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How does Market Access affect Smallholder Behavior? The Case of Tobacco Marketing in Malawi

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The case of Tobacco Marketing in Malawi

Wouter Zant*

Abstract

Transaction costs play a key role in the behaviour of smallholders in developing countries. We exploit the quasi experimental design of the introduction of an additional tobacco auction floor in Malawi in order to investigate the impact of a reduction in transaction costs and improved market access on yield and underlying smallholder's decisions on production and area of tobacco, the major cash crop in Malawi. Estimations are based on annual data by Extension Planning Area, 198 in total, fully covering Malawi, for 2003-04 to 2009-10. The estimation results support a statistically significant positive impact of the introduction of a new auction floor on tobacco yield and production of smallholders. Yield increases over the years to 21-25% above base year level. Smallholder production increases are of a similar size with a larger variation, ranging from 12% to 30%. The evidence further suggests that smallholder area is not affected. Results are shown to be robust after controlling for rainfall, fertilizer use, tobacco prices, maize prices and after including the lagged dependent variable.

JEL code: D23, O13, O55, Q11, Q13

Key words: transaction costs, market access, subsistence, food & cash crops, Malawi, Africa

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Introduction

Smallholders in developing countries can choose to produce food crops for home consumption or cash crops for the market[1]. High production costs, high transaction costs, and high risks of output and input prices often make subsistence farming – food production for home consumption – the optimal choice (see e.g. De Janvry et al. 1991; Jayne, 1994; Fafchamps, 1999; Key et al., 2000)[2]. Widespread subsistence farming leads to low productivity and low growth in agriculture. And since developing countries have large agricultural sectors with a comparative advantage vis-à-vis non-agricultural sectors, large multiplier effects from agriculture to the remaining sectors of the economy and few alternative growth strategies (de Janvry and Sadoulet, 2010), a stagnant agricultural sector is likely to obstruct the economic growth potential of these countries.

The question arises how one can overcome this subsistence trap? A possible way out of this trap is to reduce transaction costs for smallholders. Transaction costs – costs incurred in order to sell agricultural output on the market – include costs of information, collection, loading, transport, bargaining, monitoring, insurance and other costs associated with access to market. It is claimed that transaction costs are large and a major cause of not selling on the market. Conversely, (improved) access to markets – both the mere existence of markets but also the logistical and marketing infrastructure that facilitates agricultural crop sales on these markets – decrease transactions costs and thereby potentially trigger smallholders to produce for the market.

To analyse this latter claim empirically we exploit the quasi experimental design of the introduction of an additional tobacco auction floor in Malawi, on top of the three already

[1] Food crops are not necessarily or exclusively used for subsistence, but may also be sold on the market.

[2] Promotion of either food crops or commercial crops also lies at the heart of policy discussions (see e.g. Harrigan, 2003, 2008).

existing auction floors. We investigate the size of the impact of reducing transaction costs on smallholders' tobacco area and tobacco production decisions. Tobacco in Malawi is – with a distance – the major cash crop, grown throughout the country and by regulation exclusively sold on auctions. Malawi does not have a domestic cigarette industry and, hence, all tobacco is exported. In the 2000/01 season realised transaction costs in Malawi tobacco are claimed to be in the range of 14.5% to 22.5% of the sales value (see FAO, 2003). This estimate of transaction costs is likely to be downward biased, as it omits unobserved costs.

The paper is organised as follows. In Section 1 we present an overview of the literature on the role of market access and transaction costs in developing countries. In Section 2 we describe developments in the Malawi tobacco industry: we discuss the importance of tobacco for the Malawi economy, the transition from estate based to smallholder based tobacco production over the past decades, the marketing institutions in the tobacco commodity chain and we show what we can learn from auction transaction data. In Section 3 we show how we plan to measure the impact of improved market access for tobacco smallholders in Malawi. In Section 4 we present and discuss the estimation results. In Section 5 we give the summary and conclusion of this paper.

1. Market access and transaction costs in the literature

In this section we discuss the literature that studies how transaction costs affect market participation and behaviour of farmers. Part of this literature is structural in nature and attempts to explain the decision to grow either subsistence crops or cash crops, and the decision to participate in the market. What drives farmers to grow low yielding food crops for home consumption rather than high return cash crops for the market? And what explains that large groups of farmers prefer not to participate in the market? De Janvry, Fafchamps and Sadoulet (1991) discuss the implications of market failure in food markets, cash crop markets and labor markets, by assessing the effects of shocks and compare these with the case of complete markets. Their exercise makes clear that under market failures households have a tendency to get trapped into self sufficiency. Limited participation in the market also explains a sluggish supply response. Goetz (1992) develops a model where the decision of a food producing household is split up in a decision to enter the market and trade, and a decision how much to trade conditional on participating on the market as a buyer or seller. Three groups are identified: seller, buyers and non-participants. A switching regressing estimation strategy is proposed along these lines, and empirically applied to household survey data for Senegal. Improved market information for households is shown to significantly raise the probability of participation. Jayne (1994) argues that high costs related to purchasing food on the market make cash crop production unattractive, despite higher returns of cash crops on the farm. The wedge between producer prices of home produced maize and consumer prices of maize purchased in the market drives the decision to cultivate food crops rather than cash crops, and this wedge is especially large in rural areas. On the basis of smallholder survey data of five semi arid Zimbabwean areas for 1990 it is shown that consumers prices need to decrease with 5% to 30% to make cash crop production attractive. Omamo (1998) uses a household model with transport costs to explain why farmers in the Kenyan Siaya District allocate larger shares of land to low yielding food crops rather than high return cash crops. Simulations of the optimal choice between cash crops and food crops and incorporating transport costs are shown to do a better job in generating empirically observed cropping patterns and confirm that transport costs alone are sufficient for these results. In other words: food dominated cropping patterns are optimal responses to high transport costs between farms and markets and uncertainty and risk aversion is not required for this purpose. Key et al. (2000) extend and generalize the model proposed by Goetz (1992) that explains that some farmers sell on the market, some buy on the market and some do not participate, by incorporating proportional and fixed transaction costs into an agricultural household model of supply response. Supply is shown to depend on proportional transaction costs and market participation on fixed transaction costs, which allows identification of both types of transaction costs. Empirical estimations, based on data of Mexican corn producers, indicate that both types of transaction costs matter, both for sellers and buyers. They find on the basis of their empirical work that 60% of the supply response to a price increase is due to producers who enter the sales market, while 40% is due to those producers who are already sellers on the market. Reduction of transaction costs is concluded to be an important complement in improving supply response. Using a similar model as developed by Key et al. (2000), Renkow et al. (2004) investigate – on the basis of data of rural households in Kenya – to what extent autarkic households need to be compensated with higher market prices to offset the fixed transaction costs that are made to either sell or buy on the market. They find that the ad valorem tax equivalent of fixed transactions costs is 15%. They assert on the basis of their results that public investment in reducing transaction costs may well hold a greater potential for poverty alleviation than additional agricultural research.

This completes the review of attempts to offer structural models to explain subsistence farming[3]. There is another line of recent research that makes use of impact evaluation techniques (see e.g. Duflo et al., 2007) and that is less concerned with developing structural models on transaction costs. This literature has focused on a specific type of transaction costs, notably information and search costs and aims to show the importance of information for the

[3] This literature review is highly selective. Alternative structural models are proposed. For example, Cadot et al. (2006) approach the "commercial versus subsistence farming" issue from a different angle. They use a simple asset-return model of occupational choice in order to provide estimates of the cost of moving out of subsistence farming. The model is applied to data of Madagascar farmers. They find that the entry cost associated with moving out of subsistence are in the range of 124% to 153% of subsistence farmers' annual production. Several other contributions in this area reveal interesting characteristics and insights of marketing behavior of farmers, transaction costs, food prices and domestic trade in developing countries. Interesting work concerns e.g. Fafchamps et al., 2005; Fafchamps and Vargas Hill, 2005, and Minten and Kyle, 1999.

proper functioning of markets. The empirical studies therefore focus for a large part on the introduction of mobile phone services, how this new information technology has impacted on access to and costs of information (search costs), on market prices and on economic behavior[4]. Often the introduction of mobile phone coverage is used for the identification of impacts, but also experimental designs are documented. Jensen (2007) makes use of micro level survey data to show that price dispersion on fish markets in Kerala, India has dramatically reduced after the introduction of mobile phones. This change is claimed to have established a nearly perfect adherence to the Law of One Price. The evidence further supports increased fishermen's profits and consumer welfare due to mobile phones. The gains from mobile phones services are not exclusively reserved for the wealthy but are shown to be shared by smaller and poorer fishermen as well. Easy and timely access to information is also shown to prevent waste, inefficiency and spoilage of production of perishable crops (Jensen, 2007; see also Muto and Yamano, 2009, on bananas). Aker(2010) uses market and trader level data to estimate the impact of mobile phones on price dispersion across grain markets in Niger. The empirical evidence on the introduction of mobile phone services in Niger between 2001 and 2006 supports a 10 to 16% reduction in price dispersion. The reduction in price dispersion is shown to be stronger for market pairs with higher transport costs. Reduction in price dispersion is also shown to be larger once a critical mass of market pairs has mobile phone coverage. Reduction in search costs and inter market price dispersion is associated with improvements in trader and consumer welfare. The lower reduction in price dispersion compared to Jensen (2007) is attributed to better storability of grain and lesser perishability than fish. Along similar lines Muto and Yamano (2009) investigate the reduction in marketing costs of agricultural

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[4] Despite the emphasis in empirical work on mobile phone technology and information and search costs, there are also a few contributions that make use of other changes in the marketing channel that affect transaction costs.

commodities due to the introduction of a mobile phone network in Uganda using household data for 2003 and 2005. They investigate marketing and trade of maize and bananas and find that the improved information due to mobile phone coverage has induced market participation of farmers in remote areas who produce bananas. Their study does not find impacts of mobile phone expansion on maize marketing. Mobile phone services cannot avoid potential asymmetric information between traders and farmers, and thereby block potential benefits for farmers. Farmers' organizations are suggested to tackle this problem and to strengthen the bargaining power of farmers. Fafchamps and Minten (2012) estimate the benefits for farmers of SMS based agricultural information in Maharashtra, India, using a randomized controlled trial. The information includes prices, weather forecasts, crop advice and new items. They find no effect of this service on the prices received by farmers, value added, crop losses, crop choices and cultivation practices. These disappointing and somewhat disturbing results are in line with the limited commercial take-up of the information service, but difficult to reconcile with previous investigations on the impact of information, as documented above. A comparative advantage in transport is suggested as an explanation why benefits accrue in the first place to traders and not to producers. Finally, we discuss – as an example of a change in marketing services rather than mobile phone services – Goyal (2012) who investigates the impact of a change in marketing of a major private company in the soy market in the central Indian state of Madhya Pradesh. The company aimed at an improvement in procurement efficiency of soybeans to be achieved by the creation of a direct marketing channel (internet kiosks and warehouses) and by a reduction in transaction costs. After the introduction of kiosks and warehouse prices of soybean increased, price dispersion decreased and area under soy cultivation increased. This study highlights the benefits from direct interaction between producers and processors in agricultural marketing. For a full welfare assessment, however, the loss to traders needs to be quantified.

In summary, we find persuasive and rigorous evidence in the literature, both theoretical and empirical, of the key role that transaction costs play in explaining subsistence farming and on the impact of transaction costs on prices, arbitrage and economic behavior. The current paper aims to complement this literature by investigating the impact of market access – caused by the introduction of a new auction floor – on the household decision to grow a cash crop. For this purpose we look at tobacco production in Malawi. Tobacco in Malawi is – with a distance – the major cash crop, grown in nearly all districts[5] and exclusively sold on auctions. In 2004 an additional auction floor started operations in Chinkhoma, Kasungu district, on top of the three already existing and operational auction floors (respectively in Limbe (Blantyre), Kanengo (Lilongwe) and Mzuzu (Mzimba); see Appendix B for a map of Malawi with the locations of the auction floors). We claim that the introduction of this new auction floor establishes a natural experiment: a comparison of supply response of those producers who did and those who did not benefit from this new auction floor provides a measure of the impact of market access. For the empirical measurement of impact we make use of (aggregate) annual area and production data of smallholders at Extension Planning Area level (EPA). There is a total of 198 EPAs, covering the whole of Malawi, for a period of seven years, from 2003 to 2009. Prior to elaborating the research methodology and presenting the impact results we give an overview of the Malawi tobacco industry.

2. The Malawi tobacco industry

Various articles and publications describe market developments in the Malawi tobacco sector, the marketing and regulatory infrastructure that evolved over time and the (nearly complete) transformation that took place from estate based to smallholder based (see e.g. Kydd and

[5] The southern districts of Chikwawa and Nsanja have negligible tobacco cultivation. Additionally there are a few EPAs in other districts that report zero tobacco area and tobacco production.

Christiansen, 1982; Orr, 2000; Jaffee, 2003; World Bank, 2004; Poulton et al., 2007; Tchale and Keyser, 2010). Rather than making repeated references we note that we draw extensively on these sources to highlight the key developments and events which are relevant to the subsequent analysis. Complementary to this description we analyse the 2009 transaction data of the all Malawi tobacco auctions.

The role of tobacco in the domestic economy of Malawi

Tobacco is the major export product of Malawi accounting for a share of 45 to 65% of total merchandise exports (1994 to 2009, NSO data). The second largest single export product (either tea or sugar) is only a fraction of tobacco exports. The contribution of tobacco to GDP, measured as the export value of tobacco in terms of GDP, varies from 9 to 16% (1994 to 2009, NSO data). Tobacco is cultivated by 19% of the smallholder households, around 375,000 farmers (2004). The bulk of the tobacco growing households is poor or ultra poor (around 65% (Economic Council, 2000)). Smallholder crop area allocated to tobacco varies from 120,000 to 185,000 hectare, and smallholder crop production from 90 to 210 thousand tons, both in the period from 2003 to 2010 (source: Agro Economic Survey, Ministry of Agriculture and Food Security). Using the methodology employed in FAO (2003), direct employment in tobacco production and marketing (including processing, transport, auctioning and research) varies from 11 to 19% of total labor supply[6] during 2000-2009.

Tobacco exports generate a major contribution to total government tax revenue in the form of withholding tax levied at the auctions (respectively 7% with exemptions for sales below 600000 MK, and from 2010 onwards 3% without exemption), export tax (in 1995, government imposes a 10% export tax on tobacco leaves, reduced to 8% in 1996, then to 4%

[6] The estimate of direct employment in tobacco production and marketing depends both on the applied tobacco data (MoAFS, FAO), the labor supply data (population between 20 and 60) and how employment is related to area and production.

in 1997) and most importantly export surrender requirements imposed by the Reserve Bank of Malawi (till 1994 60%, and from 1994 onwards 40%). All tobacco taxes and levies add up to a share of 30% in 2000 decreasing to around 20% in 2008 of total government tax revenue (Jaffee (2003) reports 23%; FAO (2003) reports: "…tax accounted for more than 20 percent of total national tax revenue")[7].

In summary the figures indicate that tobacco is of extraordinary importance to the Malawi economy. It is likely that the role of tobacco extends well beyond these figures. Malawi's export of tobacco is also claimed to be the major driver of economic growth (see e.g. Lea and Hammer, 2009).

Tobacco cultivation in Malawi: from colonial heritage to smallholder domination

The Special Crops Act of 1964 continued pre-independence existing restrictions, that made the cultivation of tobacco the exclusive domain of estates. A new government – elected in 1993 and following an era of one party rule since independence – shifted the policy stance to a more broad based economic growth aiming at poverty alleviation. Under the new government – but also because of pressure by donors to liberalise the tobacco industry – amendments to the Special Crop Act were realised which allowed smallholders to grow burley tobacco (Jaffee, 2003). In the course of the 1990s, these developments have given rise to a complete transformation from estate based tobacco cultivation with a high share of western type tobacco's (Flue Cured, NDDF, SDDF, Sunair), to a smallholder based tobacco cultivation with a high and dominant share of burley tobacco (see Figure 1). The changes in regulation laid the foundation for this transformation. High profitability of tobacco as a cash crop – the only really remunerative cash crop available to smallholders – and the broad spread of

[7] The large share of tobacco proceeds that flows to the Government of Malawi jeopardizes GoMs credibility in defending the interests of smallholders farmers in their annually revolving claim against too low prices offered by colluding buyers at the auctions.

technical knowledge on tobacco cultivation – since many farmers worked previously on estates as labourers – triggered high growth of smallholder tobacco production. The increase of smallholder production was further supported by the formation of burley clubs, the introduction of intermediate buyers who provided the logistical link from farmers to auction floors[8] and the availability of credit to smallholders provided by the Malawi Rural Finance Company (Jaffee, 2003). Simultaneously the more labour, capital and input intensive quality tobacco's, mainly grown by large estates, were quickly losing commercial viability because of high production costs (labour, fuel wood and investment).

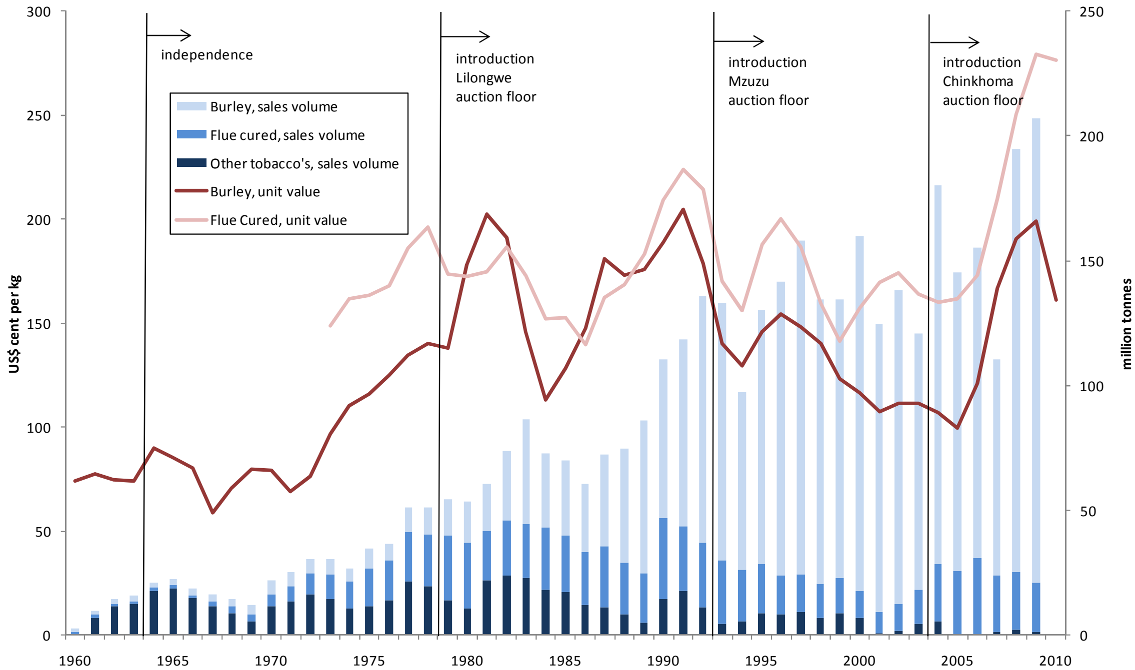
Since all tobacco exported from Malawi is required to be sold at auction (see also below), unit values and sales volume at auctions can be considered to be a good reflection of price and production developments in the Malawi tobacco industry[9]. Over the years, sales volume – separated in burley, flue cured and other tobacco's – shows a nearly continuous upward development (see Figure 1). High growth rates in tobacco, however, are entirely on account of burley production. Especially, since the end of the 1980s burley sales realize high growth rates, which slightly level off by the end of the 1990s. Flue cured production is stagnant during the 1980s, declines during the 1990s to reach a production low in 2001, after which year a moderate recovery has taken place. Flue cured tobacco is nearly exclusively grown by estates. As a result of the higher capital requirements in the form of curing barns and other supporting equipment, smallholders are reluctant to take up the production of flue cured

[8] The minimum requirement for selling tobacco on the auction was overcome with the introduction of the intermediate buyer (FAO, 2003).

[9] Some authors report sales of tobacco from Zambia or Mozambique at Malawi auctions. This is likely to occur occasionally but we assume that the size of these sales are relatively small and do not disturb the general message of the auction data for the Malawi tobacco industry.

tobacco. Hence, it is safe to assume that the decline in sales volume of flue cured tobacco since 1990 should be attributed to the collapse of the estate sector[10].

Figure 1 Auction Sales Volume and Unit Values of Burley and Other Tobacco[a]



[a] Nominal unit values in US$ cent per kg are on the left axis and sales volume in million tonnes on the right axis. Other tobacco's produced in Malawi are NDDF, SDDF (resp. Northern and Southern Division Dark Fired, so-called western tobacco's) and Sun Air; source: annual aggregate data from the Tobacco Control Commission, Malawi.

Figure 1 further illustrates distinct periods of increases and decreases in burley prices (increasing prices: 1971-1981, 1984-1991, 1994-1996 and 2005-2009; decreasing prices: 1981-1984, 1991-1994, 1996-2005). Flue cured prices are on average higher than burley prices but follow a similar development. Visual inspection of the figure suggests a positive response of production to (lagged) auction prices: (lagged) price increases (decreases) coincide with

[10] It should be noted that the flue cured-burley divide does not run entirely parallel with the estate-smallholder divide as some estates are active in burley production.

production increases (decreases) in a remarkably systematic way. This observation is confirmed by other work in this area (see e.g. Jaffee, 2003).

Tobacco marketing: auctions, regulations, farmers clubs and other institutions

The tobacco auction system in Malawi has a long history, which dates back to the colonial times, at the start of the previous century. In the early days marketing institutions were adapted to production and marketing needs of estates. We focus on post-colonial times – Malawi gained independence in 1964 – and specifically the period since the start of the 1990s, when the sector was liberalized. Transport of tobacco to auctions was – both pre and post liberalization – on account of the tobacco farmer. Hence, in the 1990s – in the course of liberalisation of the Malawi tobacco industry – a logistical infrastructure for tobacco transport and marketing from rural areas to auctions had to be put in place to service smallholder farmers. A variety of institutions and organisations came into being. Of key importance in this context are farmer clubs or burley clubs: groups of 10 to 30 farmers that share specific services. Upon registration with the Tobacco Control Commission clubs were allocated a quota and were entitled to receive burley seed, fertilizer, advice on cultivation and extension support. From 1991/92 onwards clubs were authorized to sell directly on the auction floors and since 1994 also to intermediate buyers (Orr, 2000). Access to auctions and thereby access to world market prices, credit facilities and economies of scale in transport are the major incentives for smallholders burley growers to join a burley club (Orr, 2000; Negri and Porto, 2008). Additionally, the intermediate buyer system was introduced in 1994 to help smallholders to transport their burley tobacco to the auctions. The existing Tobacco Association of Malawi (TAMA) and the National Association of Smallholders Farmers of Malawi (NASFAM), which was established in the 1990s, also assisted in the organisation of collection, storage, transport and sale of smallholder tobacco from rural areas to the auction floors, in cooperation with burley clubs, estates and intermediate buyers (see Appendix C for more information on the major institutions of tobacco sector in Malawi). Shortcomings to this marketing infrastructure – which is continuously developing – were experienced in the area of widely diverging transport rates, storage losses and lack of accountability (see Jaffee, 2003).

Tobacco marketing is regulated by the Tobacco Control Commission (TCC), a government statutory body. TCC is responsible for market regulation and control, licensing of farmers, quality standards, data and statistics of the tobacco sector and advising the government on tobacco issues. Operations on (all) tobacco auction floors are run by a single private sector company, the Auction Holdings Limited (AHL). The establishment of an auction floor also requires substantial complementary investments from buyers to properly organize after sales processing, storage and international transport. As early as 1939 tobacco was auctioned only at the Limbe auction floor, near Blantyre in the south of Malawi. In more recent years and well after independence the centre of tobacco production moved in northern direction. Auction floors were established in 1979 in Kanengo, near Lilongwe in Central Malawi; in 1993 in Mzuzu in Northern Malawi; and in 2004 in Chinkhoma in the central district Kasungu, between Lilongwe and Mzuzu (see Appendix B for a map of Malawi with locations of auction floors and Figure 1 for the timing of the introduction of the auction floor in relation with tobacco production and prices). The tobacco auctions normally open from mid-March and close towards the end of October. Tobacco is packaged in bales with a weight of 80-90kg. In the 2009 marketing season a total of 2.3 million bales were sold. A total of 25,000 to 30,000 bales are sold daily amongst the four auction floors. According to weekly reports from TCC[11] direct trade and contract trade is primarily important for specialty tobacco's (Flue Cured, NDDF and SDDF) and hardly plays a role for burley tobacco.

[11] These reports are only available for the period from 2001 to 2006.

Moreover, direct trade and contract trade transactions also need to be settled on auctions. Sellers that are not satisfied with the contract prices have the opportunity to switch to the auction market once. The traditional auction system has four national sales daily: two in Lilongwe and one each in Limbe and Mzuzu. The Chinkhoma floor trades twice weekly on which days Lilongwe only has one auction sale. The sale of tobacco by auction is concluded to the highest bidder.

On the demand side there is a limited number of companies active, notably Dimon, Standard Commercial, Universal Leaf, Limbe Leaf Tobacco Company, Alliance One and Premium Tama. Most companies are subsidiaries of large international traders or international cigarette manufacturers. Over the years the composition of the buying side has changed due to new entrants, mergers and takeovers. However, the degree of concentration on the buyer side is high. The presence of only a limited number of buyers on the auction floors (7 in 2011) raises suspicion of a lack of competitiveness of tobacco pricing and collusion between buyers at the auction floors (see e.g. Otañez at al., 2007). This is particularly manifest with occasional outbursts of protest from tobacco farmers who complain about the low prices at the auction.

Auction transactions: comparison of district composition and unit values

Auction transaction data allow to analyse the composition of sales volume and unit values, by auction floor and by district of origin (see Appendix E for an overview of sales volume by auction floor and by district of origin)[12]. A total share of 56.6% of all tobacco sales originates from the central districts Kasungu (21.1%) and Dowa (18.3%) and the northern district Mzimba (17.2%), comprising the three largest districts of origin in terms of tobacco

[12] We use transaction data of all tobacco auction transactions – a total of around 60,000 transactions – for the year 2009, which are kindly made available by the Tobacco Control Commission. The transaction data pertain to a year that comes a few years after the introduction of the Chinkhoma auction floor in 2004.

volume. Another share of 8.2% is on account of the northern district Rumphi. A few districts in the south – Mwanza, Chikwawa and Nsanja – have negligible or no sales.

The distribution of sales over auctions is as follows: 33.6% of total volume is traded on the Mzuzu auction floor, 13.4% on the Chinkhoma auction floor, 26.4% on the Lilongwe auction floor and 26.5% on the Limbe auction floor[13]. The Mzuzu auction floor in the north trades in particular tobacco from Mzimba (50%), Rumphi (20%) and Kasungu (13%); the Chinkhoma auction floor in the central region trades tobacco from Kasungu (60%), Dowa (20%) and Ntchisi (7%); the Lilongwe auction floor, also in the central region, trades tobacco from Dowa (54%) and Kasungu (30%); and finally the Limbe auction floor trades tobacco from Mangochi (24%), Machinga (19%), Ntcheu (13%) and Phalombe (15%). To a large extent these figures reflect the relative importance of nearby production areas.

All districts in the north and the south – and this is no surprise – transport their tobacco almost exclusively to one single auction floor: the Mzuzu auction floor for the northern districts and the Limbe auction floor for the southern districts. Central districts with the exception of Salima and Ntcheu, spread their sales over two or even three auctions. This suggest that the preferred auction of sale is not only determined by distance. In a number of districts this is particularly clear: the Limbe auction floor is more popular for tobacco produced in the districts Salima, Mchinji and Nkhotakota than the more closely located Lilongwe (see Table 1 and Appendix E). This is possibly explained by congestion at the

[13] This clearly diverges from the situation at the start of the 2000s when the Kanengo auction was the largest auction (see Jaffee, 2003). Also the, most likely outdated, Limbe Leaf website (accessed in June 2011) reports: "*The Lilongwe floor facilitates trade of 50% of the national crop, while the Limbe floor accommodates 17%. The Mzuzu and Chinkhoma floors make up the remainder of the national crop at 25% and 8% respectively. Future patterns indicate that Lilongwe floor's capacity will remain much the same while Mzuzu's and Chinkhoma's will increase slightly to the detriment of the Limbe floor*". Our TCC transaction data for 2009 diverge drastically from these values. We infer from the 2009 TCC data – in terms of future patterns – that Mzuzu and Chinkhoma indeed have gained, but also Limbe has gained market share and Lilongwe has lost substantial market share.

Lilongwe auction floor, cheap transport alternatives from Mchinji and Salima (transport by train[14]) and different prices at auctions (see below). Tobacco farmers from other districts also appear to avoid the Lilongwe auction floor (e.g. Ntcheu). Finally, one would expect tobacco sales from Mzimba on the Chinkhoma auction floor, which are, however, negligible. This may be caused by the (still) moderate trading volume at the Chinkhoma auction floor and the – on average – higher prices at Mzuzu auction floor.

Table 1 Burley prices by auction floor of sale and district of origin[a]

district \ auction	Mzuzu	Chinkhoma	Lilongwe	Limbe
Nkhotakota	1.74 (308)	1.62 (284)	1.39 (8)	1.51 (370)
Kasungu	1.78 (4576)	1.67 (4453)	1.54 (5040)	1.65 (1146)
Ntchisi	1.70 (366)	1.61 (949)	1.81 (22)	1.63 (566)
Dowa	1.72 (1387)	1.60 (2740)	1.54 (8201)	1.58 (1649)
Mchinji	1.49 (435)	1.45 (652)	1.28 (52)	1.56 (1397)
Lilongwe	1.72 (370)	1.48 (864)	1.57 (1661)	1.59 (1602)
Mzimba	1.78 (6812)	1.66 (339)	1.82 (2)	1.52 (78)
Salima	1.75 (26)	1.68 (31)	1.29 (2)	1.54 (509)

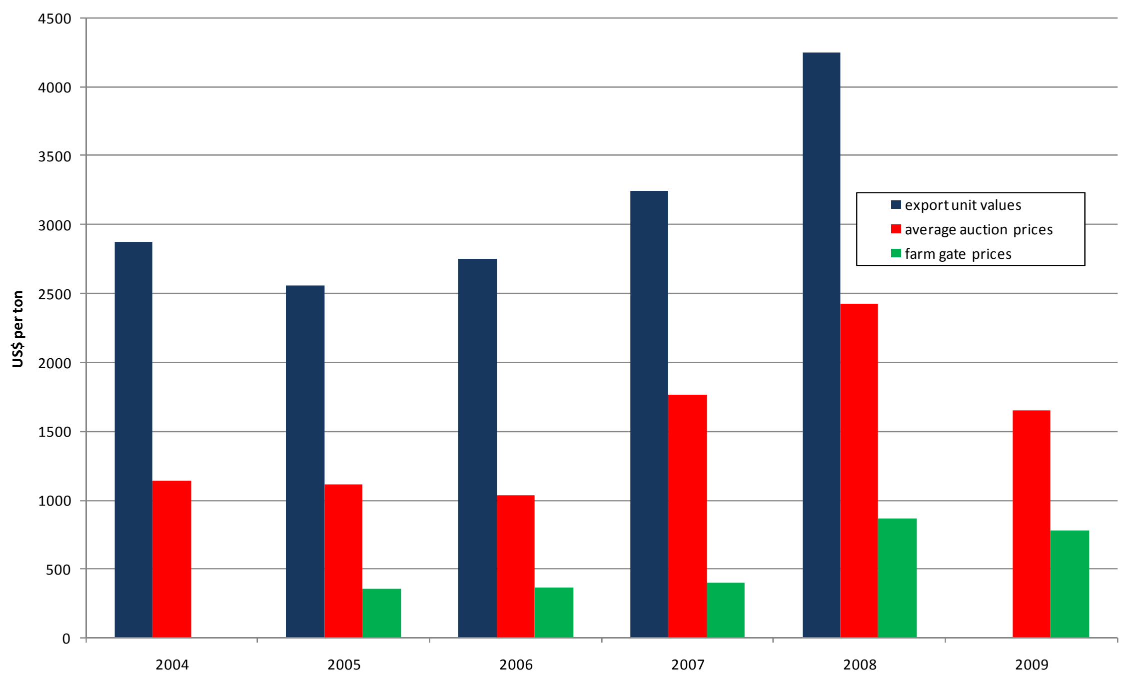
[a] The table reports average transaction prices for 2009 in US$ per kg by district of origin, for districts of the Central region. Source: transaction data of 2009 from the Tobacco Control Commission. Number of transactions are in brackets behind the average price and in case of only a few transactions (and hence less reliable) average prices are shaded.

Our primary interest is in districts that sell their tobacco on the Chinkhoma floor, either exclusively or combined with sales on other floors. Hence, for these districts we have

[14] The Malawi rail network consists of a rail line – with a total within Malawi length of 797 km – running from Zambia in the west, via Lilongwe to the south where it splits into a line further south to Blantyre and Beira in Mozambique (the Beira corridor), and a line to the east, to Nacala in Mozambique (the Nacala corridor). Both Mchinji and Salima have railway stations along the railway line to the south which potentially offers these locations low cost transport services to the Limbe auction floor (Limbe is along the railway line and also has a railway station), near Blantyre in the south. A similar situation applies to tobacco from Ntcheu district. Freight data from the Central and East African Railways (CEAR, www.cear.mw) confirm that substantial quantities of tobacco are transported from rural areas to auction floors along the railway line, notably Lilongwe and Blantyre (these traded quantities are distinct from tobacco transported for export abroad).

calculated average unit values of burley tobacco for the different auctions (see Table 1). The table indicates that the highest average prices for burley are realized on the Mzuzu auction floor, while the lowest average prices are realized on the Lilongwe auction floor. From the perspective of realized auction prices the Chinkhoma auction floor offers an attractive alternative outlet to the Lilongwe auction floor.

Figure 2 Tobacco export unit values, auction prices and farm gate prices (US$ per 1000 kg, nominal)



Source: FAOSTAT, TCC and Agro-Economic Survey (MoAFS)

Another issue that deserves attention are the different prices in the tobacco commodity chain. How do Malawi tobacco export unit values, auction prices and farm gate prices compare? Annual observations for tobacco export unit values, auction prices and farm gate prices are shown in Figure 2[15]. The figure reveals a tremendous gap between farm gate prices and auction prices: auction prices are more than twice as high relative to farm gate prices – well in excess of the 15 to 23% transaction costs – or, conversely farm gate prices are 24% to 46% of auction prices. Such producer shares in market prices are small but not uncommon[16]. However, in the case of Malawi it is not certain if this gap can be fully explained by transaction costs. At auctions tobacco is sold directly by farmers or their representative grower clubs. Hence, next to transaction costs the gap is likely to represent a premium for farmers or farmer clubs. Even if we take account of such a premium, the gap remains large.

The difference between auction prices and export unit values is captured by two components: value addition from 'after auction' processing and export tax. On the basis of annual aggregate value and volume data of tobacco export and tobacco auction sales for the years 1980 to 2009, we compute that – on average – around 18% of tobacco production volume is lost due to after-auction-withdrawal or rejection for export, losses in after-auction-processing, after-auction-diversion for domestic use and non-registered exports. After auction tax consists of withholding tax imposed at the auctions (7% with an exemption for transaction below 600,000 MK; and from 2010 onwards 3% without exemption) and an export surrender requirement to the Reserve Bank of Malawi (RBM; 60% before 1994 and 40% after 1994). Value addition is determined by change in the product quality due to after-auction processing, by the market power of international tobacco buyers, by export tax policy and by world market prices. Our calculations indicate a drastic increase in value addition after the 1994 export tax

[15] It should be noted that each of these prices originates from a different source: export unit values are from FAOSTAT, auction prices are from Tobacco Control Commission and farm gate prices are from the Agro Economic Survey from the Ministry of Agriculture and Food Security.

[16] Low producer prices are not uncommon, especially not in large countries. E.g. for the former Zaire, Minten and Kyle (1999) demonstrate on the basis of data from a traders' survey that transportation costs explain most of the differences in food prices between producer regions and that road quality is an major determinant of transportation costs. They report similarly low producer prices for former Zaire.

change: this shift of rent extraction from tobacco sales from the government of Malawi to the international tobacco buyers / processors awaits further investigation.

3. Methodology

Estimating Impact of Interventions with Panel Data

The impact of an intervention is estimated using a fairly standard and straightforward framework for impact evaluation with panel data (see e.g. Duflo et al., 2007). A reasonably general specification to estimate the dynamic impact of an intervention with a panel of observations runs as follows:

$$Y_{it} = \beta_0 + \sum_t \beta_{1t} I_{it} + \sum_k \beta_{2k} X_{k,it} + \varphi_i + \omega_t \qquad (1)$$

where Y_{it} is the outcome indicator, I_{it} is a binary intervention variable with a unit value in case of an intervention and zero elsewhere (hence, zero before the intervention and without intervention), $X_{k,it}$ is a set of k exogenous covariates, and φ_i and ω_t are not observed time invariant and location (household) invariant effects. The coefficients of the intervention variable (β_{1t}) is the parameter of interest. We allow impacts to vary over time, thereby increasing the flexibility of the specification and the informational content of the data. Covariates ($X_{k,it}$) may also include observed time-invariant and location (household) invariant fixed effects.

We investigate the impact of (a reduction in) transaction costs on yield and on crop area and crop production decisions of tobacco smallholders in Malawi that arises with the introduction of a new auction floor. Farmers' area and production decisions are both driven by expected profits, and a changes in transaction costs changes expected profits. We claim that the introduction of a new auction floor improves markets access and leads to a reduction of transaction costs, in the first place by a reduction in transport costs. The resulting increase in expected profits will trigger increases in tobacco production and larger allocations of crop area to tobacco. The reduction in transaction costs consists of the mere availability of a nearby marketing opportunity – an opportunity which did not exist previously – and it consists of the reduction in transport costs. Transport costs are for a large part proportional to distance, and, likewise, there will be a component proportional to distance and a fixed component in transaction costs. Consequently, a possible increase in production of tobacco or a possible increase in area allocated to tobacco, as a result of the introduction of a new auction floor, is likely to be larger for locations that are nearer to the newly established auction. In the specification we investigate if changes are correlated with distance by using the inverse of the distance to newly established auction as intervention variable, provided that this auction has become the nearest auction[17].

$$Y_{it} = \beta_0 + \sum_t \beta_{1t} I_{it} + \sum_t \beta_{2t} (1/d_{nearest\ auction}) I_{it} + \sum_k \beta_{3k} X_{k,it} + \varphi_i + \omega_t \qquad (2)$$

We may difference equation (3) to sweep out time invariant observed and unobserved location (household) fixed effects, represented in the equation by φ_i. Since differencing sacrifices one year of observations, we rather maintain the equation in levels and control for (un)observed fixed effects by including a complete set of location dummies.

Impact of market access to the Malawi tobacco sector: empirical specification

We implement the framework set out in the previous section to estimate the impact of the introduction of a new auction floor in Malawi (the intervention) on yield, production and area of tobacco. The exercise aims to measure if and to what extent this intervention has given rise to changes in yield, and if these changes correspond with changes in production, area or both. Hence, we measure the supply effect of market access. In order to transform equation (3) to an equation that can be estimated empirically, we simply insert tobacco yield, tobacco area and tobacco production as outcome indicator and add error terms:

[17] The condition that the auction has become the nearest auction, is automatically controlled for if interacted with the intervention variable.

$$y_{it} = \alpha_0 + \sum_t \alpha_{1t}\ I_{it} + \sum_t \alpha_{2t}\,(1/d_{nearest\ auction})\, I_{it} + \sum_k \alpha_{3k}\, X_{k,it} + \theta_i + \vartheta_t + \varepsilon_{it} \tag{3a}$$

$$q_{it}/q_{i0} = \gamma_0 + \sum_t \gamma_{1t}\ I_{it} + \sum_t \gamma_{2t}\,(1/d_{nearest\ auction})\, I_{it} + \sum_k \gamma_{3k}\, X_{k,it} + \varphi_i + \omega_t + \mu_{it} \tag{3b}$$

$$a_{it}/a_{i0} = \delta_0 + \sum_t \delta_{1t}\ I_{it} + \sum_t \delta_{2t}\,(1/d_{nearest\ auction})\, I_{it} + \sum_k \delta_{3k}\, X_{k,it} + \rho_i + \tau_t + \nu_{it} \tag{3c}$$

Where y_{it}, q_{it} and a_{it} are tobacco yield, production and area of EPA i in year t, q_{i0} and a_{i0} are base period tobacco production and base period area of EPA i, and ε_{it}, μ_{it} and ν_{it} are error terms with zero mean and constant variance. Yield is in kilogram per hectare and can directly be compared between different EPAs. Tobacco production is kilogram and crop area in hectare. To make tobacco production and crop area comparable between locations, we have expressed these dependent variables relative to their pre-intervention or base period level[18]. All outcome variables are transformed into natural logarithms. We use the specifications of equation (3a) to (3c) as the basic specification of our estimations, with appropriate restrictions on coefficients. The restrictions are apparent from the tables with estimation results.

A variety of additional covariates $X_{k,it}$ is used: in case of the area equation potential candidates are previous year tobacco prices, available labour and number of tobacco clubs. Both tobacco area and production are likely to respond to previous year auction prices (see Figure 1 in this study, but also Jaffee, 2003). Price series on tobacco by auction are not available, let alone prices by location of origin, and we have to approximate prices at EPA level with national average auction prices[19]. We make nominal tobacco prices comparable over time

[18] We have used the years 2003-2004, 2004-2005 and 2005-2006 or combinations of these years as base period. Estimation results are robust for different specifications of the base period.

[19] We do have auction transaction data for one year (2009) but unfortunately we do not have auction transaction data for all the years of the sample (from 2003 to 2010). Hence, we use national aggregate prices, averaged over

by expressing these prices relative to nominal maize prizes, the major food crop. As we do have maize market prices on EPA level this creates variation in the price variable between EPAs. Additionally, tobacco, the major cash crop, is also competing with maize on the production side. Available labour by EPA is approximated with population by EPA. Since population variables do not change much over time, this variable is likely to interact with the EPA fixed effects. Data on tobacco clubs by EPA are available for a few years.

In case of the production equation we may select the same additional covariates, however, with different coefficients. A number of other covariates are peculiar to production and need to be added. Climatic variables, most notably rainfall, are likely to correlate with production outcomes. Fertilizer inputs used in the cultivation of tobacco need to be added as well. Agronomic sources acknowledge the importance of NPK applications in tobacco cultivation. Estimations of tobacco production functions on the basis of district data (not documented) support a significant correlation of both chemical fertilizer (NPK) and rainfall on tobacco production.

Identification of intervention locations

Locations that benefit from the introduction of the new auction floor in Chinkhoma in 2004 (the intervention group) are identified by determining the minimum of the distances from each location to the different auction floors. For a number of locations the Chinkhoma auction floor becomes the closest auction floor. Practically this implies that all locations in the districts Kasungu and Nkhotakota, a large part of locations in the districts Ntchisi, Dowa and Mchinji, and a few in the district Mzimba are intervention locations. In all this concerns 31 locations, 15.3% of all locations.

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auctions and over districts and we hope that maize prices (that do vary by EPA) and EPA dummies pick-up the differences (in tobacco prices) by EPA.

The distribution of sales by district of origin (see Appendix E) suggests the Chinkhoma auction floor also attracts tobacco outside these districts. This motivates to identify an additional set of locations that potentially benefits from the new auction floor. There are a number of other locations where the new auction floor at Chinkhoma has become the second closest auction floor. In case the difference in distance between the closest and the second closest auction floor is small – say less than around 50 km – we have included those locations to the intervention group as well. These latter locations are included to the group of intervention locations since the difference in transaction costs between the closest and the second closest auction floor is negligible and consequently other issues may determine the preferred auction floor. The obvious practical example is the high cost of congestion at the Kanengo auction floor in Lilongwe. But also the different sales prices at different auction floors could motivate producers to sell elsewhere (see Table 1 in this paper[20]). Moreover, inaccuracies in the measurement of distance justify to use a certain margin for the identification of intervention locations. On these grounds we have identified another 17 locations, summing to a number of 48 locations (24%), out of a total of 198 locations, that potentially benefit from the newly established auction floor.

Instrumenting the intervention

The choice of location of the new tobacco auction floor is not the result of a random assignment. The auction company will have carefully considered several alternatives and investigated the optimal location for doing this investment, basing its eventual choice on an assessment of current and expected turnover of tobacco and long run profit potential. Consequently, causality may not run (only) from market access to decisions of tobacco

[20] As a matter of fact, the price differences may motivate producers from the district Mzimba to sell their tobacco at the Mzuzu auction floor, because realized prices at this auction are higher than those at the Chinkhoma auction floor.

growers, but also the other way around, from (future) tobacco area and production to the establishment of an auction floor. Estimations are likely to be biased if this problem is not appropriately addressed. The standard response in the literature on identification of impacts is to instrument the intervention.

We will proceed likewise and exploit two intuitively appealing notions to construct instruments for intervention: in the first place we use expected tobacco turnover in EPA i, approximated with the sum pre-intervention production in the surrounding area as instrument. Surrounding area is defined as the potential source area for an auction floor if it was based in EPA i. We assume that the potential source area of an auction is within a radius of at most 200 km[21]. Hence, the instrumental variable for each EPA is computed by aggregating pre-intervention tobacco production that is produced in the neighborhood of this EPA, where neighborhood is defined to be those EPAs located within a radius of 150km. Note that expected production in the surrounding area includes the pre-intervention production of tobacco in EPA i itself. In formula this yields:

$$expected\ turnover_i = \sum_k q_{k0} \qquad (4)$$

where $expected\ turnover_i$ is expected turnover of a tobacco potential auction if established in EPA i, q_{k0} is (pre-intervention) production in EPA k and k pertains to all EPAs that are located within the source area of the possible auction. In the empirical work we have assumed that these EPAs are at most 50-150 kilometers away from EPA i.

Secondly, we assume that it makes no sense for the auction company to establish a new auction floor that competes for tobacco with an existing auction floor[22]. Therefore the second

[21] By varying the radius for sourcing tobacco we may calibrate the sum of 2008-2009 EPA production in surrounding area on the 2009 realized turnover for each auction (for this year we have sales volume by auction, see Appendix D). This exercise suggests a radius for sourcing tobacco of well above 200km for Blantyre, around 200km for Mzuzu, around 60km for Lilongwe, around 45km for Chinkhoma.

[22] It should be noted that there is only one auction company active in Malawi (Auction Holding Limited (AHL)).

instrument is a binary variable that characterizes proximity to an existing auction floor, where proximity to an existing auction floor is – again – defined as those EPAs located in the source area of the existing auction. In the empirical work we have assumed – again – that this concerns EPAs within a radius of at most 50-150 km from existing auctions. Thus, $d(existing\ auction)_i = 1$ if there is an existing auction floor within a radius of 50-150km of EPA i and zero elsewhere. In summary we run a probit estimation using the following specification:

$$I_i = f(expected\ turnover_i,\ d(existing\ auction)_i) \quad (5)$$

We expect partial derivatives of the intervention variable with respect to expected turnover to be positive ($\partial I_i / \partial expected\ turnover_i > 0$) and negative with respect to proximity to existing auctions ($\partial I_i / \partial \big(d(existing\ auctions)\big)_i < 0$). It should be noted that the second instrument, proximity to existing auctions, may lead to a perfect fit. Therefore, we may as well run the probit estimation of the intervention variable only with the expected turnover instrument, on a restricted sample. In that case we estimate:

$$I_i = f(expected\ turnover_i) \quad (6)$$

At this stage both expected turnover of a potential auction and proximity to existing auctions are loosely defined in terms of distance: we determine the relevant radius for both variables empirically.

Data for estimations

Data, data sources and variable construction are documented in Appendix A. Here we comment on a few data related issues. The impact estimations are based on annual data of agricultural production and crop area on the level of Extension Planning Area's (EPAs). Extension Planning Areas (EPAs) are subdivisions of districts and have an average area of 523 km2 (median: 489 km2 [23]), an average population of around 68,000 (median: 60,000) and an average of around 17,000 households (median: 16,000). Data on production and area by EPA are available for the crop years from 2003/04 to 2009/10. The EPA data cover the whole of Malawi, a total of 198 EPAs. A substantial number of EPA observations at the start of the sample period are, however, missing. This is clear from comparison of aggregate production volumes with aggregate auction volumes (see Appendix A, Figure A2). There are also a few EPAs that have negligible tobacco cultivation, most notably EPAs in the district Chikwawa and Nsanje.

In order to calculate distances between locations we use standard Great Circle Distances on the basis of latitude and longitude coordinates: Great Circle Distance is the shortest path between two points on the surface of a sphere (for calculation see e.g. www.cpearson.com). Hence, calculated distance from EPAs to the different auction floors is a crow's eye distances. This involves a variety of errors (it is assumed that the earth is a perfect sphere, which is not the case; identified locations within EPAs may not necessarily be representative of the tobacco area in the EPA and road distance differs from crow's eye distance[24]). Nevertheless, distances calculated on the basis of latitude – longitude coordinates are considered to be reasonable approximations for most pairs of locations.

Data on maize prices are only by district, while data on tobacco prices are annual national average auction data (and, hence, do not distinguish the different auctions). We have also used farm gate prices for tobacco, but these often generated poor results, much poorer than

[23] A few districts have very large sized EPAs (Kasungu and Nkhotakotha, respectively above 1300km2 and 1050km2 and one very small EPA (Likoma, 18km2). The bulk of the EPAs has a size between 230km2 and 800km2.

[24] This applies most explicitly for a number of EPAs in the district of Mangochi: crows eye distance assumes that transport to Lilongwe, Chinkhoma and Mzuzu runs across lake Malawi. In principle transport by ship is feasible, but transport costs differ drastically from transport costs by truck. Hence, whatever is the case crow's eye distance is not a good approximation for transport costs for these EPAs.

auction prices: possibly this is an indication that behavior is more guided by auction prices rather than farm gate prices. Rainfall data are available for a selection of weather stations – around 30 – which are attributed to EPAs on the basis of distance.

4. Impact of market access on tobacco yield, area and production

Selected estimation results for equation (4a) to (4c) are reported in Table 2, 3 and 4, respectively for yield, production and area. The tables show results with the intervention variable as a binary variable (first three columns) and as a variable that is inversely proportional to the minimum distance to the new auction floor (last three columns). We report respectively specifications with dummies only (column 1 and 4), including dummies and additional covariates (column 2 and 5) and including dummies, additional covariates and the lagged dependent variable (column 3 and 6). Following Arellano and Bond (1991), specification in column 3 and 6 include the lagged dependent variable as an additional regressor in order to control for endogeneity. If we include the lagged dependent variable we lose one year observations, the base year. As a result we cannot distinguish impact dummies from EPA fixed effects: again, impacts are identified through the EPA fixed effect. Therefore we have omitted the impact dummy for 2004-05. This appears justified, since the impact in this year is small and insignificant in previous estimations of both yield, area and production. In the specifications including the lagged dependent variable, the long run impact is calculated as $\beta/(1-\varphi)$ where β is the coefficient of the intervention variable and φ is the coefficient of the lagged dependent variable, and using $y_{i,t} = y_{i,t-k}$ (or $q_{i,t} = q_{i,t-k}$, or $a_{i,t} = a_{i,t-k}$) for any k.

Table 2 Estimated effects of market access on tobacco yield: basic specification

Dependent variable: natural logarithm of tobacco yield by Extension Planning Area ($\ln(q_{tobacco,i,t} / a_{tobacco,i,t})$)						
	(1)	(2)	(3)	(4)	(5)	(6)
I(2004-2005)	0.1155	0.1394				
	(1.4)	(1.9)				
I(2005-2006)	0.1093	0.1187	-0.0250			
	(1.3)	(1.6)	(0.4)			
I(2006-2007)	0.2062	0.2280	0.0710			
	(2.5)	(3.1)	(1.1)			
I(2007-2008)	0.2554	0.2672	0.1135			
	(3.1)	(3.6)	(1.8)			
I(2008-2009)	0.2715	0.3120	0.0988			
	(3.3)	(4.2)	(1.6)			
I(2009-2010)	0.2369	0.2710	0.1128			
	(2.9)	(3.7)	(1.8)			
$1/d_{na}$ x I(2004-2005)				0.0068	0.0094	
				(1.4)	(2.1)	
$1/d_{na}$ x I(2005-2006)				0.0062	0.0093	-0.0029
				(1.2)	(2.1)	(0.8)
$1/d_{na}$ x I(2006-2007)				0.0124	0.0149	0.0046
				(2.5)	(3.4)	(1.3)
$1/d_{na}$ x I(2007-2008)				0.0155	0.0174	0.0076
				(3.1)	(3.9)	(2.1)
$1/d_{na}$ x I(2008-2009)				0.0163	0.0200	0.0068
				(3.3)	(4.5)	(1.9)
$1/d_{na}$ x I(2009-2010)				0.0144	0.01765	0.0076
				(2.9)	(4.0)	(2.1)
ln(lagged tobacco yield)			0.1231			
			(3.7)			
ln(lagged tobacco price)		0.0805	0.2811		0.0873	-0.1802
		(0.9)	(1.2)		(1.0)	(0.7)
ln(lagged maize price)		0.2352	0.1306		0.2274	0.1292
		(2.6)	(1.1)		(2.6)	(1.1)
ln(rainfall)		0.1921	-0.0042		0.1854	0.0405
		(3.4)	(0.1)		(3.3)	(0.7)
ln(chemical fertilizer use)		-0.0117	0.0260		-0.0149	0.0167
		(0.4)	(0.7)		(0.5)	(0.5)
dEPA(i)	yes	yes	yes	yes	yes	yes
dYEAR (t) x REG(k)	yes	yes	yes	yes	yes	yes
Number of observations	1182	1150	942	1182	1148	940
F (.)	(213, 968) 7.79	(210, 939) 10.46	(204, 737) 11.62	(213, 968) 7.80	(210, 937) 10.57	(203, 736) 11.81
Prob > chi2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Adjusted R2	0.5506	0.6335	0.6972	0.5509	0.6367	0.7003
RMSE	0.27472	0.23549	0.20411	0.27465	0.23381	0.19651

Notes – The table reports estimates of tobacco yield. Estimations are based on annual data from 2003-04 to 2009-10 (seven years). Tobacco price and maize prices are nominal prices and are expected to have an opposite sign. All equations are estimated with OLS. Absolute *t*-statistics are given in parentheses (.) below the coefficient. Adjusted R2 = coefficient of determination, adjusted for degrees of freedom, and RMSE = Root Mean Squared Error. We do not report coefficients and t-values of the constant term and a complete set of EPA dummies and year by region dummies (dEPA(i), dYEAR(t) x REG(k)). Estimations follow the specification of equation (4a), with restrictions on the coefficients.

Table 3 Estimated effects of market access on tobacco production: basic specification

Dependent variable: natural logarithm of tobacco production relative to base period tobacco production, by Extension Planning Area ($\ln(q_{tobacco,i,t} / q_{tobacco,i,base})$)

	(1)	(2)	(3)	(4)	(5)	(6)
I(2004-2005)	0.2286	0.2829				
	(1.5)	(1.8)				
I(2005-2006)	0.2413	0.4080	0.0339			
	(1.5)	(2.6)	(0.3)			
I(2006-2007)	0.2813	0.3461	0.1853			
	(1.8)	(2.2)	(1.5)			
I(2007-2008)	0.4746	0.5192	0.2960			
	(3.0)	(3.4)	(2.4)			
I(2008-2009)	0.3110	0.3764	0.0923			
	(2.0)	(2.4)	(0.8)			
I(2009-2010)	0.2593	0.2185	-0.0323			
	(1.6)	(1.4)	(0.3)			
$1/d_{na}$ x I(2004-2005)				0.0135	0.0189	
				(1.4)	(2.1)	
$1/d_{na}$ x I(2005-2006)				0.0137	0.0202	0.0022
				(1.4)	(2.2)	(0.3)
$1/d_{na}$ x I(2006-2007)				0.0202	0.0200	0.0034
				(2.1)	(2.2)	(0.5)
$1/d_{na}$ x I(2007-2008)				0.0282	0.0337	0.0157
				(2.9)	(3.6)	(2.1)
$1/d_{na}$ x I(2008-2009)				0.0164	0.0216	0.0006
				(1.7)	(2.3)	(0.1)
$1/d_{na}$ x I(2009-2010)				0.0149	0.0147	-0.0072
				(1.5)	(1.6)	(1.0)
ln(lagged tobacco production)			0.4012			0.4294
			(13.3)			(14.2)
ln(lagged tobacco price)		-0.1018	2.5735		-0.2384	1.1593
		(0.5)	(7.5)		(1.3)	(3.5)
ln(lagged maize price)		0.5220	-0.0087		0.4917	0.0053
		(2.8)	(0.0)		(2.7)	(1.0)
ln(rainfall)		0.3070	0.3221		0.3056	0.4042
		(2.5)	(2.7)		(2.5)	(3.3)
ln(chemical fertilizer use)		-0.0850	-0.0065		-0.0800	-0.0578
		(1.4)	(0.1)		(1.3)	(0.8)
dEPA(i)	yes	yes	yes	yes	yes	yes
dYEAR (t) x REG(k)	yes	yes	yes	yes	yes	yes
Number of observations	1116	1101	896	1117	1104	912
F (.)	(190, 925) 7.15	(191, 909) 7.56	(187, 708) 12.68	(190, 926) 6.89	(191, 912) 7.65	(187, 724) 12.21
Prob > chi2	0.00000	0.0000	0.0000	0.0000	0.0000	0.0000
Adjusted R2	0.5117	0.5352	0.7093	0.5006	0.5353	0.6971
RMSE	0.50676	0.48360	0.38134	0.52359	0.48384	0.39754

Notes – The table reports estimates of tobacco production. Estimations are based on annual data from 2003-04 to 2009-10 (seven years). Tobacco price and maize prices are nominal prices and are expected to have an opposite sign. All equations are estimated with OLS. Absolute *t*-statistics are given in parentheses (.) below the coefficient. Adjusted R2 = coefficient of determination, adjusted for degrees of freedom, and RMSE = Root Mean Squared Error. We do not report coefficients and t-values of the constant term and a complete set of EPA dummies and year by region dummies (dEPA(i), dYEAR(t) x REG(k)). Estimations follow the specification of equation (4b), with restrictions on the coefficients.

Table 4 Estimated effects of market access on tobacco area: basic specification

Dependent variable: natural logarithm of tobacco area relative to base period tobacco area, by Extension Planning Area ($\ln(a_{tobacco,i,t} / a_{tobacco,i,base})$)

	(1)	(2)	(3)	(4)	(5)	(6)
I(2004-2005)	0.0515	0.1473				
	(0.4)	(1.1)				
I(2005-2006)	0.1101	0.1821	0.0550			
	(0.9)	(1.4)	(0.5)			
I(2006-2007)	0.0630	0.0792	-0.0169			
	(0.5)	(0.6)	(0.2)			
I(2007-2008)	0.0979	0.2300	0.2008			
	(0.8)	(1.8)	(1.9)			
I(2008-2009)	0.0125	0.0199	-0.0871			
	(0.1)	(0.2)	(0.8)			
I(2009-2010)	-0.0557	-0.1196	-0.1524			
	(0.4)	(0.9)	(1.4)			
$1/d_{na}$ x I(2004-2005)				0.0037	0.0071	
				(0.5)	(0.9)	
$1/d_{na}$ x I(2005-2006)				0.0054	0.0091	0.0011
				(0.7)	(1.1)	(0.2)
$1/d_{na}$ x I(2006-2007)				-0.0001	0.0028	-0.0024
				(0.0)	(0.4)	(0.4)
$1/d_{na}$ x I(2007-2008)				0.0087	0.0111	0.0099
				(1.1)	(1.4)	(1.5)
$1/d_{na}$ x I(2008-2009)				-0.0039	-0.0011	-0.0069
				(0.5)	(0.2)	(1.1)
$1/d_{na}$ x I(2009-2010)				-0.0134	-0.1411	-0.0111
				(1.7)	(0.9)	(1.7)
ln(lagged tobacco area)			0.4940			0.5025
			(15.8)			(16.1)
ln(lagged tobacco price)		-0.1400	0.4340		-0.1411	1.0366
		(0.9)	(1.1)		(0.9)	(3.2)
ln(lagged maize price)		0.3480	-0.0972		0.3967	-0.1233
		(2.3)	(0.5)		(2.5)	(0.7)
dEPA(i)	yes	yes	yes	yes	yes	yes
dYEAR (t) x REG (k)	yes	yes	yes	yes	yes	yes
Number of observations	1110	1122	921	1123	1123	927
F (.)	(189, 920) 5.68	(191, 930) 5.85	(187, 733) 10.15	(189, 933) 5.75	(191, 931) 5.74	(186, 740) 11.01
Prob > chi2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Adjusted R2	0.5387	0.4523	0.6502	0.5379	0.4465	0.6679
RMSE	0.40312	0.41780	0.34152	0.42093	0.42402	0.34503

Notes – The table reports estimates of tobacco area. Estimations are based on annual data from 2003-04 to 2009-10 (seven years). Tobacco price and maize prices are nominal prices and are expected to have an opposite sign. All equations are estimated with OLS. Absolute *t*-statistics are given in parentheses (.) below the coefficient. Adjusted R2 = coefficient of determination, adjusted for degrees of freedom, and RMSE = Root Mean Squared Error. We do not report coefficients and t-values of the constant term and a complete set of EPA dummies and year by region dummies (dEPA(i), dYEAR(t) x REG(k)). Estimations follow the specification of equation (4c), with restrictions on the coefficients.

In the estimations we have checked for outliers in order to prevent that size and (in)significance of coefficients are to a large extent due to a few observations[25]. The dummies used in the estimations concern a complete set of EPA dummies combined with a complete set of region-by-year dummies. The intervention dummies are identified by the inclusion of EPA dummies / EPA fixed effects.

We first consider the estimations of the impact of market access on yield (Table 2). The intervention dummies are statistically significant for all impacts except the one of the first years of possible impact, 2004-2005 and 2005-2006. The size of the impact is large, grows over the years but drops in the final year. Including additional covariates increases the size of the impact coefficients moderately, but essentially does not change the pattern of impact. Additional covariates – tobacco prices, maize prices, rainfall and chemical fertilizer use (NPK) – perform mixed: coefficients not always have the expected sign and are statistically significant with the expected sign in only a few instances. Also the contribution to explaining variation is limited. Including the lagged dependent variable to the additional covariates deteriorates the impact coefficients: the impact coefficients are still positive and significant, but become slightly lower and particularly small in the last year.

The estimation results of Table 2 support a statistically significant impact of the new auction floor on yield. We are keen to find out if this increase in yield is due to production increases, area increases or both and this can be investigated on the basis of impact estimations using production and area as outcome variable, as is implemented in Table 3 and Table 4. The impact estimations using production as outcome variable, reported in Table 3, are similar to the yield equations. The intervention dummies are also statistically significant for all impacts except the ones of the first years of possible impact, 2004-2005 and 2005-2006.

[25] This notion – that size and (in)significance of coefficients are to a large extent due to one or a few observations – constitutes our definition of an outlier.

The size of the impact is large, grows over the years, reaches a peak in 2007-2008, and drops in the final years. Including additional covariates, again, increases the size of the impact coefficients somewhat, but essentially does not change the pattern of impact. Again, the performance of the additional covariates is mixed. However, rainfall is consistently statistically significant with the expected positive sign. Including the lagged dependent variable to the additional covariates deteriorates the impact coefficients even more than in the case of the yield equation: all impact coefficients become statistically insignificant except the one for 2007-2008.

Next, we turn to the estimations that measure the impact of market access on area (Table 4). The output shows consistently insignificant impact coefficients for all years, in all specifications. Including additional covariates and the lagged dependent variable also does not change the pattern of impact: hardly any significant impact, with a possibly exception for the impact in 2007-2008 that becomes weakly significant. The performance of additional covariates – in case of the area equation only tobacco prices and maize prices – is again mixed. We may conclude on the basis of the estimations in Table 2, 3 ad 4 that market access has a statistically significant positive impact on yield that stems primarily from increases in production.

In the previous section we stated that the intervention variable – the introduction of a new auction floor – is endogenous and needs to be modelled. We proceed with presenting the estimation results for instrumenting the intervention variable and re-running the impact estimations for yield, production and area using instrumental variables.

Table 5 Estimation of selection of EPAs that benefit from the Chinkhoma auction floor

Dependent variable: intervention locations (binary variable: 1 if Chinkhoma auction floor is (approximately) the closest auction floor (see also *Identification of intervention locations*) and zero elsewhere)

	(1)	(2)	(3)	(4)	(5)	(6)
ln(expected tobacco turnover)	1.6610	4.9701	2.5014	6.3769	1.5400	14.2009
	(6.6)	(5.3)	(4.8)	(3.1)	(3.9)	(3.4)
d(proximity to Lilongwe auction floor)		-4.8356		-5.6167		-12.924
		(5.3)		(3.0)		(3.3)
d(proximity to Mzuzu auction floor)		-1.7040		-2.3751		-3.8461
		(3.7)		(2.7)		(2.2)
Excluding EPAs near to auction floor in			Bla(200)	Bla(200)	Bla(200) Mzu(50) Lil(30)	Bla(200) Mzu(50) Lil(30)
Number of observations	199	199	113	113	94	94
LR chi2 (.)	(1) 78.84	(3) 143.51	(1) 46.55	(3) 80.31	(1) 31.07	(3) 93.87
Prob > chi2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Pseudo R2	0.3549	0.6460	0.3010	0.5193	0.2388	0.7212
Log pseudo likelihood	-71.65	-39.32	-54.05	-37.17	-49.53	-18.14

Notes – The table reports estimates of selection of EPAs that benefit from the Chinkhoma auction floor. Estimations are based on annual data of 2005-2006, or later (for the dependent variable, or the intervention variable) and data from 2003-04 to 2005-06 (for the pre-intervention explanatory variables). All equations are estimated with PROBIT. Absolute z-statistics are given in parentheses (.) below the coefficient, and these are based on robust standard errors (Huber/White/sandwich estimator). Pseudo R2 = pseudo coefficient of determination. We do not report coefficients and t-values of the constant term.

Table 6 Estimated effects of market access on tobacco yield: instrumental variables

Dependent variable:
natural logarithm of tobacco yield by Extension Planning Area ($\ln(q_{tobacco,i,t} / a_{tobacco,i,t})$)

	(1)	(2)	(3)	(4)	(5)	(6)
I(2004-2005)	0.0974	0.1108				
	(1.0)	(1.1)				
I(2005-2006)	0.0790	0.0940	-0.0325			
	(0.8)	(0.9)	(0.4)			
I(2006-2007)	0.2301	0.2333	0.1093			
	(2.4)	(2.4)	(1.5)			
I(2007-2008)	0.2790	0.2890	0.1503			
	(2.9)	(2.9)	(2.0)			
I(2008-2009)	0.3146	0.3604	0.1454			
	(3.3)	(3.6)	(2.0)			
I(2009-2010)	0.2723	0.3111	0.1666			
	(2.9)	(3.2)	(2.3)			
$1/d_{na}$ x I(2004-2005)				0.0002	0.0028	
				(0.0)	(0.5)	
$1/d_{na}$ x I(2005-2006)				0.0046	0.0070	0.0022
				(1.0)	(1.5)	(0.6)
$1/d_{na}$ x I(2006-2007)				0.0105	0.0118	0.0093
				(2.2)	(2.4)	(2.7)
$1/d_{na}$ x I(2007-2008)				0.0094	0.0108	0.0082
				(2.0)	(2.3)	(2.3)
$1/d_{na}$ x I(2008-2009)				0.0116	0.0147	0.0102
				(2.5)	(3.0)	(2.9)
$1/d_{na}$ x I(2009-2010)				0.0116	0.0139	0.0110
				(2.5)	(2.9)	(3.2)
ln(lagged tobacco yield)			0.1189			0.0897
			(3.6)			(2.7)
ln(lagged tobacco price)		0.8974	0.2789		0.3225	-0.6627
		(2.8)	(1.2)		(3.3)	(2.3)
ln(lagged maize price)		0.2235	0.1411		0.1868	0.1063
		(2.2)	(1.2)		(1.8)	(0.9)
ln(rainfall)		0.2003	0.0001		0.1837	0.0332
		(3.1)	(0.0)		(2.8)	(0.6)
ln(chemical fertilizer use)		-0.0059	0.0216		0.0030	0.0171
		(0.2)	(0.6)		(0.1)	(0.5)
dEPA(i)	yes	yes	yes	yes	yes	yes
dYEAR (t) x REG(k)	yes	yes	yes	yes	yes	yes
Number of observations	1182	1154	942	1182	1152	940
F (.)	(213, 968) 7.82	(209, 944) 7.68	(204, 737) 11.70	(213, 968) 7.76	(209, 942) 7.64	(203, 736) 11.84
Prob > chi2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Adjusted R2	0.5515	0.5476	0.6988	0.5492	0.5466	0.7008
RMSE	0.27446	0.27504	0.20358	0.27515	0.2747	0.19635

Notes – The table reports estimates of tobacco yield. Estimations are based on annual data from 2003-04 to 2009-10 (seven years). Tobacco price and maize prices are nominal prices and are expected to have an opposite sign. All equations are estimated with IV of the intervention variable. Absolute *t*-statistics are given in parentheses (.) below the coefficient. Adjusted R2 = coefficient of determination, adjusted for degrees of freedom, and RMSE = Root Mean Squared Error. We do not report coefficients and t-values of the constant term and a complete set of EPA dummies and year by region dummies (dEPA(i), dYEAR(t) x REG(k)). Estimations follow the specification of equation (4a), with restrictions on the coefficients.

Table 7 Estimated effects of market access on tobacco production: instrumental variables

Dependent variable: natural logarithm of tobacco production relative to base period tobacco production, by Extension Planning Area ($\ln(q_{tobacco,i,t} / q_{tobacco,i,base})$)

	(1)	(2)	(3)	(4)	(5)	(6)
I(2005-2006)	0.3236	0.2883				
	(1.7)	(1.5)				
I(2004-2005)	0.2810	0.3127	0.0198			
	(1.5)	(1.7)	(0.1)			
I(2006-2007)	0.3547	0.3184	0.2031			
	(1.9)	(1.7)	(1.3)			
I(2007-2008)	0.6471	0.5834	0.4059			
	(3.5)	(3.1)	(2.8)			
I(2008-2009)	0.4535	0.4249	0.1392			
	(2.4)	(2.2)	(0.9)			
I(2009-2010)	0.4193	0.2200	-0.0042			
	(2.2)	(1.1)	(0.0)			
$1/d_{na}$ x I(2004-2005)				0.0228	0.0276	
				(2.3)	(2.8)	
$1/d_{na}$ x I(2005-2006)				0.0210	0.0270	-0.0077
				(2.2)	(2.9)	(0.9)
$1/d_{na}$ x I(2006-2007)				0.0193	0.0228	-0.0066
				(2.0)	(2.4)	(0.8)
$1/d_{na}$ x I(2007-2008)				0.0269	0.0185	0.0055
				(2.7)	(2.0)	(0.6)
$1/d_{na}$ x I(2008-2009)				0.0196	0.0187	-0.0065
				(2.0)	(2.0)	(0.8)
$1/d_{na}$ x I(2009-2010)				0.0199	0.0193	-0.0079
				(2.0)	(1.9)	(1.0)
ln(lagged tobacco production)			0.4022			0.4160
			(13.3)			(12.5)
ln(lagged tobacco price)		1.0117	2.6206		0.6421	1.1031
		(3.2)	(7.6)		(3.6)	(3.1)
ln(lagged maize price)		0.5199	-0.0263		0.5966	0.1853
		(2.7)	(0.1)		(3.1)	(0.7)
ln(rainfall)		0.2923	0.3311		0.2728	0.4194
		(2.3)	(2.8)		(2.1)	(3.1)
ln(chemical fertilizer use)		-0.0692	-0.0082		-0.0157	-0.1081
		(1.1)	(0.1)		(0.3)	(1.4)
dEPA(i)	yes	yes	yes	yes	yes	yes
dYEAR (t) x REG(k)	yes	yes	yes	yes	yes	yes
Number of observations	1116	1106	896	1117	1105	912
F (.)	(190, 925) 7.20	(190, 915) 6.84	(187, 708) 12.73	(190, 926) 6.89	(190, 914) 6.75	(187, 724) 9.55
Prob > chi2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Adjusted R2	0.5137	0.5011	0.7102	0.5005	0.4973	0.6371
RMSE	0.50571	0.50960	0.38073	0.50799	0.50567	0.43475

Notes – The table reports estimates of tobacco production. Estimations are based on annual data from 2003-04 to 2009-10 (seven years). Tobacco price and maize prices are nominal prices and are expected to have an opposite sign. All equations are estimated with IV of the intervention variable. Absolute *t*-statistics are given in parentheses (.) below the coefficient. Adjusted R2 = coefficient of determination, adjusted for degrees of freedom, and RMSE = Root Mean Squared Error. We do not report coefficients and t-values of the constant term and a complete set of EPA dummies and year by region dummies (dEPA(i), dYEAR(t) x REG(k)). Estimations follow the specification of equation (4b), with restrictions on the coefficients.

Table 8 Estimated effects of market access on tobacco area: instrumental variables

Dependent variable: natural logarithm of tobacco area relative to base period tobacco area, by Extension Planning Area ($\ln(a_{tobacco,i,t} / a_{tobacco,i,base})$)						
	(1)	(2)	(3)	(4)	(5)	(6)
I(2004-2005)	0.1046	0.2112				
	(0.7)	(1.4)				
I(2005-2006)	0.1208	0.1713	0.0455			
	(0.8)	(1.1)	(0.4)			
I(2006-2007)	0.0419	0.0978	-0.0491			
	(0.3)	(0.6)	(0.4)			
I(2007-2008)	0.1279	0.2694	0.2543			
	(0.9)	(1.8)	(2.0)			
I(2008-2009)	0.0463	0.0387	-0.1212			
	(0.3)	(0.3)	(1.0)			
I(2009-2010)	-0.0144	-0.1578	-0.1912			
	(0.1)	(1.0)	(1.5)			
$1/d_{na}$ x I(2004-2005)				0.0068	0.0126	
				(0.9)	(1.6)	
$1/d_{na}$ x I(2005-2006)				0.0053	0.0062	-0.0056
				(0.7)	(0.8)	(0.9)
$1/d_{na}$ x I(2006-2007)				-0.0037	-0.0026	-0.0083
				(0.5)	(0.3)	(1.3)
$1/d_{na}$ x I(2007-2008)				-0.0055	-0.0005	-0.0054
				(0.8)	(0.1)	(0.9)
$1/d_{na}$ x I(2008-2009)				-0.0114	-0.0054	-0.0109
				(1.6)	(0.7)	(1.8)
$1/d_{na}$ x I(2009-2010)				-0.0211	-0.0110	-0.0181
				(3.0)	(1.5)	(2.9)
ln(lagged tobacco area)			0.4965			0.4926
			(15.9)			(15.7)
ln(lagged tobacco price)		-0.0788	0.4766		0.3264	0.2506
		(0.3)	(1.1)		(2.4)	(0.9)
ln(lagged maize price)		0.3429	-0.1233		0.3648	-0.0255
		(2.3)	(0.6)		(2.5)	(0.1)
dEPA(i)	yes	yes	yes	yes	yes	yes
dYEAR (t) x REG (k)	yes	yes	yes	yes	yes	yes
Number of observations	1110	1117	921	1123	1119	927
F (.)	(189, 920) 5.68	(189, 927) 5.50	(187, 733) 10.19	(189, 933) 5.90	(190, 928) 5.76	(186, 740) 10.97
Prob > chi2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Adjusted R2	0.4435	0.4325	0.6513	0.4523	0.4472	0.6669
RMSE	0.40328	0.41702	0.34098	0.41971	0.41364	0.34552

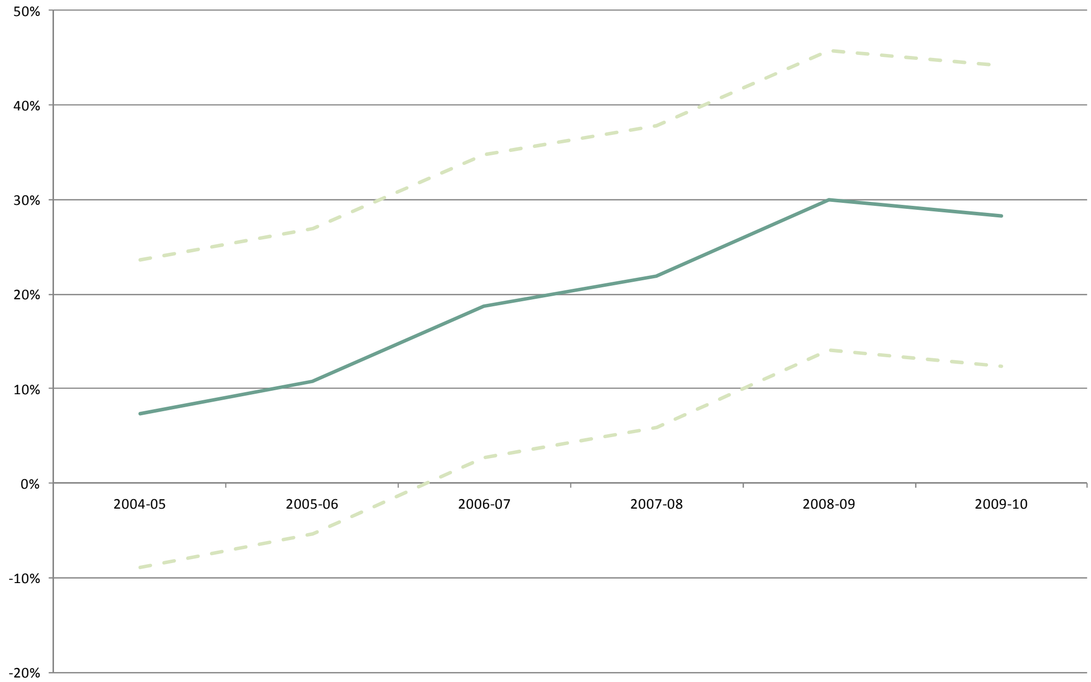
Notes – The table reports estimates of tobacco area. Estimations are based on annual data from 2003-04 to 2009-10 (seven years). Tobacco price and maize prices are nominal prices and are expected to have an opposite sign. All equations are estimated with IV of the intervention variable. Absolute *t*-statistics are given in parentheses (.) below the coefficient. Adjusted R2 = coefficient of determination, adjusted for degrees of freedom, and RMSE = Root Mean Squared Error. We do not report coefficients and t-values of the constant term and a complete set of EPA dummies and year by region dummies (dEPA(i), dYEAR(t) x REG(k)). Estimations follow the specification of equation (4c), with restrictions on the coefficients.

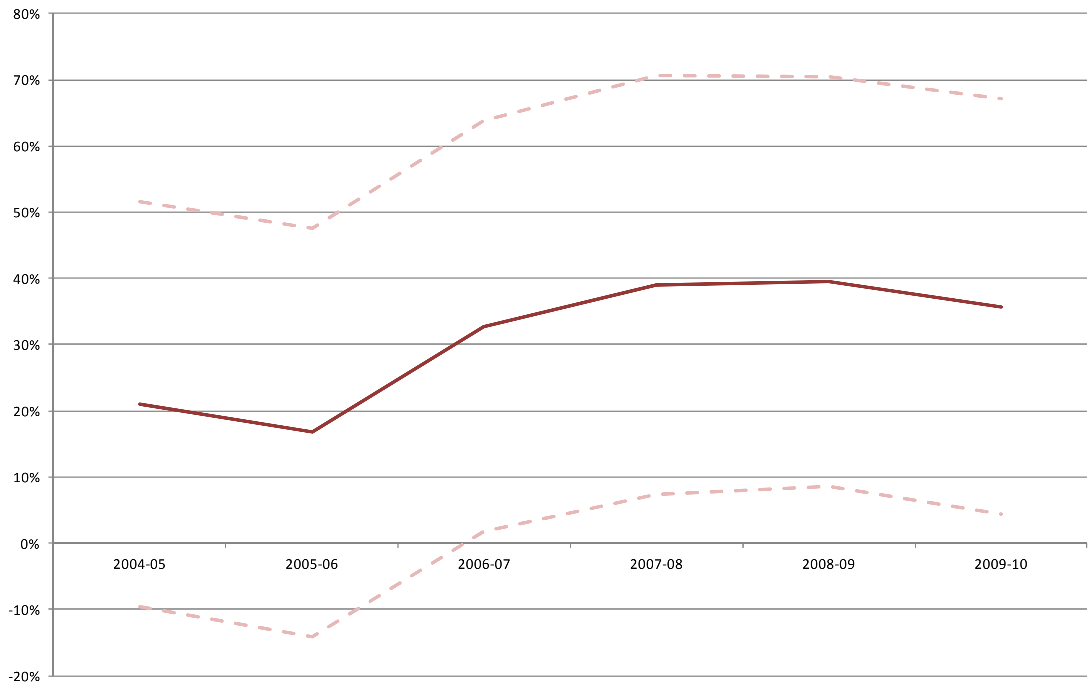
Table 5 reports equations that explain the intervention variable – the question if farmers in a specific EPA benefit from the newly established auction floor or not – using expected revenue and proximity to an existing auction floor as instruments. The estimated coefficienets are well behaved: expected turnover and proximity to existing auctions are both significant and have the expected sign. It should be noted that variations in source area, both of possible new auction floors as well of existing auction floors, allow quite some flexibility in these estimations. We have used the estimate reported in column 6 as the basis of the instrumental variable estimations, reported in Table 6, 7 and 8.

The instrumental variable estimations, reported in Table 6, 7 and 8, further confirm the results that are also generated with the basic estimations: the estimations support a positive impact of the introduction of a new auction floor on yield and production, and no impact on crop area. The yield equations estimated with instrumental variables (Table 6) indicate a significant impact starting in 2006-2007. The production equations estimated with instrumental variables (Table 7) also indicate a significant impact starting in 2006-2007. The size of the production impact appears to be slightly larger.

The estimation results from the tables are summarized in Figure 3. In this figure we have plotted the impact on area and production relative to the average "pre-intervention" levels of area and production in the intervention EPAs. In the specification using the inverse of the minimum distance we have evaluated the impact coefficient against the average annual inverse of the minimum distance. We have also included the 95% confidence intervals of the estimated impact.

Figure 3 Effects of market access on tobacco yield (upper panel) and on production (lower panel)[a], in % of base year production and area)





[a] The dotted lines indicate 95% confidence intervals
Notes – Figures are calculated on the basis of estimation results.

The figures are self explanatory. Apart from summarizing the estimations presented in the tables, the figures summarize the major message of this research. The EPA data used for this work support a large impact of market access on tobacco yield and tobacco production. The impact on yield and production is marginal in the first years, but increases after some years to reach a maximum of 30 to 40% above base year levels, after around four years. The size of the impact is large but not out of proportion in view of the sizable reduction in costs realized by market access. In the last year of our sample the impact drops: more research and more data are needed to explain this. We could not find a significant impact on area. Inclusion of additional covariates (rainfall, fertilizer use, tobacco prices, maize prices), lagged dependent variables and instrumenting of the intervention variable all maintain the basic message of this exercise.

Alternative explanations

Trend developments

The measured impact could be the result of differences between the intervention and non intervention EPAs that existed before the intervention took place. Hence, we need to verify if the intervention and non-intervention EPAs were on a similar time path during the pre-intervention period. Unfortunately we have few observations in the pre-intervention period: strictly, we have only one year of pre-intervention data (2003-04) since the auction floor started operation in 2004. However, from the estimations it is evident that the measured impact is delayed a few years, and therefore we may move up in the intervention period a few years for this purpose.

Table 9 Comparison of variables of intervention and non–intervention locations in the pre-intervention period

		Unconditional mean			
	period	intervention	non-intervention	difference	F test
area (level)	2003/04-2005/06	1762.3	405.5	1356.8	280.6
		(25.4)	(9.8)		(0.000)
area (trend)	2003/04-2005/06	12.3	15.8	-3.5	0.00
		(0.1)	(0.3)		(0.972)
area (growth)	2004/05-2006/07	0.029	0.024	0.005	0.01
		(0.6)	(0.8)		(0.935)
production (level)	2003/04-2005/06	1091.6	372.5	719.1	105.0
		(18.1)	(10.4)		(0.000)
production (trend)	2003/04-2005/06	83.3	63.8	19.5	0.06
		(1.2)	(1.6)		(0.811)
production (growth)	2004/05-2005/06	0.275	0.285	-0.010	0.01
		(3.7)	(5.7)		(0.910)
Rainfall	2003/04-2005/06	928.5	954.8	-26.3	0.28
		(41.4)	(67.0)		(0.595)
fertilizer use	2003/04-2005/06	394.1	398.5	-4.4	0.03
		(17.1)	(27.3)		(0.873)

Notes – The table report means and differences of the group of intervention EPAs and the group of non-intervention EPAs, both during the pre-intervention period. The table additionally reports the F test and its P-value on the significance of the difference. Trend is estimated, combined with a constant term.

Table 9 shows the unconditional means of intervention and non intervention variables, both outcome and additional covariates, its difference and mean difference tests, all during the pre-intervention period. The mean test confirm a significant difference in levels, which is not a surprise: it would have been coincidence if the level of tobacco area and production in intervention and non-intervention EPAs is similar. Since, we are more concerned with developments over time and hence we do not consider this to be relevant. Tests on trend developments and annual rates of change of the outcome variables (area and production) and on other co-variates, of both the intervention EPAs and the non-intervention EPAs are consistently shown to be similar in the pre-intervention period. Hence, we may conclude that intervention and non-intervention EPAs are on a similar time path before the intervention.

Ceilings to expansion

Another issue concerns the presence of ceilings to expand: if all land suitable for tobacco cultivation is exhausted, there are no possibilities for further growth of tobacco production. EPAs that meet these conditions cannot be used as controls. Potential availability of crop area can be investigated: EPA data are available for all major crops and for this exercise we distinguish crop area for tobacco, maize and other crops, where "other crops" is an aggregate of rice, groundnuts, pulses, cassava, sweet potatoes, cotton, sorghum and millet. The data underscore the overwhelming importance of maize, with an average share of around 50% of total crop area (see also Zant, 2012, for further details on the dominant role of maize). Expansion of tobacco crop area is realized either through expansion of total crop area or through substitution with other crops. We calculate the potential for expansion of total crop area, by computing the gap between the maximum total crop area over the years and actual total crop area by EPA ($pa_{it,expansion} = MAX_t(AREA_{it}) - AREA_{it}$ where $pa_{it,expansion}$ is potential crop area by expansion and $AREA_{it}$ is crop area of all crops, both in EPA i and in period t). The intuition is simple: we do not observe the potential crop area available for expansion, but assume that the maximum of total crop area realized over a period of several years, minus actual crop area, is a good approximation. Next, we calculate substitution for other crops by computing the difference between "other crop" area by EPA and the minimum area allocated to other crops in this EPA ($pa_{it,substitution} = area_{other\ crops,it} - MIN_t(area_{other\ crops,it})$ where $pa_{it,substition}$ is potential crop area by substitution and $area_{othercrops,it}$ is crop area allocated to other crops, both in EPA i and in period t). Implicitly, we assume that all potential substitution takes place in the "other crops" and only to the extent that crop area allocated to other crops exceeds a minimum level. The sum of potential expansion and potential substitution area ($pa_{it} = pa_{it,expansion} + pa_{it,substitution}$) expressed in terms of tobacco area ($pa_{it}/area_{tobacco,it}$), should be high for available area in order not to be a restriction for growth of tobacco area. On the basis of the numerical exercise we find very few of the control EPAs to have expansion opportunities for tobacco cultivation less than 100% of existing tobacco area in any year. Only a few EPAs in the northern districts

Rumphi and Mzimba[26] have below 100% potential area expansion opportunities. Even these EPAs have a minimum opportunity for expanding tobacco area of 20% per year. Hence, the average expansion opportunities of non-intervention EPAs, expressed in terms of existing tobacco area, are high and we should conclude that there are no effective restrictions in this respect[27].

Impact on other crops

The statistically significant impact on tobacco yield and tobacco production in the EPAs that are benefitting from the newly established auction may be a coincidental outcome that applies to all crops in these EPAs. For this reason we have repeated the impact estimations using yield, production and area of alternative crop, notably groundnuts. Groundnut is a cash crop, groundnut cultivation has a country wide distribution similar to tobacco and groundnuts is also an important source of income (although less than tobacco). The results of these estimations are reported in Appendix D. The estimation results do not support a systematic and significant impact on yield, production or area of groundnuts, thereby providing further support for the impact of market access on smallholder tobacco farmers.

5. Summary and conclusion

We have investigated the impact of improved market access on yield and the underlying smallholder's decisions on production and area. For this purpose we have exploited the quasi experimental design of the introduction of an additional tobacco auction floor in Malawi. Tobacco is the most important cash crop in Malawi, grown in the entire country and

[26] Notably Bolero, Katowo, Mhuju and Mphompha in Rumphi, and Bwenga and Malidadi in Mzimba.

[27] We cannot analyze if availability of labor is a restriction to growth of tobacco production in the control EPAs. However, it is hard to believe that labor is used for low return activities rather than profitable and commercially attractive crops. Hence, we assume there is no restriction on labor, either because of a large number of unpaid workers in rural areas, but also because of easy conversion from low return activities to high return activities.

exclusively sold on auctions. There are four tobacco auction floors (Limbe (Blantyre), Kanengo (Lilongwe), Mzuzu and Chinkhoma), of which the one in Chinkhoma has started operations in 2004. Estimations are based on annual data by Extension Planning Area (EPAs), 198 in total, covering the whole of Malawi, for a period of seven years, from 2003 to 2009. The data allow to track the dynamics of the impact of market access over the years. The estimation results support a statistically significant positive impact of the introduction of the new auction floor on yield, increasing to from at least after one year 10% to 21% after four years. The evidence further suggest that this increase is entirely due to production increases rather than area increases. The impact on production increases gradually over the year to reach a maximum of around % above base year production. Production and area impacts are statistically significant. Additionally, the results are shown to be robust after inclusion of rainfall, fertilizer use, tobacco prices, maize prices, the lagged dependent variable, and overall trend and a complete set of region by year dummies.

Since the data used for estimations are not household data, we cannot identify subsistence households, and, hence, we cannot answer the question – asked in the title of this paper – if access to market is going to help smallholders to move out of subsistence farming. However, the evidence does support a significant and sizable impact on tobacco production and area. With 81% of households in rural areas being classified as subsistence farmers (Integrated Household Survey-2, 2004-05) it is unlikely that the increase in yield and has not also affected subsistence farmers[28]. Distinct from this issue the results in this paper support a large impact of transaction costs and market access on agricultural area and production decisions in general.

[28] Technically it is possible that the entire increase in yield and production is due to the 19% non-subsistence farm households. Only household or farm level data can offer a conclusive answer.

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Appendix A Data and variables

Data used, data sources and variable construction

Annual data of smallholder agricultural production and crop area on the level of Extension Planning Area's (EPAs), for the years from 2003/04 to 2009/10, are from the Agro-Economic Survey of the Ministry of Agriculture and Food Security. All production and area data pertain to smallholders and exclude estates. Distances between locations are calculated using standard Great Circle Method (for calculation see e.g. www.cpearson.com / Excel / LatLong.aspx). Data on latitude and longitude coordinates, required for this calculation, are from www.geocom.com, www.mapcrow.com and GOOGLE Earth. Data on maize prices are again from the Agro-Economic-Survey, and are only by district, not by EPA. Data on tobacco prices are either annual national (average) auction data (and, hence, do not differ between the different auctions) or farm gate prices, also from the Agro-Economic-Survey. Farm gate prices for tobacco are available for around 60 markets, but these series are not complete: we have constructed complete series by assuming a fixed share of farm gate prices in auction prices for each market. The average (median) share of farm gate price in auction price is 35.2% (33.2%). Finally, the series are attributed to districts and hence, and again, these data are also only by district and not by EPA. Annual data on rainfall in mm from around 30 meteorological stations are from the Department of Climate Change and Meteorological Services, Blantyre. Aggregate data on fertilizer use are from the 2007-2008 Annual Agricultural Statistical Bulletin of the MoAFS. Annual aggregate fertilizer consumption by type of fertilizer is allocated to districts using the allocation of subsidized fertilizer packages (data also from the Ministry of Agriculture and Food Security). Data on the number of households by EPA for the year 2007/08 are from the Ministry of Agriculture and Food Security, and are extrapolated to the years 2003/04 to 2009/10 on the basis of population by district data from the National

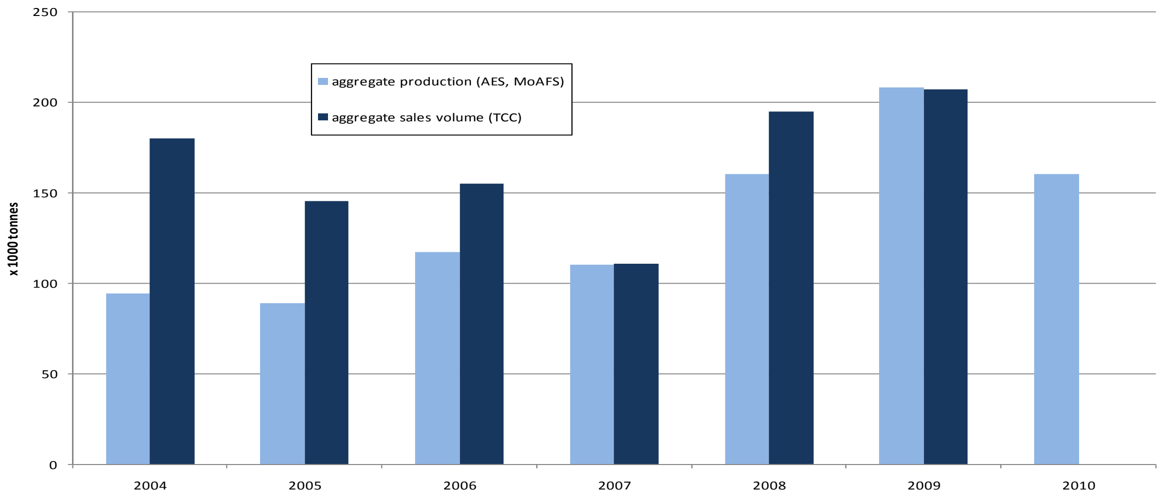
Statistical Office (NSO). Data on the number of (members of) agricultural clubs, or burley clubs, by EPA are from the Ministry of Agriculture and Food Security.

For descriptive purposes we use one year of auction transaction data. Auction transaction data were kindly made available by the Tobacco Control Commission. In particular we use all transactions (around 62,000) for the year 2009. Each transaction contains information on type of tobacco, number of bales, volume in kg, value in US$, district of origin and club. Also for descriptive purposes we use annual aggregate times series data on the tobacco sector from Tobacco Control Commission, posted on their website (www.tccmw.com).

Auction data vis-à-vis production data

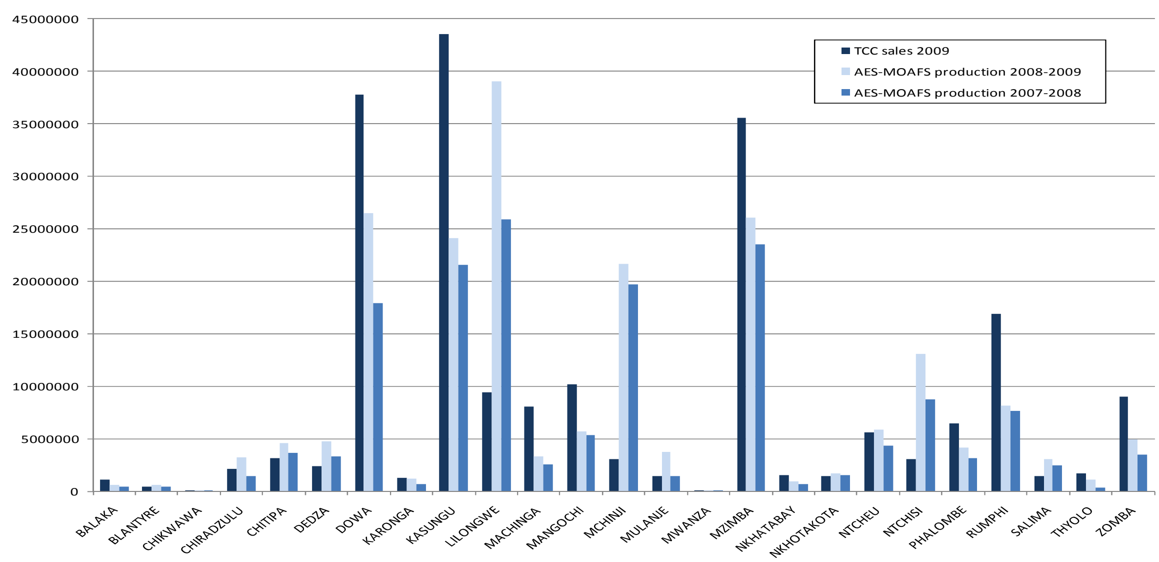
How do the auction sales data from the Tobacco Control Commission compare with the production data from the Agro-Economic Survey of the Ministry of Agriculture and Food Security? With the available data we compare national production aggregates for the crop seasons 2003/04 to 2009/10 with sales totals for the years 2004 to 2010 (see Figure A1). Additionally, we compare the district composition of production of the crop season 2008/09 (2007/08) with the district composition of sales by origin for the year 2009 (see Figure A2). The comparison reveals a number of large discrepancies: the aggregates appear to differ substantially in 2004 and 2005, while the difference gets smaller in later years; and the district distribution shows large production overestimates / sales underestimates for Lilongwe, Mchinji and Ntchisi and large sales overestimates / production underestimates for Dowa, Kasungu, Mzimba and Rumphi. At this stage we do not know what explains these discrepancies. It is clear, however, that the often claimed upward bias in data from the Agro Economic Survey / Ministry of Agriculture and Food Security is not supported by the tobacco transaction data from auctions, collected by the Tobacco Control Commission (see Figure A2).

Figure A2 Aggregate tobacco production and total auction sales volume



Source: Tobacco Control Commission and Agro Economic Survey, Ministry of Agriculture and Food Security

Figure A3 Tobacco production and auction sales volume by district



Source: Tobacco Control Commission and Agro Economic Survey, Ministry of Agriculture and Food Security

Appendix B

Figure B1 Tobacco auction floors in Malawi

Appendix C Institutions in the tobacco commodity chain in Malawi

The Tobacco Association of Malawi (TAMA) was founded in 1929 and became a registered trust in 1983. TAMA is financed by the tobacco growers through a levy on the auction floors. Its objective is to take an active role in representing tobacco growers' interests in Malawi, to ensure profitable production and marketing of their tobacco through provision of such services as research, training, education and marketing promotion (www.tamalawi.com, accessed in June 2011). TAMA has a total number of association members (tobacco growers) of close to 50,000. Among a variety of activities like marketing, finance and inputs, TAMA runs – through their operations department – close to 100 satellite depots across the country to enable growers to deliver their tobacco at places near their farms. The operations department further coordinates tobacco haulage and tobacco re-handling through its fully fledged TAMA Re-handling Company.

The Tobacco Control Commission (TCC) was established in 1938 by the Minister of Agriculture under the control of the Tobacco Auction Floors Act, financed by tobacco growers through a levy on the auction floors. The major responsibilities of TCC are: control and regulation of tobacco marketing in Malawi; licensing and registration of tobacco growers and sellers; setting product quality standards (notably defining tobacco grades and classes); collecting, processing and distributing data and statistics on tobacco; carrying out market research and dissemination of markets studies; advising the government on tobacco issues and promotion and expansion of tobacco sales and the growth of tobacco industry and enhancing its contribution to the agricultural sector and GDP, and its contribution to Malawi's foreign exchange earnings (See TCC website (www.tccmw.com), accessed in June 2011).

Auction Holdings Limited (AHL) is the private sector company that runs the auctions. Tobacco Auctions Limited and Producers Warehouse Limited, the predecessors of AHL whose first operations date back as early as 1936, operated in competition with each other until 1962, when they were amalgamated as Auction Holdings Nyasaland Limited. Following Malawi's Independence, the company was renamed Auction Holdings Limited in 1965 (See AHL website (www.ahlmw.com), accessed in June 2011). AHL currently runs operations at the four main tobacco auction floors (Limbe (Blantyre), Kanengo (Lilongwe), Mzuzu (Mzimba) and Chinkhoma (Kasungu)), together with a number of satellite auction floors, mini auction floors and rural markets[29]. In 2004 the Chinkhoma auction floor – near Kasungu in Central Malawi – has started as a satellite auction floor. At all floors AHL provides tobacco marketing facilities and related support structures. The auction floor infrastructure includes large storage facilities and warehouses and after auction processing factories from buying companies. AHL claims to ensure that growers are paid the proceeds on their bank account within 24 hours after the sale.

The National Association of Smallholder Farmers of Malawi (NASFAM), grown out of the USAID funded Smallholder Agribusiness Development Project and founded in 1997, originally aimed at supporting and organizing smallholder tobacco production, with farmers clubs and associations as major organisational unit. NASFAM currently has an extension network that reaches over 100,000 smallholder farmers, an estimated share of 15 to 25% of all smallholder tobacco farmers (Jaffee, 2003; www.nasfam.org (accessed in June 2011) and supplies - amongst other things – insurance and transport services for transport of tobacco to the auction floors under the NASFAM transport program.

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[29] TCC's tobacco market report covering the period from 1st March 2006 to 5th July 2006 states, for example: "Highlights of this year's tobacco marketing season include the opening of mini auction floors at Mgode in the Southern region, Linyangwa and Mpasadzi in the Central region and Kabwafu in the Northern region. The mini floors were opened to reduce congestion on the main floors of Lilongwe, Mzuzu and Limbe, and Chinkhoma satellite floors. The mini floors are also there to reduce the cost of transporting tobacco to the marketing that is entirely borne by the growers".

Appendix D

Table D1 Impact estimations with placebo crop (groundnuts)

Dependent variable:
natural logarithm of groundnut yield ($\ln(q_{groundnut,i,t} / a_{groundnut,i,t})$, column (1) and (2)),
natural logarithm of groundnut production relative to base ($\ln(q_{groundnut,i,t} / q_{groundnut,i,base})$, column (3) and (4))
and natural logarithm of groundnut area relative to base ($\ln(a_{groundnut,i,t} / a_{groundnut,i,base})$, column (5) and (6))
all by Extension Planning Area (EPA)

	yield		production		area	
	(1)	(2)	(3)	(4)	(5)	(6)
I(2004-2005)	0.0190	0.0531	0.2165	0.2104	0.1857	0.1753
	(0.3)	(0.8)	(1.9)	(1.9)	(2.0)	(1.9)
I(2005-2006)	-0.0297	0.0189	0.0133	0.0311	0.0688	0.0362
	(0.4)	(0.3)	(0.1)	(0.3)	(0.7)	(0.4)
I(2006-2007)	0.0447	0.0664	-0.1112	-0.1145	-0.1086	-0.1393
	(0.6)	(0.9)	(1.0)	(1.0)	(1.1)	(1.5)
I(2007-2008)	0.0679	0.0993	0.1162	0.1496	0.0737	0.0786
	(1.0)	(1.4)	(1.0)	(1.3)	(0.8)	(0.9)
I(2008-2009)	0.0659	0.1190	0.0150	-0.0014	-0.0277	-0.0805
	(0.9)	(1.7)	(0.1)	(0.0)	(0.3)	(0.9)
I(2009-2010)	0.1016	0.1540	0.1047	0.0777	0.0311	-0.0355
	(1.5)	(2.1)	(0.9)	(0.7)	(0.3)	(0.4)
ln(lagged groundnut price)		-0.0086		-0.1200		-0.1009
		(0.3)		(2.7)		(2.9)
ln(lagged maize price)		0.2525		0.0798		-0.1334
		(3.2)		(0.6)		(1.4)
ln(rainfall)		0.2338		0.1055		
		(4.7)		(1.3)		
dEPA(i)	yes	yes	yes	yes	yes	yes
dYEAR (t) x REG (k)	yes	yes	yes	yes	yes	yes
Number of observations	1310	1303	1289	1284	1289	1281
F (.)	(220,1089) 15.76	(222,1080) 16.76	(210,1078) 6.85	(212,1071) 7.32	(210,1078) 4.81	(211,1069) 6.12
Prob > chi2	0.0000	0.0000	0.0000	0.0000	0.0000	0.00000
Adjusted R2	0.7127	0.7288	0.4883	0.5109	0.3844	0.4578
RMSE	0.23889	0.22986	0.37696	0.36781	0.31539	0.29587

Notes – The table reports estimates of groundnut yield, production and area. Estimations are based on annual data from 2003-04 to 2009-10 (seven years). Groundnut price and maize prices are nominal prices and are expected to have an opposite sign. All equations are estimated with OLS. Absolute *t*-statistics are given in parentheses (.) below the coefficient. Adjusted R2 = coefficient of determination, adjusted for degrees of freedom, and RMSE = Root Mean Squared Error. We do not report coefficients and t-values of the constant term and a complete set of EPA dummies and year by region dummies (dEPA(i), dYEAR(t) x REG(k)).

Appendix E

Table E1 Sales volume by tobacco auction floor* and by district of origin, 2009

	Sales volume (in 1000 kg)					per district distribution over auctions in %					per auction distribution over districts in %				
District	**MZZ**	**CNK**	**LIL**	**LMB**	**TOTAL**	**MZZ**	**CNK**	**LIL**	**LMB**	**TOTAL**	**MZZ**	**CNK**	**LIL**	**LMB**	**TOTAL**
Chitipa	2991	0.1	118	0.1	3110	96.2	0.0	3.8	0.0	100	4.3	0.0	0.2	0.0	1.5
Karonga	12288	16	24	4.0	1272	96.5	1.3	1.9	0.3	100	1.8	0.1	0.0	0.0	0.6
Rumphi	16383	469		4.0	16856	97.2	2.8		0.0	100	23.6	1.7		0.0	8.2
Nkhatabay	1530	3		2.7	1535	99.6	0.2		0.2	100	2.2	0.0		0.0	0.7
Mzimba	34913	550	34	46	35543	98.2	1.5	0.1	0.1	100	50.2	2.0	0.1	0.1	17.2
Nkhotakota	472	568	29	403	1472	32.1	38.6	1.9	27.4	100	0.7	2.0	0.1	0.7	0.7
Kasungu	9228	16737	16424	1139	43528	21.2	38.5	37.7	2.6	100	13.3	60.2	30.1	2.1	21.1
Ntchisi	415	1977	73	633	3098	13.4	63.8	2.4	20.4	100	0.6	7.1	0.1	1.2	1.5
Dowa	1361	5494	29337	1593	37786	3.6	14.5	77.6	4.2	100	2.0	19.8	53.7	2.9	18.3
Mchinji	400	678	421	1580	3079	13.0	22.0	13.7	51.3	100	0.6	2.4	0.8	2.9	1.5
Salima	54	45	4.9	1345	1450	3.7	3.1	0.3	92.8	100	0.1	0.2	0.0	2.5	0.7
Lilongwe	481	1199	6364	1428	9471	5.1	12.7	67.2	15.1	100	0.7	4.3	11.7	2.6	4.6
Dedza	4.1	22	1733	629	2388	0.2	0.9	72.6	26.3	100	0.0	0.1	3.2	1.1	1.2
Ntcheu	7.4	4.7	13	5583	5608	0.1	0.1	0.2	99.5	100	0.0	0.0	0.0	10.2	2.7
Mangochi	4.8	1.8		10225	10232	0.0	0.0		99.9	100	0.0	0.0		18.6	4.9
Machinga	2.4	1.5	2.2	8050	8056	0.0	0.0	0.0	99.9	100	0.0	0.0	0.0	14.7	3.9
Balaka		1.6	0.3	1080	1082		0.1	0.0	99.8	100		0.0	0.0	2.0	0.5
Zomba	10	2.1		9015	9027	0.1	0.0		99.9	100	0.0	0.0		16.4	4.4
Mwanza				48	48				100.0	100				0.1	0.0
Blantyre	5.9	3.0	3.3	390	402	1.5	0.8	0.8	96.9	100	0.0	0.0	0.0	0.7	0.2
Chiradzulu	13	11	6.7	2071	2102	0.6	0.5	0.3	98.6	100	0.0	0.0	0.0	3.8	1.0
Phalombe	0.4	3.2		6429	6433	0.0	0.0		99.9	100	0.0	0.0		11.7	3.1
Mulanje	0.7			1441	1442	0.1			99.9	100	0.0			2.6	0.7
Thyolo			0.0	1714	1714			0.0	100.0	100			0.0	3.1	0.8
Chikwawa	0.0	0.0	0.0	19	19	0.0	0.0	0.0	100.0	100				0.0	0.0
Total	69504	27788	54588	54871	206750	33.6	13.4	26.4	26.5	100	100.0	100.0	100.0	100.0	100.0

Source: transaction data for 2009 from the Tobacco Control Commission, Malawi; * CNK = Chinkhoma; LIL = Lilongwe (Kanengo); LMB = Limbe; MZZ = Mzuzu;
Notes – Districts of origin and auction floors are ordered from north to south and regions (north, central and south) are distinguished in the table by shading.