be widely felt among certain groups of the population, particularly women landowners, tenant farmers in densely settled areas and pastoralists (Rugadya, 2009). Indeed, the endemic

presence of land disputes in Uganda is well documented in the literature.[6] In general, then, the narrow spread of the practice of land registration is to be viewed with some concern, especially in the light of increasing population pressure on resources, technological change, and, most importantly for the focus of the present paper, agricultural terms of trade appreciation, which all make land more profitable (Feder and Feeny, 1991) and hence more subject to dispute and more vulnerable to predatory behaviours by political and economic elites.

4 Empirical strategy

To study how land registration responds to changing agricultural prices, I follow a fixed-effects approach. Given a household-level land outcome y and a sub-county-level price index P (both to be detailed below), the regression equation for household i living in sub-county s at time t is

$$y_{ist} = \alpha + \beta \log P_{st-1} + x'_{ist}\gamma + \sum_{t=2005}^{2011} \theta_t + \eta_i + \epsilon_{ist}, \tag{1}$$

where θ_t's are year fixed effects, η_i is a household fixed effect, and x' is a row vector of household-level covariates. Covariates are region fixed effects[7], ethnicity, education, gender, age and age squared of the household head. Standard errors are clustered at the sub-county level.

4.1 The price index

I build the price index as a geometric average of world agricultural commodity prices,[8] with weights equal to the sub-county-level average acreage of land harvested with each crop as of year 2000, then normalised to obtain a value between 0 and 100.[9]

Given world prices p for each crop $j = 1 \dots J$, the price index faced by a household residing in sub-county s at time t is

$$P_{st} = \prod_{j=1}^{J} p_{jt}^{w_{sjt_0}}, \tag{2}$$

where w_{sjt_0} is fixed area of land used for production of crop j in sub-county s in a reference year t_0 prior to my period of analysis.[10] I obtain the weights elaborating crop-specific land use

[6] Rugadya (2009) identifies various avenues for competing claims on land. These can occur as a result of ethnic rivalries, clashes between cultivators and pastoralists for the right of access to common grazing land and water, prospects of oil discovery in the Albertine Rift, returning of displaced households from refugees camps in civil conflict areas, degazettment (conversion of public land to private use), and forced evictions by land owners without appropriate compensation of tenants.

[7] As a number of farmers migrate during the sample period, these do not get systematically dropped in the fixed effect estimation.

[8] An assessment of the degree of pass-through of international prices to local markets is provided in Appendix section A.

[9] As the price index enters my regression equation in logs, I then use $P + 1$.

[10] I have information on a set of nine major agricultural commodities: bananas, coffee, corn, cotton, ground nuts, rice, sorghum, soy beans, sugar cane; and two residual categories: cereals and other vegetable products.

data prior to my period of analysis. Weighting prices by the structure of land use provides a measure of how much farmers in a certain area are exposed to fluctuations in the price of each specific commodity. In addition, using sub-county level rather than individual weights has the further desirable property to allow me to account for the interdependence of the farming decisions of households living in the same area.

Moreover, choosing a reference year t_0 prior to my period of analysis avoids the threat of reverse causality: improved land titles could in fact affect farmers' decisions on how to cultivate their land, which may well include the type of crops grown on it (this is especially true for a tree crop like coffee, which represents a sunk investment that might not be worth incurring in the absence of secure land tenure). Having a predetermined weight scheme therefore rules out the simultaneity bias and should allow for more consistent estimation.

4.2 Outcome Variables

Given a land tenure or land market characteristic Y, the outcome variable for household i holding K parcels of land at time t is computed as

$$y_{it} = \frac{\sum_{k=1}^{K} \tilde{y}_{kit} \times s_{kit}}{\sum_{k=1}^{K} s_{kit}}, \quad \tilde{y}_{kit} = \begin{cases} 1 & \textit{if } k \textit{ has characteristic } Y \\ 0 & \textit{otherwise} \end{cases} \tag{3}$$

where $\tilde{y}_{kit}$ is a binary variable for whether parcel k held by household i at time t displays characteristic Y, s is parcel size (in acres) and the term in the denominator is the size of total household landholding.[11]

Given the discussion on the Ugandan system of land tenure in Section 3.1, the paper focusses on the following land market characteristics Y:

- parcels acquired by purchase (rather than through inheritance, lease, or squatting), as a proxy for the degree of land market activity. According to Platteau (1996), one of the most resistant aspect of traditional land tenure systems is the inalienability of land by individuals through commercial sales, rentals, or credit-related pledging. A more active land market therefore represents a desirable outcome inasmuch as it enables the reallocation of land from less to more productive individuals, and provides an incentive for farmers and potential entrepreneurs to invest in land improvement activities;

- parcels with a formal certificate of title. This refers to a written and signed official record of an agreement concerning the ownership of a parcel under freehold, *mailo* or leasehold tenure. It registers the right to own the land, and to use and develop it for any purpose. A formal certificate of title also gives the owner the right to enter into any dealings (selling, renting, and using the land as collateral), to allow other people to use the land, and to bequest it;

[11] A parcel is defined as a contiguous piece of land with uniform tenure and physical characteristics, entirely surrounded by either infrastructure or by other land with different tenure and/or physical characteristics. A household's landholding may be composed of more than one parcel, but it is not possible to track parcels over time. Each outcome can thus be considered only at the household and not at the parcel level.

- parcels with a certificate of customary ownership. The document, which must be issued by the local land board, is given to a person (or group) who owns a parcel under a customary system in order to recognise and guarantee their interest in the land. It gives the owner the right to rent the land for a limited period of time, to allow another person to use the land for a limited period, to use the land as collateral, divide it, sell it (under specified conditions), and bequest it;
- parcels with a certificate of occupancy. This title is a document issued to a bona fide tenant, which details the interests or claims of the occupant. Provided the legal owner of the land formally agrees, a tenant with certificate of occupancy can give the parcel away, sublet it, bequest it, give it as security or create usage rights to another person;
- parcels with none of the above certificates. In this case, the parcel is either held under a short term rental or license agreement, or is used by squatters.

5 Data sources

Household data come from the Living Standards Measurement Study (LSMS) of the World Bank. The LSMS has a panel study of Uganda for the years 2009-10, 2010-11, 2011-12, which can be joined to the 2005-06 Ugandan household survey. Other than standard demographics, the LSMS surveys feature detailed information about each parcel of land owned or rented by households, and on any land market activity that occurred in a standard recall period. The only major downside of the dataset is that parcel identifiers are not constant across waves of the survey, hence it is not possible to track specific plots of land over time. This means the outcome variables considered will be at the household rather than parcel level: for example, instead of investigating whether over time a household acquires ownership rights or a certificate of title for a specific plot of land, the analysis will be concerned on the average acreage of plots held by the household for which this occurs (cf. Section 4.2).

Price data mostly come from the international price indices series of the International Monetary Fund International Financial Statistics (IFS) database. The index maintained by the IMF tracks prices of internationally traded primary commodities, reporting benchmark prices that are representative of the global market, determined by the largest exporter of a given commodity. Every year, a price index measures the level of the commodity price relative to a reference year (2010 in my case). In this way, a price index is unit-independent, and can therefore be used to build aggregate measures over different commodities (cf. Section 4.1). For commodities that are not available in the IFS price data, I use additional price indices series from the US Bureau of Labour Statistics (BLS). More information on the specific price series used is available in Appendix section A.

Finally, data on aggregated land use come from the Global Agro-Ecological Zones (GAEZ) project of the Food and Agriculture Organization (FAO) and the International Institute for Applied Systems Analysis (IIASA), which collects agro-ecological data for assessing agricultural resources and potential. I use data on crop harvested area for rain-fed and irrigated cultiv-

ated land, which GAEZ reports as of year 2000. The crops I am considering here are banana, coffee, corn, cotton, ground nuts, millet, palm oil, potatoes, pulses, rice, sorghum, soya beans, sugar cane, and a composite category "green vegetables". Although the GAEZ data are very fine-grained (individual grid-cells are 5 arc-minute in size, equivalent to a 10 by 10 kilometre square), I am only able to exploit sub-county variation in land use, due to the lack of precise parcel coordinates in the LSMS survey.

5.1 Descriptive statistics

Table 1: Descriptive statistics

	2005	2009	2010	2011
total landholdings (acres)	11.200	3.913	3.771	3.062
	(16.729)	(6.472)	(6.926)	(5.315)
property right (share)	0.047	0.103	0.108	0.055
	(0.202)	(0.297)	(0.304)	(0.225)
cert. customary (share)	0.011	0.023	0.017	0.014
	(0.101)	(0.147)	(0.127)	(0.117)
cert. occupancy (share)	0.004	0.079	0.059	0.115
	(0.065)	(0.264)	(0.228)	(0.314)
no certificate (share)	0.938	0.682	0.721	0.750
	(0.232)	(0.447)	(0.431)	(0.421)
perceived insecurity (yes/no)	0.224	0.156	0.113	0.107
	(0.417)	(0.363)	(0.317)	(0.309)
purchased (share)	0.250	0.314	0.311	0.284
	(0.392)	(0.440)	(0.443)	(0.435)
inherited (share)	0.417	0.553	0.579	0.624
	(0.450)	(0.469)	(0.470)	(0.464)
other acquisition (share)	0.333	0.133	0.110	0.092
	(0.424)	(0.306)	(0.286)	(0.274)
banana (yes/no)	0.547	0.538	0.582	0.574
	(0.498)	(0.499)	(0.493)	(0.495)
coffee (yes/no)	0.301	0.282	0.327	0.314
	(0.459)	(0.450)	(0.469)	(0.464)
corn (yes/no)	0.774	0.762	0.714	0.695
	(0.419)	(0.426)	(0.452)	(0.460)
cotton (yes/no)	0.101	0.029	0.047	0.065
	(0.302)	(0.168)	(0.212)	(0.246)
ground nuts (yes/no)	0.317	0.330	0.323	0.351
	(0.465)	(0.470)	(0.468)	(0.478)
rice (yes/no)	0.052	0.035	0.050	0.043
	(0.221)	(0.185)	(0.217)	(0.203)
sorghum (yes/no)	0.289	0.267	0.193	0.174
	(0.453)	(0.442)	(0.395)	(0.379)
soy beans (yes/no)	0.040	0.055	0.069	0.094
	(0.195)	(0.228)	(0.254)	(0.292)
sugarcane (yes/no)	0.044	0.047	0.035	0.027
	(0.205)	(0.211)	(0.183)	(0.161)
Observations	1503	1456	1313	1003

Notes: Each cell reports the mean of each variable in the sample used for the main estimating equation. Standard deviations are in parentheses. Property right refers to a formal, written and signed official record of an agreement concerning the full ownership of a parcel of land. Customary ownership is a document given to a person who owns a parcel under a customary system in order to recognise and guarantee their interest in the land. Certificate of occupancy is a document issued to a bona fide tenant, which details the interests or claims of the occupant. No certificate refers to an informal short term agreement or squatting. Crop variables are dummies for whether the household harvests the crop in at least one of their parcels. Perceived insecurity is whether the farmer subjectively feels their use of a parcel of land my be threatened by a third party. The price index is built as a geometrically-weighted index of agricultural commodity prices, with weights equal to the sub-county-level average acreage of land harvested with each crop as of year 2000.

Table 2: Land rights, investment and farm income

	property right	customary ownership	certificate of occupancy	no certificate
pesticides	0.068	0.018	0.077	-0.106
	[0.041; 0.095]	[−0.009; 0.045]	[0.05; 0.103]	[−0.133; −0.079]
chemical fertilisers	0.118	-0.002	0.02	-0.082
	[0.091; 0.144]	[−0.029; 0.025]	[−0.007; 0.047]	[−0.109; −0.055]
organic fertilisers	0.053	0.002	0.066	-0.029
	[0.026; 0.08]	[−0.025; 0.029]	[0.039; 0.092]	[−0.056; −0.002]
farming income	0.019	-0.018	0.071	-0.036
	[−0.016; 0.054]	[−0.053; 0.017]	[0.036; 0.106]	[−0.071; −0.001]
agricultural income	0.058	-0.009	0.04	-0.048
	[0.024; 0.092]	[−0.044; 0.025]	[0.006; 0.074]	[−0.082; −0.013]

Notes: Each cell reports the correlation of the share of land under the tenure system in each column and the land-improving investment or income measure (per acre) in each row. 95 percent confidence intervals are in brackets. Property right refers to a formal, written and signed official record of an agreement concerning the full ownership of a parcel of land. Customary ownership is a document given to a person who owns a parcel under a customary system in order to recognise and guarantee their interest in the land. Certificate of occupancy is a document issued to a bona fide tenant, which details the interests or claims of the occupant. No certificate refers to an informal short term agreement or squatting.

Descriptive statistics are reported in Table 1. Farmers in my sample are quite small, with total landholdings averaging around 3-4 acres in 2009-2011. This marks a sharp reduction compared to 2005, when average farm size was almost three times as high even after getting rid of outliers. As this pattern might potentially undermine the quality of my results, I explicitly account for this issue later in Section 6.1.

As is clear from the next four rows of the Table, the vast majority of land is untitled, despite a sizeable increase in the share of land with a certificate of occupancy. In 2005, almost a quarter of the sample felt insecure about at least one of their parcels, meaning that the household was concerned that someone might dispute their property or use rights on the land. The percentage however appears to have dropped significantly over time, more than halving by 2011.

Most of the land is acquired through bequest, especially in 2011 when almost two thirds of each farmer's landholdings are inherited. This is the result of relatively stable shares of land acquired by purchase (around 30 percent) and a substantial reduction in the relative importance of other types of land acquisition (like lease, gift, or outright trespassing).

The table also reports on the harvesting of the main crops entering the price index in Equation (2). The most popular crops are bananas, coffee, corn, ground nuts and sorghum, whereas cotton, rice, soy beans and sugar cane are less prevalent.

In Table 2, I report simple correlations between tenure types and measures of land-improving investment or income. Although the numbers are quite small overall, both property rights and certificates of occupancy are positively correlated with the use of pesticides and fertilisers, as well as with agricultural income; the converse is true for untitled land. These patterns, though clearly just descriptive, match the discussion about the benefits of land rights in Section 2 quite closely, and implicitly hint at the desirability of a wider-spread formalisation of land titles.

6 Results

Table 3: The effect of crop prices on land markets

VARIABLES	(1) purchase	(2) property right	(3) cert. customary	(4) cert. occupancy	(5) no certificate
Panel A					
price	0.007	0.040	0.010	0.054***	-0.099***
	(0.019)	(0.026)	(0.007)	(0.016)	(0.037)
Observations	5,449	5,449	5,449	5,449	5,449
Outcome mean	0.269	0.071	0.015	0.06	0.787
Sub-county fixed effects	YES	YES	YES	YES	YES
Year fixed effects	YES	YES	YES	YES	YES
HH fixed effects	NO	NO	NO	NO	NO
Additional controls	NO	NO	NO	NO	NO
Panel B					
price	0.021*	0.047**	0.014	0.043***	-0.092***
	(0.011)	(0.020)	(0.009)	(0.016)	(0.030)
Observations	5,449	5,449	5,449	5,449	5,449
Number of HH	1,855	1,855	1,855	1,855	1,855
Outcome mean	0.269	0.071	0.015	0.06	0.787
HH fixed effects	YES	YES	YES	YES	YES
Year fixed effects	YES	YES	YES	YES	YES
Additional controls	NO	NO	NO	NO	NO
Panel C					
price	0.022*	0.039**	0.013	0.042***	-0.082***
	(0.011)	(0.018)	(0.009)	(0.016)	(0.028)
Observations	5,275	5,275	5,275	5,275	5,275
Number of HH	1,828	1,828	1,828	1,828	1,828
Outcome mean	0.269	0.072	0.016	0.06	0.785
HH fixed effects	YES	YES	YES	YES	YES
Year fixed effects	YES	YES	YES	YES	YES
Additional controls	YES	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: Column (1): share of land acquired by purchase; (2) share of land for which the household has a formal certificate of title; (3): share of land with a certificate of customary ownership; (4): share of land with a certificate of occupancy; (5): share of land without any certificate. Standard errors are clustered at the sub-county level. The outcome is linearly regressed on year fixed effects, the log of the lag of a price index, and sub-county (Panel A) or household (Panels B and C) fixed effects. Controls include gender, age (linear and square), education and ethnicity of the household head, region fixed effects. The price index is built as a geometrically-weighted index of agricultural commodity prices, with weights equal to the sub-county-level average acreage of land harvested with each crop as of year 2000.

I initially run pooled OLS analysis with sub-county fixed effects. Results are reported in Panel A of Table 3. The fact that P enters Equation (1) in logs means that the coefficients reported in the Table measure the effect of percent increases in the price index on the outcome variable: here, a 10 percent increase in the price index produces a reduction in untitled land of 1 percentage point (Column 5), and an increase in the share of land with a certificate of occupancy (Column 4) of 0.55 percentage points.

When I run fixed effects analysis, results are very similar, and more precisely estimated. In Panels B and C of Table 3, a 10 percent increase in the price index still produces a reduction in untitled land of almost 1 percentage point (Column 5), which is driven by a parallel increase in the share of land with a formal certificate of property right (Column 2) and with a certificate of occupancy (Column 4) of around 0.4 percentage points each. This represents an increase by roughly 5 and 6 percent of the overall mean in each type of tenure, respectively. Moreover, the combined increase of both formal certificates of property (*mailo*, freehold and leasehold) and

titles certifying user rights points to a widespread effect of agricultural prices, which prompt both landowners and land users to register their land.

At the same time, a 10 percent increase in crop prices has a statistically significant effect on the share of land acquired by purchase rather than with other methods, which increases by 0.2 percentage points (Column 1). The evidence on land purchases is in general suggestive of more dynamic, better functioning land markets following periods of land appreciation. As official land transactions are severely hampered by the lack of formal titles, the rise in purchases can also be partly explained by the improvement in overall land titling documented in Columns 2, 4 and 5.

6.1 Robustness checks

I first address the possible bias arising from the inclusion of year 2005 in the analysis. Given the four-year gap between 2005 and the next round of the household survey, and the sharp decline in farmers' total land acreage observed between 2005 and 2009 and noted in Section 5.1, it may be possible that including this year in the analysis makes the results depend on some unobserved event or trend, which might in turn affect both the price index and outcome variables in ways not accounted for by the simple 2005 year fixed effect in Equation (1). When I perform the analysis only on the 2009-2011 period (Appendix Table C.1), the effect of prices looks indeed much stronger (by almost a degree of magnitude), but the qualitative interpretation of results is broadly in line with the main evidence reported in Table 3, with an increase in the share of land under certificates of occupancy and a parallel reduction in the share of untitled land.

In order to make sure that results do not depend on the specific way prices are aggregated in Equation (2), I replicate the analysis using alternative specifications for the price index.

As a preliminary check, I build the price index as an arithmetic rather than geometric average of international price indices. Results, reported in Table C.2 in the Appendix, are somewhat lower in magnitude but very similar to those of my main specification.

Having established that the use of a geometric rather than arithmetic aggregator does not seem to affect the direction and size of my findings, I return to aggregating prices through a geometric average, and then try various alternative weighting schemes to sub-county predetermined land use.

First, to account for the possibility that land use in 2000 may not adequately reflect the actual structure of agricultural production almost a decade later, I use as weights the average suitability of land for the production of the various crops for which I have price series. I compute sub-county level averages using data from GAEZ, which estimates soil suitability based on knowledge of crop requirements, prevailing soil conditions, and applied soil management, quantifying to what extent soil conditions match crop requirements under defined input and management circumstances.[12] Results are reported in Appendix Table C.3 and go in pretty

[12]Specifically, I retrieve soil suitability estimates for rain-fed land, at intermediate input level, averaged over the baseline period 1961-1990.

much the same direction as those in Table 3, but are now way bigger in magnitude, which casts some doubt on the reliability of the measure in accurately reflecting land use patterns.

To try and tackle this issue, I predict land use in 2000 with crop suitability for each crop, and use fitted values as weights in my price index. Appendix Table C.4 displays the outcome of the exercise, which delivers a set of coefficients much more in line with those in Table 3.

As a further check, I also construct my price index as the geometric average of the change in agricultural commodity prices over the past 5 years (returning to use weights equal to the sub-county-level average acreage of land harvested with each crop), rather than just considering the first lag of prices, to account for the possibility that farmers might adjust their response to developments over a longer time span. Results, reported in Appendix Table C.5, are slightly less precisely estimated, but show a reduction in the share of land with formal certificates, which is however compensated by an almost 40 percent higher increase in certificates of occupancy.

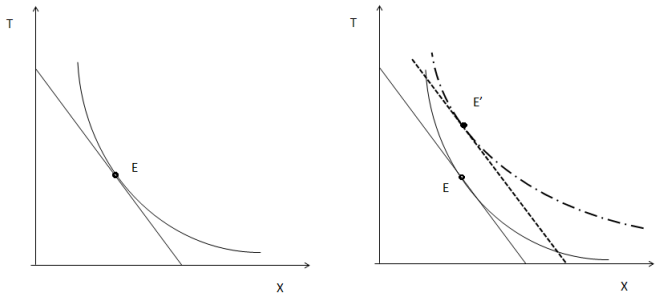
In a separate exercise, I also account for individual land use choices, exploiting information in the LSMS survey about the acres of land harvested with each crop by farmer households. I consider both contemporaneous land use (Appendix Table C.6) and, to address potential endogeneity to prices of the choice on which crops to harvest, time-invariant use of land, first at baseline in year 2005 (Appendix Table C.7) and then as an average over the entire sample period (Appendix Table C.8). Again, albeit somewhat less precisely estimated, results stay very similar to my main findings, both in terms of direction and magnitude.

Turning to the choice of functional form, I relax the linearity restriction imposed by OLS and fixed effect regression, and run Tobit regression with sub-county fixed effects, where the outcome variables are constrained between 0 and 1. Results are reported in Appendix Table C.9, and, notwithstanding their substantially higher magnitudes, have the same qualitative interpretation as the ones in Table 3 above.

As a final check, I address the possibility of asymmetries in the response of land titles to prices, and I analyse whether prices induce an increase, decrease, or nil change in the share of titled land owned by farmers. To this end, I build a set of dummy variables for whether the household increased, decreased, or left unchanged the share of land under each outcome listed in Section 4.2 from one round of the household survey to the next, and then run regression (1), also controlling for the lag of the underlying outcome variable. Appendix Table C.10 reports the results, and shows that an increase in the price index is associated to an increase in the likelihood of increasing one's share of land with a certificate of occupancy, a reduction in the likelihood of decreasing the share of land with a formal certificate of title, and a reduction in the likelihood of increasing the share of untitled land, which is instead more likely to remain unchanged. All these results fit well the main evidence presented in Table 3.

7 Mechanisms

What my analysis has shown so far is that increasing agricultural prices are conducive to wider-spread demand for land registration across Ugandan farmers. To interpret the finding,



(a) Optimal consumption bundle

(b) The effect of a price increase

Figure 2: The demand for land titles: individual consumption choice

this Section now proposes a simple theoretical framework that highlights some of the channels that may drive the results, before proceeding to testing these hypotheses in the data.

7.1 The individual maximisation problem: assumptions

Let us first assume that a representative farmer is faced with the choice whether to allocate their income I to the acquisition of land titles T at a cost c_T or to the purchase of a composite consumption good X costing c_X. In the absence of any constraint on the supply side (the Government is able to issue all the land certificates the farmer demands), the maximisation problem solved by the individual is

$$\begin{aligned} &\max_{T,X} U(T,X) \\ s.t. \quad &c_T T + c_X X = I. \end{aligned} \tag{4}$$

The problem leads to the standard system of equations determining the individual optimal choice, which must satisfy equality of the marginal rate of substitution to the relative price and the budget constraint:

$$\begin{cases} \frac{MU_T}{MU_X} = \frac{c_T}{c_X} \\ c_T T + c_X X = I. \end{cases} \tag{5}$$

The solution of the problem is represented by point E in Figure 2a, at the tangency between the individual's indifference curve and their budget constraint. The location of point E might in turn be affected by agricultural prices, in ways that depend on the set of assumptions that follow.

First, I assume that the marginal utility of substitution between land titles and other goods is a positive function of land value, land insecurity, and the capability (in an Amartya Sen's way) to reap the benefits stemming from the valuable resource in practice:

Assumption 1.

$$\frac{MU_T}{MU_X} = u(\underset{+}{\text{land value}}, \underset{+}{\text{insecurity}}, \underset{+}{\text{capability}}). \tag{6}$$

Intuitively, one might expect the marginal utility from titling to be increasing in how much the land is worth. This in turn could be modelled to be a positive function of the expected future revenues that agricultural production on the plot will yield, as well as of any sunk investment the farmer has already undertaken on the land in terms of either past land improving practices or product choice:

Assumption 2.

$$\text{land value} = v(\underset{+}{\text{E}[\text{revenues}_{\text{t+n}}]}, \underset{+}{\text{investment}_{\text{t-m}}}). \tag{7}$$

Abstracting from general equilibrium effects, future revenues will in turn positively depend on the profitability of the crop mix harvested on the plot and, mechanically, on expected agricultural prices $E[P_{t+n}]$:

Assumption 3.

$$\text{E}[\text{revenues}_{\text{t+n}}] = r(\underset{+}{\text{profitability}}, \underset{+}{\text{E}[P_{t+n}]}). \tag{8}$$

Turning to the second argument of function u in Assumption 1, the appeal of registering a parcel of land should also be higher the higher the likelihood that a third party tries to unduly take possession of the land, which will very likely be a positive function of land value and a negative function of social capital:

Assumption 4.

$$\text{insecurity} = i(\underset{+}{\text{land value}}, \underset{-}{\text{social capital}}). \tag{9}$$

Social capital will also positively affect the capability to benefit from the land, together with one's relative position in the social context of reference:

Assumption 5.

$$\text{capability} = c(\underset{+}{\text{social position}}, \underset{+}{\text{social capital}}). \tag{10}$$

Finally, I am also going to assume that functions u, v, and r are imperfectly separable in their arguments, so that the effect of any change in one argument is magnified by its interaction with the other ones:

Assumption 6.

$$\frac{\partial^2 u}{\partial \text{land value}\, \partial \text{capability}} \geq 0 \tag{11}$$

$$\frac{\partial^2 v}{\partial \text{E}[\text{revenues}_{\text{t+n}}]\, \partial \text{investment}_{\text{t-m}}} \geq 0 \tag{12}$$

$$\frac{\partial^2 r}{\partial \text{E}[\text{P}_{\text{t+n}}]\, \partial \text{profitability}} \geq 0. \tag{13}$$

7.2 Predictions

If Assumptions 1-5 hold, we can expect the following set of predictions regarding the effect of agricultural prices.

Prediction 1. If farmers predict price shocks to be persistent, an increase in current prices will increase the future revenues obtainable from the land:

$$\frac{\partial \mathrm{E}[\mathrm{revenues_{t+n}}]}{\partial P} \geq 0. \tag{14}$$

Prediction 2. By Prediction 1, an increase in prices will increase the value of land:

$$\frac{\partial \mathrm{land\ value}}{\partial P} = \frac{\partial v}{\partial \mathrm{E}[\mathrm{revenues_{t+n}}]} \frac{\partial \mathrm{E}[\mathrm{revenues_{t+n}}]}{\partial P} \geq 0. \tag{15}$$

Prediction 3. By Prediction 2, an increase in prices will also increase land insecurity:

$$\frac{\partial \mathrm{insecurity_t}}{\partial P} = \frac{\partial i}{\partial \mathrm{land\ value}} \frac{\partial \mathrm{land\ value}}{\partial P} \geq 0. \tag{16}$$

Prediction 4. By Predictions 2-3, an increase in prices will increase the marginal rate of substitution between land titles and other goods:

$$\frac{\partial \frac{MU_T}{MU_X}}{\partial P} = \frac{\partial u}{\partial \mathrm{land\ value}} \frac{\partial \mathrm{land\ value}}{\partial P} + \frac{\partial u}{\partial \mathrm{insecurity}} \frac{\partial \mathrm{insecurity}}{\partial P} \geq 0. \tag{17}$$

By Assumption 6, the effect is stronger the higher past investment on the land, profitability of the harvested crop mix, and capability to benefit from favourable conditions on the market.

Prediction 4 results in a flattening of the individual's indifference curve represented by the dashed line in Figure 2b: the individual now needs to be compensated by a higher quantity of the composite good X in order to give up any amount of land titles.

If we now assume away any general equilibrium effects, if the farmer is a net producer of agricultural goods we also have the following:

Prediction 5. Individual income will be an increasing function of prices:

$$\frac{\partial I}{\partial P} \geq 0. \tag{18}$$

This is reflected in Figure 2b by a shift of the budget constraint away from the origin, as shown by the dotted straight line. Taken together, the two effects from Predictions 4 and 5 give us our final:

Prediction 6. By Propositions 4 and 5, an increase in crop prices will increase demand for land titles:

$$\frac{\partial T}{\partial P} \geq 0. \tag{19}$$

In Figure 2b, the combined effects of prices on both the budget constraint and the indifference curve shift the individual's optimal consumption bundle from point E to point E', which is characterised by both a higher level of land titles and a higher proportion of income spent on titles with respect to other goods.

To summarise, the analysis in this Section predicts that an increase in agricultural prices will induce the individual demand for land certificates to rise. The total effect is then driven by three broad channels: (i) an income effect: rising crop prices enhance the farmer's *ability* to afford land registration; (ii) an incentive effect: agricultural prices affect the farmer's *willingness* to secure their land, by the combined pressure of higher land value and mounting land insecurity; and (iii) a capability effect: effects (i) and (ii) are more strongly felt by certain groups in the population. The next Section tests for the presence of these three effects in the data.

8 Testing the mechanisms

8.1 The income effect

To test for the presence of an income effect, I explore the impact of agricultural prices on the self-reported average value of farmers' sales, farming income, and total agricultural income in my period of interest. To avoid the noise generated by self-reported monetary data, I winsorise the variables at the top 10 percentile, and consider them in logs rather than in levels.

The regression I am running is therefore

$$\log I_{ist} = \alpha + \beta \log P_{st} + x'_{ist}\gamma + \sum_{t=2005}^{2011} \theta_t + \eta_i + \epsilon_{ist}, \tag{20}$$

where I is either sales value, farming income, or total agricultural income per acre, θ_t's are year fixed effects, η_i is a household fixed effect, and x' is a row vector of household-level covariates. Standard errors are always clustered at the sub-county level.

Note that, contrary to Equation (1), the price index is not lagged here. This is quite an intuitive choice and reflects the fact that, holding all assumptions from Section 7 fixed, an increase in prices is mechanically going to affect farmers' revenues *today*.

Results are shown in Table 4. As both the outcome and the price variables are in logs in Equation (20), the coefficient reported in Table 4 can be interpreted as the price elasticity of sales value or farmers' income: this means that a one percent increase in agricultural prices increases farmers' revenues by 2.3 percent, and both their farming and total agricultural income by around 0.6 percent.

8.2 The incentive effect

As the analysis in Section 7 predicts that commodity prices will affect farmers' incentives through land value and land insecurity, this subsection tries to disentangle the two effects, examining the underlying determinants of each channel.

Table 4: Value of sales

VARIABLES	(1) sales value (UGX)	(2) farming income (UGX)	(3) agricultural income (UGX)
price	2.347*	0.578*	0.638*
	(1.249)	(0.336)	(0.345)
Observations	3,534	3,856	4,106
Number of HH	1,610	1,732	1,799
Outcome mean	9.393	12.284	12.447
HH fixed effects	YES	YES	YES
Year fixed effects	YES	YES	YES
Additional Controls	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: Column (1): log-sales value per acre (in Uganda Shillings). Column (2): log-farming income per acre (in Uganda Shillings). Column (3): log-agricultural income per acre (in Uganda Shillings). The outcome is regressed on household and year fixed effects and the log of a price index. Controls include gender, age (linear and square), education and ethnicity of the household head, region fixed effects. The price index is built as a geometrically-weighted index of agricultural commodity prices, with weights equal to the sub-county-level average acreage of land harvested with each crop as of year 2000. Outcome data are winsorised at the top 10 percentile. Standard errors are clustered at the sub-county level. The analysis for sales value is performed only on the years 2009, 2010, 2011.

8.2.1 Land value

According to the discussion in Section 7 above, land value will ultimately depend on three variables: expectation about future prices, profitability of the harvested crops, and level of past investment.

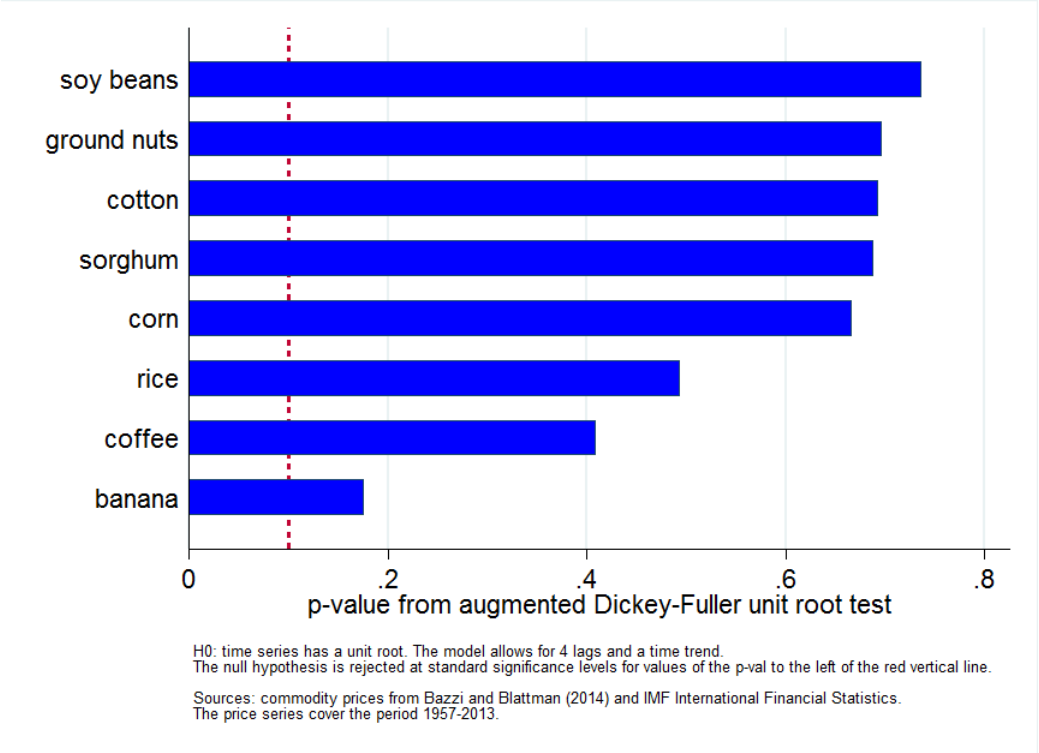
Price expectations

As regards price expectations, my data do not offer a straightforward way to assess whether farmers expect price shocks to be long-lasting or not. In order to partially address the issue, I therefore test whether the price series of the commodities included in my price index *are* indeed persistent, making the (rather strong) assumption that farmers are able to learn from past experience and adapt their expectations accordingly. In time series analysis, a situation where the effect of a shock is permanent without fading away over time is described by a series with stochastic trends, containing a unit root. A series where the effect of a shock will only be transitory before the series reverts back to its long-term mean or trend is instead referred to as (trend) stationary, and has no unit roots.[13] Here, I thus consider international commodity price data for the period 1957-2013[14], and I test for the presence of a unit root in these (log) price series. For each price series, I conduct a simple augmented Dickey-Fuller unit root test, where the null hypothesis is the absence of a unit root (cf. Fuller, 1996 for details), and report the p-values of the test in Figure 3. As all bars in the Figure are well above 0.5, the test is far from rejecting the presence of a unit root for any of the commodities considered even at very low significance levels. In this sense, I interpret this evidence in favour of persistence in price shocks as suggestive of a possible effect of current prices on price expectations for the future.

[13]Evidence by Ghoshray (2011) for the period 1900-2003 shows that, although results tend to depend on both sample size and the specific unit root test chosen, there are roughly as many primary commodities exhibiting a unit root as there are stationary ones. The picture is also confirmed by Bazzi and Blattman (2014).

[14]International commodity prices for the years until 2004 come from the series built by Bazzi and Blattman (2014), available to the public in the online Appendix to their paper.

Figure 3: Testing for unit roots in commodity price series



Profitability and past investment

To account for the effect of crop profitability and past investment, I disaggregate the price index, and analyse the price impact on land registration for a small number of selected commodities. A crop is chosen for the exercise if it meets the following requirements: (i) it accounts for a (relatively) big share of Ugandan export value, to ensure consistency focussing on the commodities that are most likely to be actually affected by international prices; (ii) my price data feature a specific price series for the crop, rather than the crop being included in the price series for a more comprehensive category;[15] and (iii) a reasonable number of farmers report harvesting the crop in the household survey, to make sure the analysis is relevant for my sample.[16] This leaves me with banana, coffee, corn and cotton. Together, these crops account for a quarter of total Ugandan exports at the beginning of my period of analysis and roughly 10 percent of total agricultural production in the country.[17]

These four crops differ among themselves in two significant ways: on the one hand, ba-

[15]For instance, beans are among the top ten Ugandan exports, but in my data their price is included in the "other vegetables" category so they cannot be included in the exercise.

[16]For example, tea is Uganda's third product in terms of export value and the IFS data include a specific price series for tea, but it is mainly produced by bigger firms and only less than 100 observations report a tea harvest in the LSMS household survey.

[17]Source: own calculation using data from the United Nations Commodity Trade Statistics Database (UN-ComTrade), HS (Harmonized System) 2002 series and country statistics from the Food and Agriculture Organization (FAOStat).

nanas, coffee and cotton are cash crops, inherently more lucrative than staples; on the other hand, banana and coffee are also tree crops, which represent a fixed investment on the land that farmers need to secure to ensure an appropriate pay off in future time periods. Studying how their prices differently affect land registration should thus shed light on the extent of both the crop profitability and past investment channel.

For each commodity j I therefore run the following regression:

$$y_{ist} = \alpha + \beta l_{sj} \times \log p_{jt-1} + x'_{ist}\gamma + \sum_{t=2005}^{2011} \theta_t + \eta_i + \epsilon_{ist}, \tag{21}$$

where $l_{sj} \times \log p_{jt-1}$ is land harvested with commodity j in sub-county s interacted with the lagged log-price of j, the θ_t's and η_i's are respectively year and household fixed effects, and x' is a vector of covariates.[18] Standard errors are always clustered at the sub-county level.

Results are reported in Tables 5-8. The prices of all crops induce a higher level of activity on the land market, increasing the share of land acquired by purchase.

Turning to the effect on actual land titling, the prices of bananas, coffee and cotton seem to behave in a very similar way, inducing an increase in the acquisition of occupancy titles. For bananas and cotton, prices also significantly decrease the share of untitled land.[19] In Table 8 instead, the situation looks quite different, as corn prices seem to reduce the share of land with formal certificates of title and increase that of unregistered land.

This evidence fits the discussion in Section 7 quite nicely: the prices of crops characterised by a higher market value, as well as requiring a fixed investment on the land in the form of tree plantation, seem to be positively, significantly, and strongly correlated with land registration. The effect is almost perfectly reversed when a staple, temporary crop is considered.

Table 5: The effect of banana prices

VARIABLES	(1) purchase	(2) property right	(3) cert. customary	(4) cert. occupancy	(5) no certificate
banana	0.236**	0.176	-0.019	0.355***	-0.439**
	(0.097)	(0.114)	(0.036)	(0.122)	(0.208)
Observations	6,262	6,262	6,262	6,262	6,262
Number of HH	2,208	2,208	2,208	2,208	2,208
HH fixed effects	YES	YES	YES	YES	YES
Year fixed effects	YES	YES	YES	YES	YES
Additional Controls	YES	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: Column (1): share of land acquired by purchase; (2) share of land for which the household has a formal certificate of title; (3): share of land with a certificate of customary ownership; (4): share of land with a certificate of occupancy; (5): share of land without any certificate. Standard errors are clustered at the sub-county level. The outcome is regressed on household and year fixed effects and an interaction of the lagged log-price of banana with the sub-county-level land harvested with banana. Additional controls include gender, age (linear and square), education and ethnicity of the household head, region fixed effects.

[18] As for the main regressions outlined in Section 4, covariates are gender, age (linear and square), education and ethnicity of the household head, and region fixed effects.

[19] The finding that investment drives improved land titling would also be in line with empirical evidence for various African countries by Baland et al. (1999); Brasselle et al. (2002); Carter et al. (1994); Roth et al. (1994a), who show that farmers tend to register land parcels with higher levels of investment, which have better prospects of profitability justifying the registration expenditures.

Table 6: The effect of coffee prices

VARIABLES	(1) purchase	(2) property right	(3) cert. customary	(4) cert. occupancy	(5) no certificate
coffee	0.137**	0.031	-0.035	0.137**	-0.096
	(0.062)	(0.049)	(0.027)	(0.059)	(0.085)
Observations	6,262	6,262	6,262	6,262	6,262
Number of HH	2,208	2,208	2,208	2,208	2,208
HH fixed effects	YES	YES	YES	YES	YES
Year fixed effects	YES	YES	YES	YES	YES
Additional Controls	YES	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: Column (1): share of land acquired by purchase; (2) share of land for which the household has a formal certificate of title; (3): share of land with a certificate of customary ownership; (4): share of land with a certificate of occupancy; (5): share of land without any certificate. Standard errors are clustered at the sub-county level. The outcome is regressed on household and year fixed effects and an interaction of the lagged log-price of coffee with the sub-county-level land harvested with coffee. Additional controls include gender, age (linear and square), education and ethnicity of the household head, region fixed effects.

Table 7: The effect of cotton prices

VARIABLES	(1) purchase	(2) property right	(3) cert. customary	(4) cert. occupancy	(5) no certificate
cotton	0.147***	0.031	0.021	0.152**	-0.187*
	(0.056)	(0.046)	(0.017)	(0.073)	(0.097)
Observations	6,262	6,262	6,262	6,262	6,262
Number of HH	2,208	2,208	2,208	2,208	2,208
HH fixed effects	YES	YES	YES	YES	YES
Year fixed effects	YES	YES	YES	YES	YES
Additional Controls	YES	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: Column (1): share of land acquired by purchase; (2) share of land for which the household has a formal certificate of title; (3): share of land with a certificate of customary ownership; (4): share of land with a certificate of occupancy; (5): share of land without any certificate. Standard errors are clustered at the sub-county level. The outcome is regressed on household and year fixed effects and an interaction of the lagged log-price of cotton with the sub-county-level land harvested with cotton. Additional controls include gender, age (linear and square), education and ethnicity of the household head, region fixed effects.

Table 8: The effect of corn prices

VARIABLES	(1) purchase	(2) property right	(3) cert. customary	(4) cert. occupancy	(5) no certificate
corn	0.033*	-0.040**	-0.001	-0.007	0.046**
	(0.018)	(0.016)	(0.006)	(0.009)	(0.021)
Observations	6,262	6,262	6,262	6,262	6,262
Number of HH	2,208	2,208	2,208	2,208	2,208
HH fixed effects	YES	YES	YES	YES	YES
Year fixed effects	YES	YES	YES	YES	YES
Additional Controls	YES	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: Column (1): share of land acquired by purchase; (2) share of land for which the household has a formal certificate of title; (3): share of land with a certificate of customary ownership; (4): share of land with a certificate of occupancy; (5): share of land without any certificate. Standard errors are clustered at the sub-county level. The outcome is regressed on household and year fixed effects and an interaction of the lagged log-price of corn with the sub-county-level land harvested with corn. Additional controls include gender, age (linear and square), education and ethnicity of the household head, region fixed effects.

8.2.2 Insecurity

According to the assumptions in Section 7, insecurity should have a positive effect on land registration, and be in turn a positive function of land value.

In Table 9, I test for the reduced-form impact of insecurity on land titles. Insecurity here is measured exploiting the subjective assessment of farmers who report being concerned that someone may dispute their property or use rights on the land.[20] My main regressor of interest is therefore the share of total landholdings on which farmers feel insecure.

Clearly, the effects measured in Table 9 cannot really be regarded as causal, as there might well be reverse causality (higher land titling could for example be expected to bring about lower insecurity). The table, however, is still informative to gauge the correlations between the variables involved, which are indeed quite substantial. Perceived insecurity is correlated with an almost twofold increase the share of land under formal certificates of title with respect to the sample mean, and with a reduction in the share of untitled land by 6 percentage points.[21] In this sense, we can speculate that the reported estimates seem intuitively more suggestive of an effect from insecurity to titling.

Table 9: The insecurity effect

	(1)	(2)	(3)	(4)	(5)
VARIABLES	purchase	property right	cert. customary	cert. occupancy	no certificate
perceived insecurity	0.016	0.130***	-0.005	0.006	-0.060**
	(0.022)	(0.028)	(0.007)	(0.014)	(0.029)
Observations	6,262	6,262	6,262	6,262	6,262
Number of HH	2,208	2,208	2,208	2,208	2,208
Outcome mean	0.275	0.076	0.016	0.054	0.785
HH fixed effects	YES	YES	YES	YES	YES
Year fixed effects	YES	YES	YES	YES	YES
Additional Controls	YES	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: Column (1): share of land acquired by purchase; (2) share of land for which the household has a formal certificate of title; (3): share of land with a certificate of customary ownership; (4): share of land with a certificate of occupancy; (5): share of land without any certificate. Standard errors are clustered at the sub-county level. The outcome is regressed on household and year fixed effects and on the share of land on which the household feels insecure. Land insecurity is defined as the household being concerned that someone may dispute their property or use rights. Additional controls include gender, age (linear and square), education and ethnicity of the household head, region fixed effects.

[20] A land dispute is defined in the LSMS survey as a disagreement, either between specific individuals or against collective interests, over land rights, boundaries or uses.

[21] This result runs contrary to recent findings by Bezu and Holden (2014), who note that a fear of land expropriation may negatively influence the willingness to pay for a land registration certificate, but is consistent with Collin et al. (2012), who find that demand for property rights responds positively to a higher perceived risk of expropriation.

Table 10: The effect of prices on insecurity

VARIABLES	(1) perceived insecurity
price	0.021
	(0.018)
Observations	5,275
Number of HH	1,828
Outcome mean	0.126
HH fixed effects	YES
Year fixed effects	YES
Additional Controls	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: Column (1): share of land on which the household feels insecure. Land insecurity is defined as the household being concerned that someone may dispute their property or use rights. Standard errors are clustered at the sub-county level. The outcome is regressed on household and year fixed effects and on the the log of the lag of a price index. Controls include gender, age (linear and square), education and ethnicity of the household head, region fixed effects. The price index is built as a geometrically-weighted index of agricultural commodity prices, with weights equal to the sub-county-level average acreage of land harvested with each crop as of year 2000.

Having established that insecurity is if anything positively correlated with land registration, in Table 10 I test whether land insecurity is in turn affected by agricultural prices, as Prediction 3 posits. As can be seen from the table though, the aggregate price index per se does not seem to affect farmers' perceptions about land insecurity in a statistically significant way.

Returning to the discussion in Section 7 however, an important qualification of the result is in order. As per Proposition 3, prices increase insecurity through their effect on land value, which as has been shown above is a function of crop profitability and past investment.

In Table 11 I thus run regression (21) for individual crop prices on perceived land insecurity. Here, a 10 percent increase in banana prices causes a significant, sizeable increase by almost 3 percentage points in perceived land insecurity (Column 1), which is equivalent to a staggering 25 percent increase with respect to the overall sample mean. Although none of the other crops analysed produces a significant effect, the signs of the estimated coefficients go in the expected direction: coffee and cotton prices enter the regression equation with a positive sign, corn price with a negative one. Overall, I interpret these results as evidence broadly in favour of a positive effect of prices on perceived insecurity.

In light of this last set of results, it is interesting to notice that in Section 8.2.1 the size of the coefficients on banana prices in Table 5 was at least twice as big as for any of the other crops analysed in Tables 6-8. If we took the joint findings from this subsection and the previous one very seriously, we could go as far as to argue that the evidence for banana prices might indicate that, when active, the insecurity effect is at least as strong as the direct effect of land value in driving the impact of prices on land registration.

Table 11: Perceived insecurity - major export crops

VARIABLES	(1) perceived insecurity	(2) perceived insecurity	(3) perceived insecurity	(4) perceived insecurity
banana	0.290**			
	(0.114)			
coffee		0.045		
		(0.058)		
cotton			0.047	
			(0.044)	
corn				-0.011
				(0.014)
Observations	6,262	6,262	6,262	6,262
Number of HH	2,208	2,208	2,208	2,208
Outcome mean	0.12	0.12	0.12	0.12
HH fixed effects	YES	YES	YES	YES
Year fixed effects	YES	YES	YES	YES
Additional Controls	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: The outcome is the share of land on which the household feels insecure. Standard errors are clustered at the sub-county level. The outcome is regressed on household and year fixed effects and a set of interactions of the log-price of four main export crops with the sub-county-level land harvested with that crop. The four main export crops are: Column (1) bananas; Column (2) coffee; Column (3) cotton; Column (4) corn. Additional controls include gender, age (linear and square), education and ethnicity of the household head, region fixed effects.

8.3 The capability effect

In this subsection, I address the capability effect of increasing crop prices, and check whether agricultural prices have a differential effect on certain socio-economic groups of the population, following patterns of long-established discrimination or privilege.

Various authors (Feder and Nishio, 1999; Feder and Noronha, 1987; Platteau, 1996) have pointed out the inequality threats that lie in the improvement of land tenure, as sections of local populations face a serious risk of being denied legal recognition of their rights to land during the registration process, in favour of wealthier and more powerful individuals. The grabbing of land can take the form of claiming exclusive rights to either open access land or to land held by others who are less informed, or lack the resources to apply for land registration. This is especially true when registration and titling are sporadic (i.e. performed upon demand by individual landholders), and when the cost charged to the individual for registration is high (Feder and Nishio, 1999). At the same time, in the more active market enabled by better enforced property rights, the smallholders and the poor might more easily resort to distress land sales, which may lead to the emergence of a large landless class, with attendant social instability. To the extent that efficiency and equity considerations are not separable due to significant transaction costs, the establishment of stronger property rights might also bring about significant output and efficiency losses, as is the case for example when marginalised land users are critical agricultural producers (Platteau, 1996).

I test for the existence of a capability effect running the following regression:

$$y_{ist} = \alpha + \beta \log P_{st-1} + x'_{ist}\gamma + \delta D_{ist} \times \log P_{st-1} + \zeta D_{ist} + \sum_{t=2005}^{2011} \theta_t + \eta_i + \epsilon_{ist}, \qquad (22)$$

where all variables are as defined in Equation (1) and D is a dummy variable identifying

a certain sub-group of the population. The coefficient of interest is now δ, which measures whether and by how much group D is able to benefit from increasing agricultural price with respect to the rest of the population.

I start by exploring the possibility that the acquisition of title is biased toward the wealthy or well-connected individuals who possess superior knowledge of government bureaucracy and procedures. The claim has found both historical and empirical support in Africa, where many have documented how those obtaining titles tend to be "political friends", to hold or have held political positions, to be better educated, to have larger holdings, and to be heavily engaged in non-farm activities.[22]

I first focus on wealthy households, building an asset ownership index through principal component analysis at baseline[23] and defining a household as wealthy if they belong in the top wealth quintile in their district of residence. Table 12 reports the results. As expected, household wealth is related to having acquired land by purchase, but not to any of the remaining outcome variables.

Table 12: Wealth

	(1)	(2)	(3)	(4)	(5)
VARIABLES	purchase	property right	cert. customary	cert. occupancy	no certificate
price	0.012	0.043**	0.009	0.043**	-0.081***
	(0.012)	(0.019)	(0.010)	(0.017)	(0.030)
price×wealthy	0.051***	-0.014	0.016	0.001	-0.022
	(0.018)	(0.016)	(0.011)	(0.014)	(0.026)
Observations	4,900	4,900	4,900	4,900	4,900
Number of HH	1,651	1,651	1,651	1,651	1,651
Outcome mean	0.269	0.07	0.016	0.058	0.789
HH fixed effects	YES	YES	YES	YES	YES
Year fixed effects	YES	YES	YES	YES	YES
Additional Controls	YES	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: Column (1): share of land acquired by purchase; (3) share of land for which the household has a formal certificate of title; (4): share of land with a certificate of customary ownership; (5): share of land with a certificate of occupancy; (6): share of land without any certificate. Standard errors are clustered at the sub-county level. The outcome is regressed on household and year fixed effects, the log of the lag of a price index, an indicator for belonging to the highest wealth quintile in the district, and an interaction of the latter two. Controls include gender, age (linear and square), education and ethnicity of the household head, region fixed effects. The price index is built as a geometrically-weighted index of agricultural commodity prices, with weights equal to the sub-county-level average acreage of land harvested with each crop as of year 2000.

Then, I perform the exercise proxying the extent of a household's political connections by whether they report having at least one family member who serves in a local council.[24] Results are shown in Table 13. Contrary to wealth, connections to local politicians cause a decrease in

[22]See e.g. Roth (1993) and Roth et al. (1994b), for Somalia; Doornbos (1975) and Noronha (1985), for Uganda; Zubair (1987), for Nigeria. More recently, Carter and Olinto (2003) have argued that given an estimated pattern of wealth-biased liquidity constraints, property rights reform will benefit only wealthier producers, and Goldstein and Udry (2008) have shown for Ghana that individuals holding powerful positions in a local political hierarchy have more secure tenure rights.

[23]More information on the wealth measure is provided in the Appendix.

[24]The Ugandan local government system has a pyramidal structure formed by the village (LC1), parish (LC2), sub-county (LC3), county (LC4), and district (LC5) in rural areas. The political organ at all levels is the council, whose members are elected in regular elections and represent specific electoral areas or interest groups (cf. Steiner, 2006 for details). Here, I have information on whether individuals are councillors in an LC1, LC2 or LC3.

the share of purchased land: as counter-intuitive as this result may sound however, the finding mirrors evidence from Goldstein and Udry (2008), whereby politically connected farmers rely less on formal land arrangements precisely because their political ties serve as a substitute source of tenure security. Again however, a relatively powerful social position does not seem to provide a strong comparative advantage when it comes to the acquisition of land titles per se.

Table 13: Political connections

VARIABLES	(1) purchase	(2) property right	(3) cert. customary	(4) cert. occupancy	(5) no certificate
price	0.029**	0.037*	0.015	0.039**	-0.083**
	(0.012)	(0.021)	(0.011)	(0.015)	(0.034)
price × politician	-0.047***	0.010	-0.017	0.019	0.011
	(0.018)	(0.034)	(0.011)	(0.023)	(0.058)
Observations	5,267	5,267	5,267	5,267	5,267
Number of HH	1,827	1,827	1,827	1,827	1,827
Outcome mean	0.269	0.072	0.016	0.06	0.785
HH fixed effects	YES	YES	YES	YES	YES
Year fixed effects	YES	YES	YES	YES	YES
Additional Controls	YES	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: Column (1): share of land acquired by purchase; (3) share of land for which the household has a formal certificate of title; (4): share of land with a certificate of customary ownership; (5): share of land with a certificate of occupancy; (6): share of land without any certificate. Standard errors are clustered at the sub-county level. The outcome is regressed on household and year fixed effects, the log of the lag of a price index, an indicator for being related to a local council member, and an interaction of the latter two. Controls include gender, age (linear and square), education and ethnicity of the household head, region fixed effects. The price index is built as a geometrically-weighted index of agricultural commodity prices, with weights equal to the sub-county-level average acreage of land harvested with each crop as of year 2000.

As belonging to a privileged group does not appear to matter much for land registration, I then turn my attention to potentially marginalised segments of society.

As a first disadvantaged group, I consider households headed by women. Many recent studies (USAid, 2010; Bomuhangi et al., 2011; and Goldstein et al., 2016, among others) document how, in spite of recent legal provisions for equitable ownership of land, women are still handicapped by formal and customary land systems, which make them vulnerable to expropriation, land-grabbing by an ex-husband or by relatives of a deceased husband, and inheritance loss. Although many elite-class women now purchase land and have reasonably secure titles on it moreover, in the late 2000s women still owned less than 8 percent of the land, despite heading 26 percent of rural households and growing between 70 percent and 80 percent of the harvest from food crops in the country (USAid, 2010).

Results are reported in Table 14, where it however looks as if women were not particularly penalised on the land titling market. If anything, they are acquiring more land by purchase than men are. This result might either represent encouraging news (if women face less barriers on the land market) or may reflect the fact that women are often formally excluded by land transfers by inheritance (Migot-Adholla et al., 1994). In any case, it does not seem to affect the amount of titled land owned by women-headed households.

Table 14: Women-headed households

VARIABLES	(1) purchase	(2) property right	(3) cert. customary	(4) cert. occupancy	(5) no certificate
price	0.009	0.042**	0.015	0.044***	-0.080***
	(0.012)	(0.020)	(0.010)	(0.016)	(0.028)
price × female head	0.053**	-0.011	-0.008	-0.005	-0.010
	(0.027)	(0.020)	(0.009)	(0.016)	(0.026)
Observations	5,275	5,275	5,275	5,275	5,275
Number of HH	1,828	1,828	1,828	1,828	1,828
Outcome mean	0.269	0.072	0.016	0.06	0.785
HH fixed effects	YES	YES	YES	YES	YES
Year fixed effects	YES	YES	YES	YES	YES
Additional Controls	YES	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: Column (1): share of land acquired by purchase; (3) share of land for which the household has a formal certificate of title; (4): share of land with a certificate of customary ownership; (5): share of land with a certificate of occupancy; (6): share of land without any certificate. Standard errors are clustered at the sub-county level. The outcome is regressed on household and year fixed effects, the log of the lag of a price index, and an interaction of the price index with an indicator for female household head. Controls include gender, age (linear and square), education and ethnicity of the household head, region fixed effects. The price index is built as a geometrically-weighted index of agricultural commodity prices, with weights equal to the subcounty-level average acreage of land harvested with each crop as of year 2000.

As a further marginalised group, I then investigate the effects of belonging to an ethnic minority. I define ethnic minorities as households whose head does not belong to the predominant group in their district of residence, measured as the ethnicity with the highest share in total district population according to a 10 percent sample of the 2002 Ugandan Population and Household Census (Bureau of Statistics, Uganda).[25]

Table 15: Non-predominant ethnicity

VARIABLES	(1) purchase	(2) property right	(3) cert. customary	(4) cert. occupancy	(5) no certificate
price	0.015	0.034	0.016	0.040**	-0.074**
	(0.016)	(0.029)	(0.011)	(0.017)	(0.033)
price × non-predominant	0.013	0.010	-0.007	0.006	-0.016
	(0.016)	(0.022)	(0.011)	(0.020)	(0.034)
Observations	5,275	5,275	5,275	5,275	5,275
Number of HH	1,828	1,828	1,828	1,828	1,828
Outcome mean	0.269	0.072	0.016	0.06	0.785
HH fixed effects	YES	YES	YES	YES	YES
Year fixed effects	YES	YES	YES	YES	YES
Additional Controls	YES	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: Column (1): share of land acquired by purchase; (3) share of land for which the household has a formal certificate of title; (4): share of land with a certificate of customary ownership; (5): share of land with a certificate of occupancy; (6): share of land without any certificate. Standard errors are clustered at the sub-county level. The outcome is regressed on household and year fixed effects, the log of the lag of a price index, an indicator for not belonging to the predominant ethnicity in the district, and an interaction of the latter two. Controls include gender, age (linear and square), education and ethnicity of the household head, region fixed effects. The price index is built as a geometrically-weighted index of agricultural commodity prices, with weights equal to the sub-county-level average acreage of land harvested with each crop as of year 2000.

Results are reported in Table 15, but are again not suggestive of a strong differential effect of agricultural prices on land tenure along ethnic lines.

To summarise the evidence so far, the capability effect outlined in Section 7 does not seem to influence farmers' incentives towards registering their land, through differential opportunities

[25]More details on geographical divisions along ethnic lines are reported in Appendix E.

afforded by their relative position in their social context of reference. The only outcome that seems to be affected by social position is the share of land acquired by purchase, although that too in a non-systematic way.

8.4 What role for social capital?

In Assumptions 4 and 5 above, both insecurity and capability depend on the social capital in the context of reference. Although the concept is quite broad in scope and multi-faceted, I here intend social capital as defined by the Organisation for Economic Co-operation and Development, as "networks together with shared norms, values and understandings that facilitate co-operation within or among groups". By definition then, one would expect an economy with a high level of social capital to enable smoother, better-functioning land markets, and hence to improve the capability of individuals to benefit from their land.

I proxy social capital with a measure of ethnic concentration in each district, in line with existing research (cf. Alesina et al., 2003; Easterly and Levine, 1997; La Porta et al., 1999) showing that ethnic fragmentation is negatively correlated with various measures of government performance, institutional quality, and economic growth.

I measure ethnic concentration by the Herfindahl-Hirschman index, using data from a 10 percent sample of the 2002 Ugandan Census. Given a population composed of $i = 1 \dots N$ ethnic groups, each one with population share s_i, the Herfindahl-Hirschman index is the sum of the squared ethnic shares:

$$HHI = \sum_{i=1}^{N} s_i^2. \tag{23}$$

Higher values of the index describe a district with a more concentrated ethnic composition, lower values a more fractionalised one. Here, I consider an ethnic area to be highly concentrated if it belongs to the top quartile of the distribution of the Herfindahl-Hirschman index across the country.

In light of existing discussion in the literature on the additional harmful effects of ethnic polarisation (cf. Alesina et al., 2003; Esteban and Ray, 1994; Garcia-Montalvo and Reynal-Querol, 2002), in Appendix Section F I also replicate the analysis in this subsection proxying high social capital with ethnic concentration *and* non-polarisation, and defining low social capital as polarisation (more details on the construction of the polarisation measure in Appendix Section F): as all results in this subsection are robust to the exercise, albeit at times slightly less precisely estimated, I report here only the findings obtained using the simple measure of ethnic concentration in Equation (23).

As a preliminary test on the overall effect of social capital, I run Equation (22) interacting the price index with my indicator for an ethnically concentrated area. Results are reported in Table 16, and portray a rather complex picture: social capital seems to positively affect certificates of customary ownership, but negatively certificates of occupancy.

Table 16: Social capital

VARIABLES	(1) purchase	(2) property right	(3) cert. customary	(4) cert. occupancy	(5) no certificate	(6) perceived insecurity
price	0.024*	0.033**	0.007	0.055**	-0.080***	0.034
	(0.012)	(0.014)	(0.007)	(0.022)	(0.029)	(0.023)
price × social capital	-0.007	0.024	0.022**	-0.045**	-0.010	-0.050*
	(0.013)	(0.026)	(0.011)	(0.018)	(0.035)	(0.025)
Observations	5,275	5,275	5,275	5,275	5,275	5,275
Number of HH	1,828	1,828	1,828	1,828	1,828	1,828
Outcome mean	0.269	0.072	0.016	0.06	0.785	0.126
HH fixed effects	YES	YES	YES	YES	YES	YES
Year fixed effects	YES	YES	YES	YES	YES	YES
Additional Controls	YES	YES	YES	YES	YES	YES

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Notes: Column (1): share of land acquired by purchase; (2) share of land for which the household has a formal certificate of title; (3): share of land with a certificate of customary ownership; (4): share of land with a certificate of occupancy; (5): share of land without any certificate; (6): share of land on which the household feels insecure. Land insecurity is defined as the household being concerned that someone may dispute their property or use rights. Standard errors are clustered at the sub-county level. The outcome is regressed on household and year fixed effects, the log of the lag of a price index, an indicator for high social capital, and an interaction of the latter two. Controls include gender, age (linear and square), education and ethnicity of the household head, region fixed effects. The price index is built as a geometrically-weighted index of agricultural commodity prices, with weights equal to the sub-county-level average acreage of land harvested with each crop as of year 2000. High social capital is proxied by ethnically concentrated areas (top quartile of the Herfindahl-Hirschman concentration index on ethnic population shares).

The effect on customary ownership is the most intuitive, as when social capital is higher, almost by definition one would expect social norms and traditions, here including those governing land ownership rights, to be more inclusive. The result on certificates of occupancy is instead less straightforward, and needs further exploring. The last column of Table 16 also explores the effect of social capital on insecurity, postulated in Assumption 4. Here, the coefficient on the interaction between prices and social capital is negative and significant: a ten percent increase in prices reduces perceived insecurity by 0.5 percentage points in areas with a higher social capital.

Now turning to the impact of social capital on capabilities introduced in Assumption 5, in Table 17 I test whether the impacts analysed in Section 8.3 above differ between high and low social capital areas. Each panel of the Table replicates the analysis performed in Section 8.3 for the effect of social position, splitting the sample in areas with high and low social capital, respectively. The last row of each panel reports the significance level for the test of equality of the coefficients obtained in the two samples.

The main finding emerging from Table 17 is that, regardless of the specific outcome variables affected in each case, social capital appears to have an equality-enhancing effect along most dimensions. This means that, among the differences between coefficients in high and low social capital areas, the ones that are statistically significant are negative for privileged groups and positive for the weaker ones: the wealthy and those with political connections are at a relative disadvantage in high with respect to low social capital areas; women benefit more in the former than in the latter.

The result goes exactly in the direction predicted by the theory outlined in Section 7. The only significant, yet somehow foreseeable, exception is represented by Panel D in the Table, where ethnic minorities are shown to be strongly penalised where social capital is higher. The most relevant result is the one in Column 3 for formal certificates of title: while in low social

capital settings ethnic minorities respond to 10 percent higher prices increasing their share of titled land by almost 0.4 percentage points, where social capital is stronger their share of titled land is actually 1.5 percentage points *lower* - an effect of opposite size, and more than three times as strong, as in the other sub-sample.

Despite being rather counter-intuitive at first sight, the results from Table 17D can nevertheless be quite readily explained. Recall that social capital in this section has been proxied by ethnic concentration: in this light, it is not so hard to imagine that, in the areas whose ethnic composition is more homogeneous, it may become increasingly difficult for those not belonging to the predominant group to establish themselves and to keep a relatively high social status. On the other hand, fractionalised areas will likely better provide a level playing field - at least along ethnic lines.

Table 17: Social position and social capital

(a) SOCIAL POSITION	(b) SOCIAL CAPITAL	(1) purchase	(2) property right	(3) cert. customary	(4) cert. occupancy	(5) no certificate
Panel A						
	high	0.004	-0.058**	0.012	-0.003	0.020
		(0.046)	(0.026)	(0.032)	(0.018)	(0.067)
wealthy	low	0.057***	-0.002	0.022**	-0.004	-0.035
		(0.020)	(0.016)	(0.011)	(0.017)	(0.028)
	difference		*			
Panel B						
	high	-0.022	-0.055	-0.048**	-0.039**	0.164**
		(0.021)	(0.036)	(0.023)	(0.016)	(0.064)
politician	low	-0.052**	0.038	-0.018	0.044*	-0.041
		(0.024)	(0.033)	(0.012)	(0.024)	(0.046)
	difference		*		***	***
Panel C						
	high	0.017	-0.028	0.042	0.066**	-0.206***
		(0.046)	(0.030)	(0.029)	(0.029)	(0.076)
female head	low	0.057*	-0.004	-0.006	-0.021	0.009
		(0.031)	(0.020)	(0.009)	(0.016)	(0.025)
	difference				***	***
Panel D						
	high	-0.056	-0.148*	-0.100***	-0.048	0.205**
		(0.092)	(0.078)	(0.032)	(0.031)	(0.095)
non-predominant	low	0.015	0.036*	0.008	-0.006	-0.052*
		(0.022)	(0.020)	(0.010)	(0.023)	(0.031)
	difference		**	***		***

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: Column (1): share of land acquired by purchase; (2) share of land for which the household has a formal certificate of title; (3): share of land with a certificate of customary ownership; (4): share of land with a certificate of occupancy; (5): share of land without any certificate. Standard errors are clustered at the sub-county level. The outcome is regressed on household and year fixed effects, the log of the lag of a price index, an indicator for belonging to the category displayed in Column (a), and an interaction of the latter two. The regression is performed on the sub-sample identified in Column (b). Controls include gender, age (linear and square), education and ethnicity of the household head, region fixed effects. The price index is built as a geometrically-weighted index of agricultural commodity prices, with weights equal to the sub-county-level average acreage of land harvested with each crop as of year 2000. Wealthy is an indicator for belonging to the highest wealth quintile in the district. Local council is an indicator for being related to a local council member. Female head is an indicator for female household head. Non-predominant is an indicator for not belonging to the predominant ethnicity in the district. High and low social capital is proxied by ethnically concentrated and fractionalised areas, respectively. Concentrated and fractionalised areas are those belonging to the top 25 and bottom 75 percent of the distribution of the Herfindahl-Hirschman concentration index on ethnic population shares.

9 Conclusion

This paper has investigated the relationship between agricultural commodity prices and individual demand for land tenure in Uganda. Using information on the tenure and transactions on the land harvested by Ugandan farmers over a six-year time span, the analysis has shown that increasing agricultural prices induce households to increase their share of titled land.

I have interpreted my findings as evidence of a combination of an income and incentive effect, and shown that they also significantly depend on the farmer's relative position in their social context of reference, as well as on existing levels of social capital.

In light of the benefits of a well-established system of property rights and of clear land titles, discussed extensively in Section 2, land reform has recently been high on the agenda of International Organisations and of the governments of many developing countries (the World Bank alone for example is, at the time of writing, implementing at least ten different major rural land tenure programmes in various parts of the world, with the aim of improving tenure security and land registration, and to strengthen institutional quality[26]). Policy efforts on the supply side however are bound to be meaningless in the absence of an adequate uptake on the part of the target beneficiaries. In this sense, understanding the determinants of individual demand for land registration is crucial to guide current and future reform and to make public investment cost-effective.

The results in this paper suggest that a context of increasing crop prices may be a fertile ground for the establishment of wider-spread formal property rights on agricultural land. I have nonetheless also shown that these positive effects appear to be mostly in favour of the rich and of "political friends" in a context of low social capital, and of ethnic majorities in ethnically concentrated areas. This finding lends empirical evidence to recent theoretical claims by Glaeser et al. (2016), who contend that demand for formality is higher where justice is more fairly administered, and that, when it is not, the strong will have a greater demand for formality or title than the weak. Their analysis is also in line with my findings on the equalising effects of social capital.

As long as the positive effects of land registration are felt differentially by different subsets of the population, and being part of local elites represents a source of comparative advantage, favourable prices may therefore even generate new distortions in the economy. This in turn (let alone concerns in terms of equity) would be likely to result in an inefficient allocation of resources or at worst in social unrest, in any case potentially watering down whatever positive effects land registration might bring about per se. In this sense, appropriate policies are needed to tackle the underlying patterns of inequality of a country, lest what could potentially be a positive shock reinforces, rather than reducing, existing systems of allocative inefficiency and privilege.

Moreover, another important qualification of the discussion thus far is that the analysis performed here has largely abstracted from any general equilibrium effects, which instead clearly need to be taken into account when designing policy. For instance, nothing has been

[26]Source: World Bank Projects and Operations website, accessed November 2016.

said on whether farmers in my sample are net producers or consumers - which of course could make the implications of rising crop (read: food) prices very different in the two cases (cf. e.g. Winters et al., 2004). The same applies to any impacts on the prices of other goods, or even on employment. It also has to be noted that the households in my sample are predominantly small farmers (the median parcel size in my sample is 2.71 acres): in this respect, it may well be that incentives faced by medium-sized (not to mention bigger) agricultural entrepreneurs are partially different.

At any rate however, the evidence provided by this paper still identifies a set of mechanisms that, *ceteris paribus*, are shaping the reaction of individual demand for land registration to changing market conditions. To the extent that the diffusion of formal property rights spurs investment, output, and other less production-oriented variables like inequality reduction or, say, land conservation, uncovering these mechanisms is an essential step to ensure that an economy that envisages undertaking land reform will actually be able to reap the benefits of its future improved institutional framework.

Appendix

A Commodity prices

A.1 Price series

I use the IMF International Financial Statistics database to retrieve price data for banana, coffee, corn, cotton, ground nuts, rice, sorghum, soy beans, and sugar. Some of these price indices are obtained as simple averages of various series:

- Coffee prices are calculated using an average of Brazilian, Brazilian (U.S.), Ugandan (U.S.), and Other coffee prices (U.S.)
- Ground nuts prices are calculated using an average of Nigerian and European prices.
- Rice prices are calculated using an average of two series of Thailand rice prices.
- Soy beans prices are calculated using an average of three US (Rotterdam) prices.
- Sugar prices are calculated by using an average of five Caribbean, U.S., and E.U. prices.

I use the US Bureau of Labour Statistics data to have price series for two comprehensive categories: cereals and other vegetable products. In the price index in Equation (2), the former price is weighted by GAEZ land harvested in millet, the latter by land harvested in potatoes, pulses, and a residual "other vegetables". Prices from US LBS are calculated as a simple average of monthly price data.

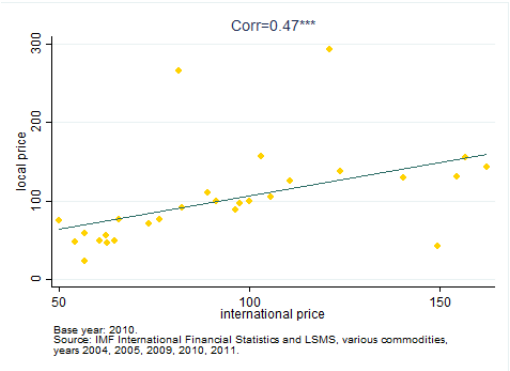
I index all price series with 2010=100.

A.2 Price pass-through

World prices are used to avoid the endogeneity created by the use of local farm-gate prices, which are determined by local market conditions that may contemporaneously affect farmers' production decisions as well as their demand for land rights. Considering how secluded many rural communities in Uganda might be however, there is a non-negligible risk that international price shocks are not transmitted to local markets, making world prices a bad predictor of the ones actually faced by Ugandan producers. The concern is echoed by recent research by the Food and Agriculture Organisation (MAFAP, 2013), showing that farm-gate prices in the country are often only weakly related to export prices. Despite the high likelihood of incomplete price transmission, for my purposes I only need a certain extent of co-movement between international and domestic prices: if that were the case, international price changes would still be representative of the price dynamics faced by local farmers, though surely not an accurate proxy of the actual price levels obtained in each rural community.

A proper test of the degree of price transmission would require a number of time series techniques like cointegration or error correction mechanism: however, I do not have enough data points to perform such analysis. To assess the correlation between international and domestic prices, I infer local prices from the household survey, using farmers' self-reported sale value for each crop divided by the quantity they report having sold rather than used otherwise. Given the noisiness of the data, I take the median price for each crop in all sub-counties, and then consider the median of these medians. I then index all prices with 2010=100, and compare the data thus obtained with my international prices. Figure A.1 shows that, although as expected the correlation is not exceedingly high, the two sets of prices are indeed positively, significantly correlated. Even though international prices do not account for much of the variation in the domestic ones, they do therefore look like a valid instrument for my analysis.

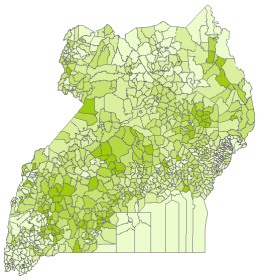
Figure A.1: Price transmission from international to local prices



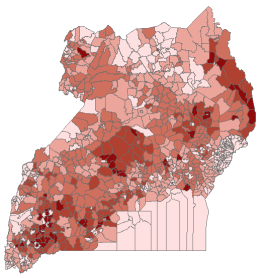
B Land use maps

Figure B.2: Land use, Uganda 2000

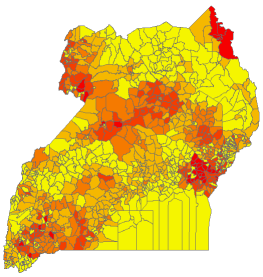
(a) Bananas



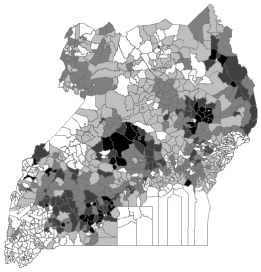
(b) Coffee



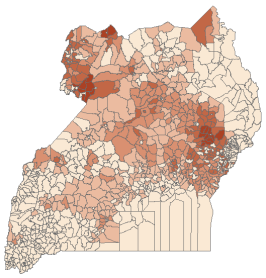
(c) Corn



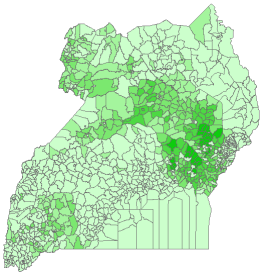
(d) Cotton



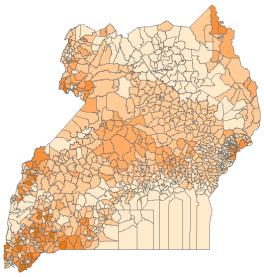
(e) Ground nuts



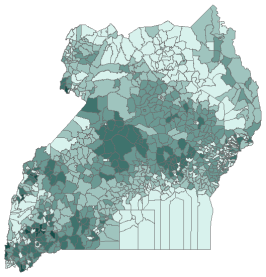
(f) Millet



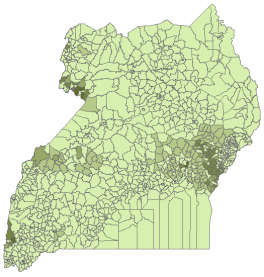
(g) Potatoes



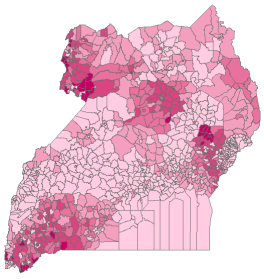
(h) Pulses



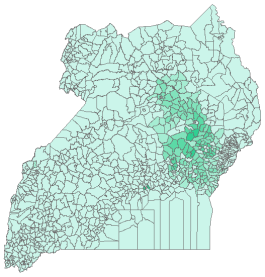
(i) Rice



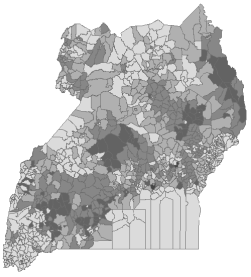
(j) Sorghum



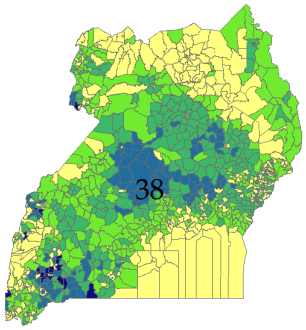
(k) Soy beans



(l) Sugar cane



(m) Other vegetables



Source: Own calculations using land use data from the FAO and IIASA Global Agro-Ecological Zones (GAEZ) project.

C Robustness checks

Table C.1: Excluding year 2005

VARIABLES	(1) purchase	(2) property right	(3) cert. customary	(4) cert. occupancy	(5) no certificate
price	0.099	-0.064	0.031	0.237***	-0.205*
	(0.089)	(0.087)	(0.039)	(0.084)	(0.114)
Observations	3,772	3,772	3,772	3,772	3,772
Number of HH	1,676	1,676	1,676	1,676	1,676
Outcome mean	0.284	0.082	0.018	0.083	0.722
HH fixed effects	YES	YES	YES	YES	YES
Year fixed effects	YES	YES	YES	YES	YES
Additional Controls	YES	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: Column (1): share of land acquired by purchase; (2) share of land for which the household has a formal certificate of title; (3): share of land with a certificate of customary ownership; (4): share of land with a certificate of occupancy; (5): share of land without any certificate. Standard errors are clustered at the sub-county level. The outcome is regressed on household and year fixed effects and the log of the lag of a price index. Controls include gender, age (linear and square), education and ethnicity of the household head, region fixed effects. The price index is built as a geometrically-weighted index of agricultural commodity prices, with weights equal to the sub-county-level average acreage of land harvested with each crop as of year 2000. The analysis is performed only on the years 2009, 2010, 2011.

Table C.2: Price index as arithmetic mean

VARIABLES	(1) purchase	(2) cert. title	(3) cert. customary	(4) cert. occupancy	(5) no certificate
price	0.018	0.038*	0.015	0.038**	-0.080***
	(0.012)	(0.020)	(0.010)	(0.015)	(0.026)
Observations	5,275	5,275	5,275	5,275	5,275
Number of HH	1,828	1,828	1,828	1,828	1,828
Outcome mean	0.269	0.072	0.016	0.06	0.785
HH fixed effects	YES	YES	YES	YES	YES
Year fixed effects	YES	YES	YES	YES	YES
Additional Controls	YES	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: Column (1): share of land acquired by purchase; (2) share of land for which the household has a formal certificate of title; (3): share of land with a certificate of customary ownership; (4): share of land with a certificate of occupancy; (5): share of land without any certificate. Standard errors are clustered at the sub-county level. The outcome is linearly regressed on year fixed effects, the log of the lag of a price index, and household fixed effects. Controls include gender, age (linear and square), education and ethnicity of the household head, region fixed effects. The price index is built as an arithmetically-weighted index of agricultural commodity prices, with weights equal to the sub-county-level average acreage of land harvested with each crop as of year 2000.

Table C.3: Weights built as subcounty-level crop suitability of land

VARIABLES	(1) purchase	(2) property right	(3) cert. customary	(4) cert. occupancy	(5) no certificate
price	0.692	1.054	-0.370	3.313***	-4.894***
	(0.643)	(0.803)	(0.283)	(0.565)	(1.094)
Observations	6,262	6,262	6,262	6,262	6,262
Number of HH	2,208	2,208	2,208	2,208	2,208
Outcome mean	0.275	0.076	0.016	0.054	0.785
HH fixed effects	YES	YES	YES	YES	YES
Year fixed effects	YES	YES	YES	YES	YES
Additional Controls	YES	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: Column (1): share of land acquired by purchase; (2) share of land for which the household has a formal certificate of title; (3): share of land with a certificate of customary ownership; (4): share of land with a certificate of occupancy; (5): share of land without any certificate. Standard errors are clustered at the sub-county level. The outcome is regressed on household and year fixed effects and the log of the lag of a price index. Controls include gender, age (linear and square), education and ethnicity of the household head, region fixed effects. The price index is built as a geometrically-weighted index of agricultural commodity prices, with weights equal to the sub-county-level average crop suitability of land for each crop.

Table C.4: Weights as subcounty-level land use predicted by crop suitability

VARIABLES	(1) purchase	(2) property right	(3) cert. customary	(4) cert. occupancy	(5) no certificate
price	-0.010	0.008	0.008	0.087**	-0.121**
	(0.023)	(0.025)	(0.011)	(0.040)	(0.061)
Observations	6,262	6,262	6,262	6,262	6,262
Number of HH	2,208	2,208	2,208	2,208	2,208
Outcome mean	0.275	0.076	0.016	0.054	0.785
HH fixed effects	YES	YES	YES	YES	YES
Year fixed effects	YES	YES	YES	YES	YES
Additional Controls	YES	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: Column (1): share of land acquired by purchase; (2) share of land for which the household has a formal certificate of title; (3): share of land with a certificate of customary ownership; (4): share of land with a certificate of occupancy; (5): share of land without any certificate. Standard errors are clustered at the sub-county level. The outcome is regressed on household and year fixed effects and the log of the lag of a price index. Controls include gender, age (linear and square), education and ethnicity of the household head, region fixed effects. The price index is built as a geometrically-weighted index of agricultural commodity prices, with weights equal to the sub-county-level average acreage of land harvested with each crop as of year 2000, predicted by crop suitability data.

Table C.5: 5-year price trend

VARIABLES	(1) purchase	(2) property right	(3) cert. customary	(4) cert. occupancy	(5) no certificate
price	-0.003	-0.048**	0.010	0.077**	-0.042
	(0.020)	(0.020)	(0.015)	(0.039)	(0.037)
Observations	3,789	3,789	3,789	3,789	3,789
Number of HH	1,671	1,671	1,671	1,671	1,671
Outcome mean	0.285	0.082	0.018	0.083	0.723
HH fixed effects	YES	YES	YES	YES	YES
Year fixed effects	YES	YES	YES	YES	YES
Additional Controls	YES	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: Column (1): share of land acquired by purchase; (2) share of land for which the household has a formal certificate of title; (3): share of land with a certificate of customary ownership; (4): share of land with a certificate of occupancy; (5): share of land without any certificate. Standard errors are clustered at the sub-county level. The outcome is regressed on household and year fixed effects and the log of a price index. Controls include gender, age (linear and square), education and ethnicity of the household head, region fixed effects. The price index is built as a geometrically-weighted index of the change in agricultural commodity prices over the past 5 years, with weights equal to the sub-county-level average acreage of land harvested with each crop as of year 2000.

Table C.6: Weights as household land use choices

VARIABLES	(1) purchase	(2) property right	(3) cert. customary	(4) cert. occupancy	(5) no certificate
price	-0.038*	0.017	0.002	0.023*	-0.020
	(0.019)	(0.017)	(0.007)	(0.013)	(0.024)
Observations	6,111	6,111	6,111	6,111	6,111
Number of HH	2,179	2,179	2,179	2,179	2,179
Outcome mean	0.274	0.076	0.016	0.054	0.786
HH fixed effects	YES	YES	YES	YES	YES
Year fixed effects	YES	YES	YES	YES	YES
Additional Controls	YES	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: Column (1): share of land acquired by purchase; (2) share of land for which the household has a formal certificate of title; (3): share of land with a certificate of customary ownership; (4): share of land with a certificate of occupancy; (5): share of land without any certificate. Standard errors are clustered at the sub-county level. The outcome is regressed on household and year fixed effects and the log of the lag of a price index. Controls include gender, age (linear and square), education and ethnicity of the household head, region fixed effects. The price index is built as a geometrically-weighted index of agricultural commodity prices, with weights equal to the average acreage of land harvested by the household with each crop in each period.

Table C.7: Weights as household land use choices (fixed land share, beginning of period)

VARIABLES	(1) purchase	(2) property right	(3) cert. customary	(4) cert. occupancy	(5) no certificate
price	-0.029	0.019	-0.000	0.032**	-0.020
	(0.019)	(0.016)	(0.007)	(0.014)	(0.026)
Observations	5,739	5,739	5,739	5,739	5,739
Number of HH	1,912	1,912	1,912	1,912	1,912
Outcome mean	0.275	0.075	0.017	0.052	0.797
HH fixed effects	YES	YES	YES	YES	YES
Year fixed effects	YES	YES	YES	YES	YES
Additional Controls	YES	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: Column (1): share of land acquired by purchase; (2) share of land for which the household has a formal certificate of title; (3): share of land with a certificate of customary ownership; (4): share of land with a certificate of occupancy; (5): share of land without any certificate. Standard errors are clustered at the sub-county level. The outcome is regressed on household and year fixed effects and the log of the lag of a price index. Controls include gender, age (linear and square), education and ethnicity of the household head, region fixed effects. The price index is built as a geometrically-weighted index of agricultural commodity prices, with weights equal to beginning-of-period average acreage of land harvested by the household with each crop.

Table C.8: Weights as household land use choices (fixed land share, average over sample period)

VARIABLES	(1) purchase	(2) property right	(3) cert. customary	(4) cert. occupancy	(5) no certificate
price	0.001	0.021	0.000	0.071***	-0.024
	(0.025)	(0.019)	(0.009)	(0.018)	(0.033)
Observations	6,153	6,153	6,153	6,153	6,153
Number of HH	2,157	2,157	2,157	2,157	2,157
Outcome mean	0.272	0.076	0.016	0.053	0.786
HH fixed effects	YES	YES	YES	YES	YES
Year fixed effects	YES	YES	YES	YES	YES
Additional Controls	YES	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: Column (1): share of land acquired by purchase; (2) share of land for which the household has a formal certificate of title; (3): share of land with a certificate of customary ownership; (4): share of land with a certificate of occupancy; (5): share of land without any certificate. Standard errors are clustered at the sub-county level. The outcome is regressed on household and year fixed effects and the log of the lag of a price index. Controls include gender, age (linear and square), education and ethnicity of the household head, region fixed effects. The price index is built as a geometrically-weighted index of agricultural commodity prices, with weights equal to the acreage of land harvested by the household with each crop averaged over the entire sample period.

Table C.9: Tobit model

VARIABLE	(1) purchase	(2) property right	(3) cert. customary	(4) cert. occupancy	(5) no certificate
price	0.104***	0.954***	2.840***	2.882***	-0.571***
	(0.001)	(0.003)	(0.006)	(0.002)	(0.001)
Observations	5,449	5,449	5,449	5,449	5,449
Outcome mean	0.269	0.071	0.015	0.06	0.787
Sub-county fixed effects	YES	YES	YES	YES	YES
HH fixed effects	NO	NO	NO	NO	NO
Year fixed effects	YES	YES	YES	YES	YES
Additional Controls	YES	YES	YES	YES	YES

Robust standard errors in parentheses
*** p¡0.01, ** p¡0.05, * p¡0.1

Notes: Column (1): share of land acquired by purchase; (2) share of land for which the household has a formal certificate of title; (3): share of land with a certificate of customary ownership; (4): share of land with a certificate of occupancy; (5): share of land without any certificate. Standard errors are clustered at the sub-county level. The analysis is performed via Tobit regression. The outcome is constrained to be between 0 and 1, and is regressed on year fixed effects, the log of the lag of a price index, and sub-county fixed effects. Controls include gender, age (linear and square), education and ethnicity of the household head, region fixed effects. The price index is built as a geometrically-weighted index of agricultural commodity prices, with weights equal to the sub-county-level average acreage of land harvested with each crop as of year 2000.

Table C.10: Asymmetric responses to prices

VARIABLES	(1) purchase	(2) property right	(3) cert. customary	(4) cert. occupancy	(5) no certificate
Panel A			Increased share		
price	-0.075	0.012	0.005	0.211**	-0.428***
	(0.105)	(0.086)	(0.039)	(0.094)	(0.103)
Observations	3,370	3,370	3,370	3,370	3,370
Number of HH	1,517	1,517	1,517	1,517	1,517
Outcome mean	0.184	0.074	0.021	0.077	0.16
HH fixed effects	YES	YES	YES	YES	YES
Year fixed effects	YES	YES	YES	YES	YES
Additional Controls	YES	YES	YES	YES	YES
Panel B			Decreased share		
price	-0.224**	-0.148**	0.007	-0.070	0.159
	(0.092)	(0.060)	(0.010)	(0.051)	(0.108)
Observations	3,370	3,370	3,370	3,370	3,370
Number of HH	1,517	1,517	1,517	1,517	1,517
Outcome mean	0.14	0.053	0.018	0.033	0.26
HH fixed effects	YES	YES	YES	YES	YES
Year fixed effects	YES	YES	YES	YES	YES
Additional Controls	YES	YES	YES	YES	YES
Panel C			Unchanged share		
price	0.298***	0.136	-0.012	-0.141	0.269**
	(0.096)	(0.115)	(0.039)	(0.091)	(0.136)
Observations	3,370	3,370	3,370	3,370	3,370
Number of HH	1,517	1,517	1,517	1,517	1,517
Outcome mean	0.676	0.873	0.961	0.89	0.58
HH fixed effects	YES	YES	YES	YES	YES
Year fixed effects	YES	YES	YES	YES	YES
Additional Controls	YES	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: Column (1): share of land acquired by purchase; (2) share of land for which the household has a formal certificate of title; (3): share of land with a certificate of customary ownership; (4): share of land with a certificate of occupancy; (5): share of land without any certificate. Standard errors are clustered at the sub-county level. The dependent variable is a dummy for whether the household increased (Panel A), decreased (Panel B), or left unchanged (Panel C) the share of land under each latent outcome variable from one period to the next. The dependent variable is linearly regressed on year fixed effects, the log of the lag of a price index, and household fixed effects. Controls include gender, age (linear and square), education and ethnicity of the household head, region fixed effects, lagged latent outcome variable. The price index is built as a geometrically-weighted index of agricultural commodity prices, with weights equal to the sub-county-level average acreage of land harvested with each crop as of year 2000.

D Household wealth

The wealth indicator used in Section 6.1 is built as the first principal component from principal component analysis on a set of the assets owned by households at baseline.[27] After building the indicator, I consider a household wealthy if they belong to the last quintile of the wealth distribution in their district of residence.
The specific items composing the wealth index are the following:

a Durable goods, appliances, buildings, and vehicles: furniture and furnishings, bed net, appliances, mobile phone, jewellery, electronic equipment, generator, solar panel or electric inverters, other goods, bicycle, motorcycle, other vehicles, own house, other buildings.

b Housing characteristics: floor made of earth, floor made of earth and cow dung, floor made of cement, floor made of tile, floor made of bricks, floor made of stones, floor made of other material; walls made of straw, walls made of mud and poles, walls made of timber, walls made of unburnt bricks, walls made of burnt bricks and mud, walls made of burnt bricks and cement, walls made of cement, walls made of stones, other walls; roof made of straw, roof made of mud, roof made of wood, roof made of iron, roof made of asbestos, roof made of tile, roof made of tin, roof made of cement, other roof.

c Sanitation: covered pit latrine private, covered pit latrine shared, vip latrine private, vip latrine shared, uncovered pit latrine, flush toilet private, flush toilet shared, bush, other toilet.

d Main source of drinking water: private connection to pipeline, public tap, borehole, protected well or spring, unprotected well or spring, river, vendor, gravity flow scheme, rain, other source.

e Type of stove and cooking fuel: traditional metal stove, traditional 3-stone stove, improved charcoal stove, improved firewood stove, gas, paraffine stove, electric plate, other stove; firewood, charcoal, paraffine or kerosene, electricity, gas, other cooking fuel.

f Source of light: electricity, paraffine, paraffine lamp, firewood, solar light, other source.

[27] See e.g. Bollen et al. (2001); Filmer and Pritchett (2001); Montgomery et al. (2000); O'Donnel et al. (2008) on the construction of asset-based household wealth indicators.

E Ethnic groups in Uganda

The population of the main ethnic groups in Uganda as of year 2002 is reported in Table E.11, while Figure E.3 reports the predominant ethnicities in each district in the same year.. Data come from a 10 percent sample of the 2002 Ugandan Population and Household Census (Bureau of Statistics, Uganda) and were retrieved from IPUMS.[28]

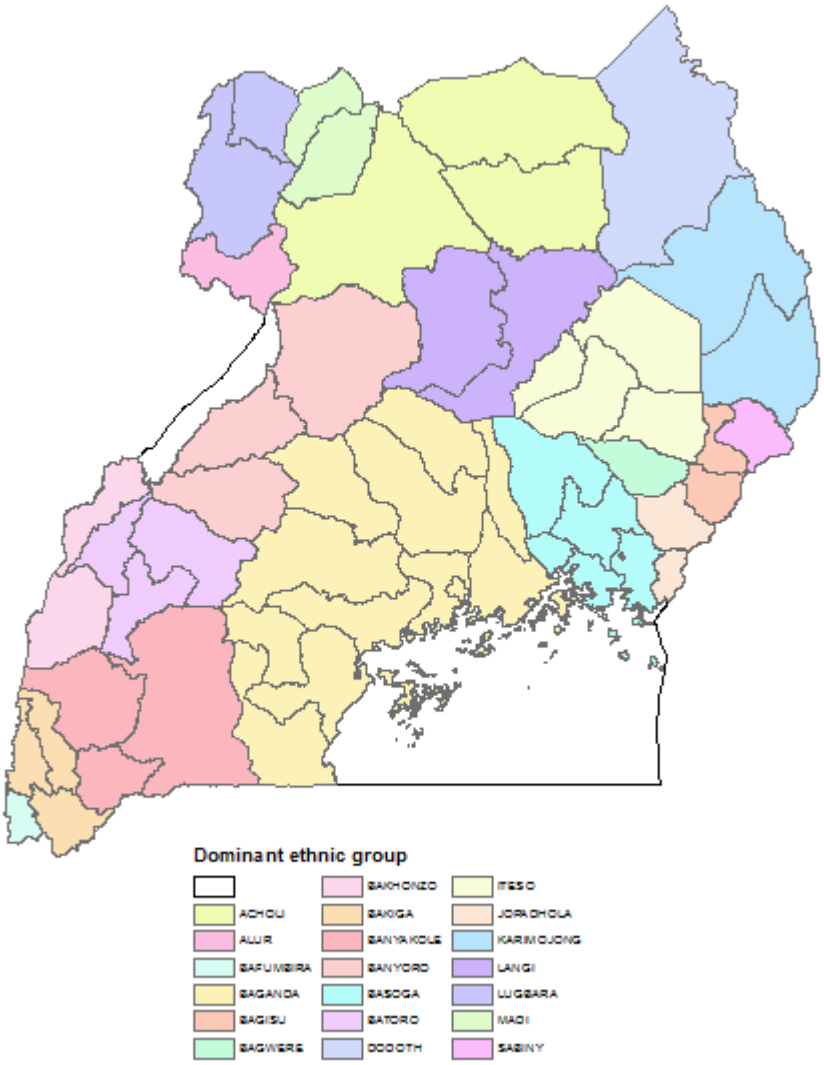
Table E.11: Population by ethnic group

Ethnic Group	Population	Ethnic Group	Population
Acholi	116960	Batwa	672
Alur	54062	Chope	2052
Baamba	3711	Dodoth	33657
Babukusu	1599	Ethur	5539
Babwisi	7045	Ik (Teuso)	1573
Bafumbira	46301	Iteso	160089
Baganda	421284	Jie	15079
Bagisu	113898	Jonam	9203
Bagungu	4904	Jopadhola	37238
Bagwe	7568	Kakwa	13241
Bagwere	41599	Karimojong	26915
Bahehe	408	Kebu (Okebu)	3326
Bahororo	18111	Kuku	3500
Bakenyi	6465	Kumam	17538
Bakhonzo	61603	Langi	151614
Bakiga	172780	Lendu	1140
Banyabindi	1467	Lugbara	103406
Banyakole	238219	Madi	30024
Banyara	2224	Mening	201
Banyarwanda	31995	Mvuba	106
Banyole	34588	Napore	3092
Banyoro	68646	Nubi	2641
Baruli	14594	Nyangia	1543
Basamia	28602	Pokot	7326
Basoga	211516	Sabiny	18390
Basongora	1089	So (Tepeth)	2186
Batagwenda	4731	Other Ugandans	9573
Batoro	61812	Missing/non-Ugandan	56582
Batuku	2222	**Total**	**2497449**

Source: own calculations using a 10 percent sample of the Ugandan Population and Household Census (Bureau of Statistics, Uganda), year 2002.

[28] Minnesota Population Center. Integrated Public Use Microdata Series, International: Version 6.4 [Machine-readable database]. Minneapolis: University of Minnesota, 2015.

Figure E.3: Dominant ethnicities by district, Uganda 2002



Source: own calculations using a 10 percent sample of the Ugandan Population and Household Census (Bureau of Statistics, Uganda), year 2002.

Figure E.4 visualises the ethnic distribution in the 37 main ethnic areas identified in the 2002 Ugandan Census.

Figure E.4: Ethnic distribution by district, Uganda 2002

Source: own calculations using a 10 percent sample of the Ugandan Population and Household Census (Bureau of Statistics, Uganda), year 2002.

F Polarisation

I measure ethnic polarisation building on the Esteban-Ray index (Esteban and Ray, 1994). Given a population composed of $i = 1 \dots N$ ethnic groups, each one with population share s_i and income y_i, the Esteban-Ray index is computed as

$$ER = K \sum_{i=1}^{N} \sum_{j=1}^{N} s_i^{1+\alpha} s_j \left| y_i - y_j \right|, \tag{24}$$

where K is a scaling factor and $\alpha \in [0; 1.6]$ is a parameter measuring the degree of polarisation sensitivity. Alesina et al. (2003) point out that to compute this measure for ethnically defined groups, one lacks a measure of the distance between groups $\left|y_i - y_j\right|$, and that the response in the literature has been to set it constant across all pairwise comparisons where $i \neq j$. I therefore set the term to 1 for every $\left|y_i - y_j\right|_{i \neq j}$. Following Alesina et al. (2003), I set K and α equal to 1 and 0.8, respectively. I then define an ethnic area to be highly polarised if it belongs to the top quartile of the distribution of the Esteban-Ray index across the country.

The results of subsection 8.4 are replicated in Tables F.12-F.14

Table F.12: Social capital

Accounting for polarisation

VARIABLES	(1) purchase	(2) property right	(3) cert. customary	(4) cert. occupancy	(5) no certificate	(6) perceived insecurity
price	0.026**	0.049***	0.007	0.034***	-0.080***	0.050**
	(0.011)	(0.013)	(0.007)	(0.009)	(0.025)	(0.020)
price × social capital	-0.007	-0.013	0.028**	-0.006	-0.019	-0.028
	(0.015)	(0.029)	(0.011)	(0.012)	(0.035)	(0.026)
Observations	2,565	2,565	2,565	2,565	2,565	2,565
Number of HH	860	860	860	860	860	860
Outcome mean	0.244	0.053	0.014	0.035	0.838	0.081
HH fixed effects	YES	YES	YES	YES	YES	YES
Year fixed effects	YES	YES	YES	YES	YES	YES
Additional Controls	YES	YES	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: Column (1): share of land acquired by purchase; (2) share of land for which the household has a formal certificate of title; (3): share of land with a certificate of customary ownership; (4): share of land with a certificate of occupancy; (5): share of land without any certificate; (6): share of land on which the household feels insecure. Land insecurity is defined as the household being concerned that someone may dispute their property or use rights. Standard errors are clustered at the sub-county level. The outcome is regressed on household and year fixed effects, the log of the lag of a price index, an indicator for high social capital, and an interaction of the latter two. Controls include gender, age (linear and square), education and ethnicity of the household head, region fixed effects. The price index is built as a geometrically-weighted index of agricultural commodity prices, with weights equal to the sub-county-level average acreage of land harvested with each crop as of year 2000. High social capital is proxied by ethnically concentrated areas (top quartile of the Herfindahl-Hirschman concentration index on ethnic population shares) that are also non-polarised. Low social capital is proxied by ethnically polarised areas (top 25 percent of the distribution of the Esteban-Ray index on ethnic population shares.).

Table F.13: Social capital and insecurity

Accounting for polarisation

VARIABLES	(1) perceived insecurity
price	0.050**
	(0.020)
price*social capital	-0.028
	(0.026)
Observations	2,565
Number of HH	860
Outcome mean	0.081
HH fixed effects	YES
Year fixed effects	YES
Additional Controls	YES

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Notes: Column (1): share of land on which the household feels insecure. Land insecurity is defined as the household being concerned that someone may dispute their property or use rights. Standard errors are clustered at the subcounty level. Standard errors are clustered at the household level. The outcome is regressed on household and year fixed effects, the log of the lag of a price index, an indicator for high social capital, and an interaction of the latter two. Controls include gender, age (linear and square), education and ethnicity of the household head, region fixed effects. The price index is built as a geometrically-weighted index of agricultural commodity prices, with weights equal to the subcounty-level average acreage of land harvested with each crop as of year 2000. High social capital is proxied by ethnically concentrated areas (top quartile of the Herfindahl-Hirschman concentration index on ethnic population shares) that are also non-polarised. Low social capital is proxied by ethnically polarised areas (top 25 percent of the distribution of the Esteban-Ray index on ethnic population shares.).

Table F.14: Social position and social capital

Accounting for polarisation

(a) SOCIAL POSITION	(b) SOCIAL CAPITAL	(1) purchase	(2) property right	(3) cert. customary	(4) cert. occupancy	(5) no certificate
Panel A						
	high	0.004	-0.058**	0.012	-0.003	0.020
		(0.046)	(0.026)	(0.032)	(0.018)	(0.067)
wealthy	low	0.042*	0.006	0.012	0.008	-0.053
		(0.021)	(0.021)	(0.009)	(0.013)	(0.037)
	difference		*			
Panel B						
	high	-0.022	-0.055	-0.048**	-0.039**	0.164**
		(0.021)	(0.036)	(0.023)	(0.016)	(0.064)
politician	low	-0.034	0.029	-0.008	0.058**	-0.057
		(0.027)	(0.055)	(0.006)	(0.027)	(0.061)
	difference			*	***	**
Panel C						
	high	0.017	-0.028	0.042	0.066**	-0.206***
		(0.046)	(0.030)	(0.029)	(0.029)	(0.076)
female head	low	0.017	0.011	-0.003	-0.016	0.004
		(0.032)	(0.022)	(0.006)	(0.011)	(0.030)
	difference				***	**
Panel D						
	high	-0.056	-0.148*	-0.100***	-0.048	0.205**
		(0.092)	(0.078)	(0.032)	(0.031)	(0.095)
non-predominant	low	0.004	0.071***	0.000	0.014	-0.082**
		(0.026)	(0.023)	(0.014)	(0.016)	(0.035)
	difference		***	***	*	***

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: Column (1): share of land acquired by purchase; (2) share of land for which the household has a formal certificate of title; (3): share of land with a certificate of customary ownership; (4): share of land with a certificate of occupancy; (5): share of land without any certificate. Standard errors are clustered at the sub-county level. The outcome is regressed on household and year fixed effects, the log of the lag of a price index, an indicator for belonging to the category displayed in Column (a), and an interaction of the latter two. The regression is performed on the sub-sample identified in Column (b). Controls include gender, age (linear and square), education and ethnicity of the household head, region fixed effects. The price index is built as a geometrically-weighted index of agricultural commodity prices, with weights equal to the sub-county-level average acreage of land harvested with each crop as of year 2000. Wealthy is an indicator for belonging to the highest wealth quintile in the district. Local council is an indicator for being related to a local council member. Female head is an indicator for female household head. Non-predominant is an indicator for not belonging to the predominant ethnicity in the district. High and low social capital is proxied by ethnically concentrated, non-polarised and fractionalised or polarised areas, respectively. Concentrated and fractionalised areas are those belonging to the top 25 and bottom 75 percent of the distribution of the Herfindahl-Hirschman concentration index on ethnic population shares. Polarised and non-polarised areas are those belonging to the top 25 and bottom 75 percent of the distribution of the Esteban-Ray index on ethnic population shares.

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