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Analysing the **Maize Value Chain** for Export in **Lao People's Democratic Republic**

Integrating **Landlocked** Commodity Dependent Developing Countries into **Regional and Global Value Chains**

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ABSTRACT

This study analyses the maize value chain for export in Lao People's Democratic Republic. Using tailored survey data derived from six districts in three maize-producing provinces, this study carries out three tasks. First, it identifies and analyses the different roles played by three main stakeholders in the maize value chain: farmers producing maize, small traders aggregating and carrying out basic processing, and larger traders doing further processing and exporting. Second, we analyse the relationships between farmers and traders. In this regard, our analysis highlights the role of traders in the provision of farmer finance, where bargaining power and "relational capital" appear to be especially important. Third, we empirically explore the relationship between selected stakeholder characteristics and maize prices. Controlling for geographical location, we find a positive and statistically significant relationship between farmer maize sale prices and whether they sell maize in grain (versus cob) form, cooperative membership, ownership of storage, and duration of maize storage; and a negative relationship between prices and whether a farmer receives trader-supplied inputs. Similarly, we find a statistically significant positive relationship between trader size (measured as the quantity of maize traded in a year) and maize price margins, sales prices, and purchase prices. These correlations were found controlling for the form of maize bought, the geographic location of traders and whether traders are engaged in external trade. On the basis of our findings, we discuss a series of policy implications for improving the functioning of the chain and benefits to stakeholders, focusing on improving information availability, enhancing farmer and trader access to finance, and potential measures to foster smallholder farmers' earnings.

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ACRONYMS AND ABBREVIATIONS

DAFO .....District Agriculture and Forestry Office

DICO .....District Industry and Commerce Office

Ha .....hectare

kg.....kilogram

km.....kilometre

LAK.....Lao Kip

PAFO.....Provincial Agriculture and Forestry Office

PICO .....Provincial Industry and Commerce Office

US$.....United States dollars

NOTES

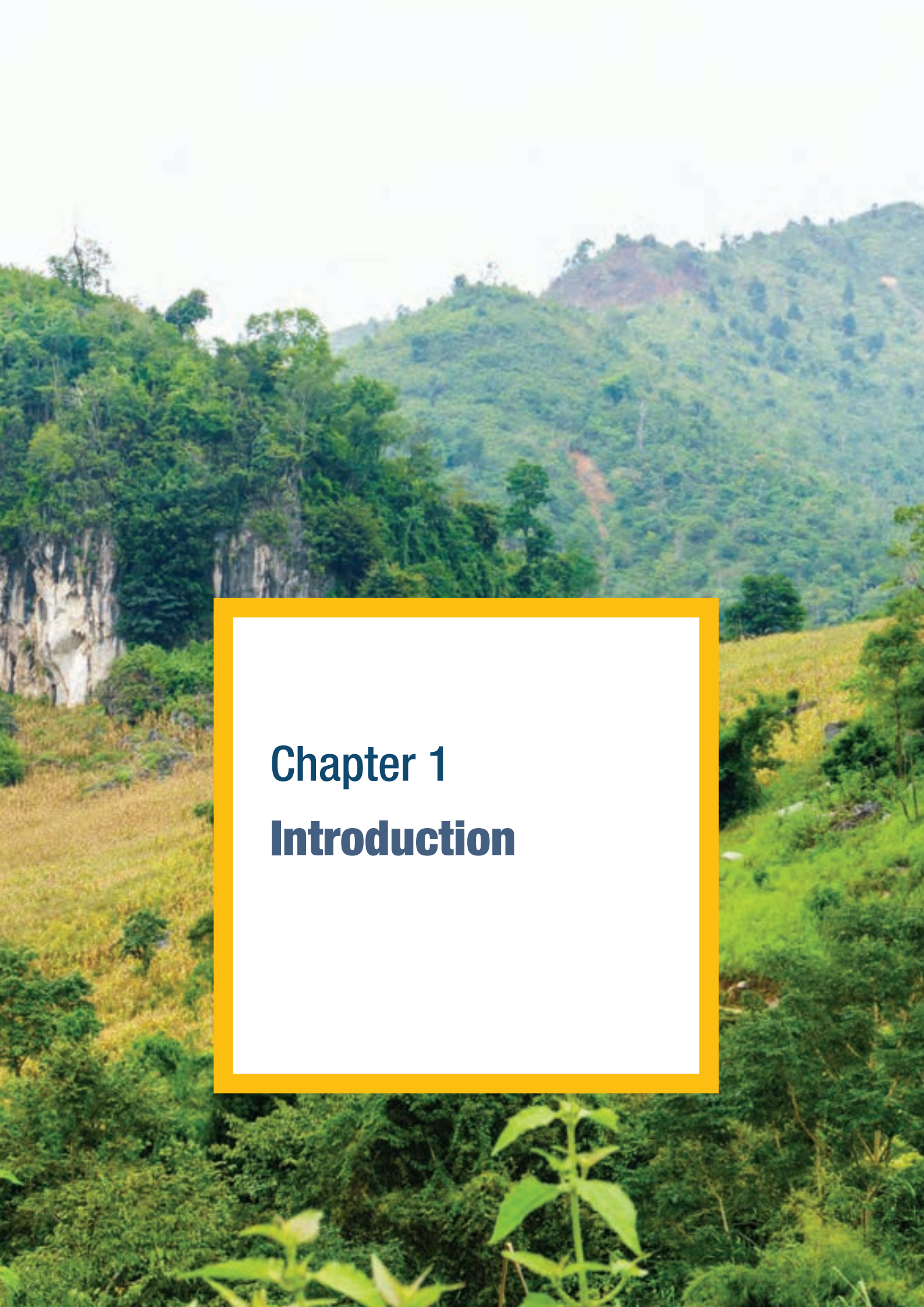
The term "billion" signifies 1,000 million.

The term "tons" refers to metric tons.

Use of a dash between years (e.g. 2000–2001) signifies the full period involved, including the initial and final years.

An oblique stroke between two years (e.g. 2000/01) signifies a fiscal or crop year.

CONTENTS



Chapter 1
Introduction

After rice, maize is the second largest crop by planted area in Lao People's Democratic Republic, where the agricultural sector accounts for 10 per cent of the country's GDP. As such, the maize value chain plays an important role in rural employment and poverty reduction in rural areas of the country (Castella and Nanthavong, 2014; Lestrelin, 2015). Furthermore, maize is one of the most important export products of the Lao agriculture and forestry sector. Key export destination markets include China, Thailand and Viet Nam, where maize produced in the country is used as an input of the growing animal feed sectors. Given the special development challenges that Lao People's Democratic Republic faces as a landlocked developing country, its ability to take advantage of export opportunities has an important bearing on welfare and economic development. For these reasons, the maize value chain is crucially important for the attainment of the Sustainable Development Goals (SDGs) in the country, especially SDG 1: *No Poverty* and SDG 8: *Decent Work and Economic Growth*.

Public authorities in Lao People's Democratic Republic are well aware of the economic importance of the domestic maize value chain, and the development of the maize sector. This is evidenced by the focus given to maize production in both the 8th National Socio-Economic Development Plan, and the *Agriculture Development Strategy to 2025 and Vision to the Year 2030* published by the Ministry of Agriculture and Forestry.

The importance of the maize value chain in the country has motivated substantial research and policy interest during the last two decades from development agencies, the Lao authorities and academia. While these efforts have covered different important aspects of the maize value chain in the country, much of this analysis has focussed on the challenges to farmers of increasing sustainable production and productivity, or the environmental effects associated to maize production. For example, National Agriculture Forestry Research Institute (2011) finds that practices such as monoculture and mechanized tilling, and the clearing of forest and fallow lands for maize cultivation, highlights the need to ensure the sustainability of rural development. In another study, Castella et al. (2012) analyse maize farming in Xiengkhuang province using data from 600 households in 20 villages of Kham and Nong Het districts. The authors find that the main cropping practice that had been operating in 2012 was soil tillage, using herbicides, pesticides and hybrid seeds. The authors conclude that this led farmers to become more vulnerable to land degradation, agrobiodiversity loss and vulnerability to price fluctuations emanating from monoculture of maize.

Viau, Keophosay and Castella (2009) analyse how the expansion of commercial maize production affected livelihoods and upland rice production in Xiengkhor district of Huaphanh province. Using detailed survey data from 100 households in four villages of the Natong village cluster, obtained in 2008, the authors explore the influence on livelihoods of changes in land use, including increased commercial production of maize in upland areas. In a similar vein, Boundeth et al. (2013) present a cross-section study of maize production in Bokeo province, reporting positive associations between maize production and different variables, including membership of farmer producer groups ("cooperatives"), credit access and input provision like seeds.

This study contributes to the fact-finding efforts mentioned above by shedding new light on the workings of the maize value chain for export of Lao People's Democratic Republic. The study is part of UNCTAD's technical assistance to the country, provided under the project *Integrating Landlocked Commodity-Dependent Developing Countries into Regional and Global Value Chains (PDF-SDG-2017-04)*. The objective of the project in Lao People's Democratic Republic is to support the upgrading of the maize sector in the country, by fostering better integration into regional and global value chains.[1]

Value chain analysis is intimately concerned with the identification and characterisation of key market stakeholders, and the interactions between them. This in turn requires qualitative and quantitative data about the value chain. In particular, quantitative data are essential to evaluate the influence of stakeholder characteristics on metrics of performance of the value chain, including income levels, vulnerability to shocks, and the distributions of trader surpluses. For the elaboration of this study, therefore, survey data obtained from a purpose-built field survey conducted in May-June 2019 are employed, covering the three most important maize-producing provinces in Lao People's Democratic Republic by production and planted area: Oudomxay, Xayaboury and Xiengkhuang. These three provinces are also important maize exporters, trading with China, Thailand and Viet Nam, respectively.

[1] The project aims at enhancing the countries' capacities in formulating and implementing policies and strategies in in selected key agricultural sectors of four beneficiary countries. In addition to maize in Lao People's Democratic Republic, the project targets roasted coffee in Ethiopia, meat in Mongolia and dried fruits in Uzbekistan. In particular, the project's activities aim to improve the analytical and data capacity of beneficiary countries in effective policy formulation to promote the integration of local food industries into regional and global value chains. For more information on the project, see https://unctad.org/en/Pages/SUC/Commodities/SUC-Project-LLDCs-in-GVCs.aspx

Our analysis of the Lao maize value chain in this study undertakes three key tasks.

First, we map the export maize value chain, composed of (largely, smallholder) producers, and traders. Our focus here is to identify and analyse the different roles that each stakeholder plays in the maize value chain, and to explore how those roles vary by stakeholder characteristics. This first subject of our study complements and updates previous work focusing on the maize value chain in Lao People's Democratic Republic, by: (i) providing updated information about production, trade, international prices, yields, harvested area and other relevant maize sector statistics; (ii) showing the high degree of maize income dependency of maize farmers (median of 94.5 per cent of estimated agricultural income), which renders maize farmers vulnerable to the occurrence of negative shocks to maize; and (iii) describing and reviewing the different economic roles fulfilled by traders, such as aggregation, transport, and quality control and improvement. These roles vary according to trader size, with small traders carrying out "aggregation" for larger traders and often input provision to farmers. Producer groups ("cooperatives") can also play these latter roles in product markers dominated by smallholder farmers (Bonin et. al, 1993).

Second, we analyse the relationships between farmers and traders. In this regard, our analysis highlights the role of traders in the provision of farmer finance, where bargaining power and "relational capital" appear to be especially important. Our survey data suggests that trader-provided productive finance is very extended in the country, being reported by 29 per cent of surveyed farmers and 50 per cent of surveyed traders in Oudomxay, Xayaboury and Xienkhuang provinces. This suggests that further empirical research could usefully explore the risk-adjusted costs of rural finance, as well as strengthening the provision of the latter in the country.

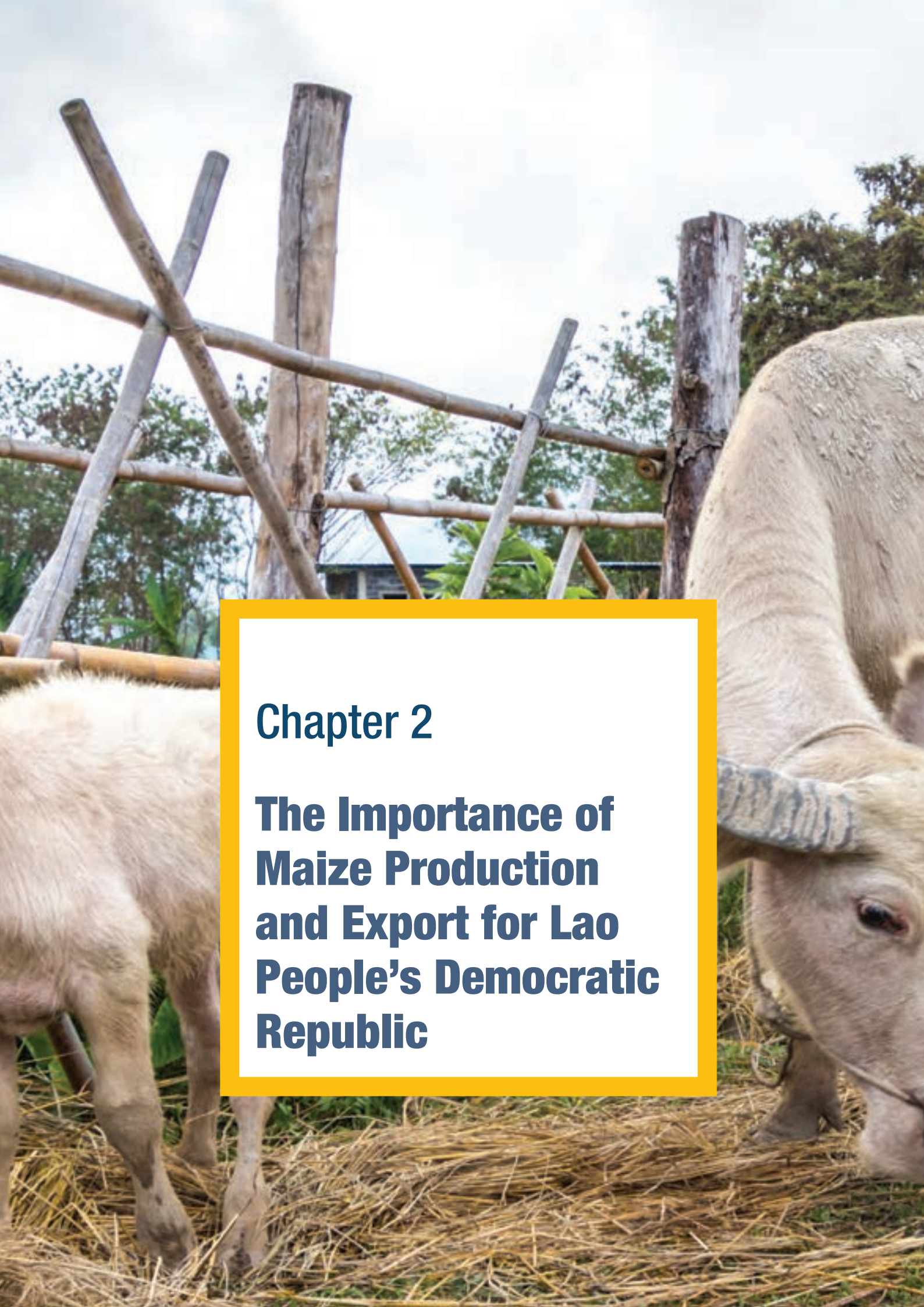
Third, we empirically explore the relationship between selected stakeholder characteristics and maize prices.

In the case of farmers, and controlling for geographical location, we estimate the relationship between sale prices for maize and five farmer characteristics: whether they sell maize in grain versus cob forms, cooperative membership, ownership of storage, duration of maize storage, and whether a farmer receives inputs from traders. We find a positive and significant relationship between sale prices and the first four mentioned variables, and a negative relationship between maize prices and whether a farmer receives inputs.

Similarly, our empirical analysis for traders highlights the statistically significant positive relationship between trader size (measured as the quantity of maize traded in a year) and maize price margins, purchase prices, and sales prices. These correlations were found controlling for the form of maize bought, the geographic location of traders and whether traders are engaged in external trade. In this regard, we argue that trader size can be interpreted as a proxy for variables that are hard to measure, including participation as an aggregator in the value chain, access to quality maize, storage capacity availability and length of storage.

Finally, on the basis of our findings, we discuss a series of policy implications. In particular, we focus on improving information availability, enhancing farmer and trader access to finance, and potential measures to foster smallholder farmers' earnings.

The remainder of this study is organized as follows. Section II expands on the importance of maize for Lao People's Democratic Republic and its regional dimension. Section III characterizes, maps and analyses the existing maize value chain in the country quantitatively and qualitatively. Section IV concludes by discussing potential areas for policy intervention by the authorities in the light of some of the findings of the study.



Chapter 2

The Importance of Maize Production and Export for Lao People's Democratic Republic

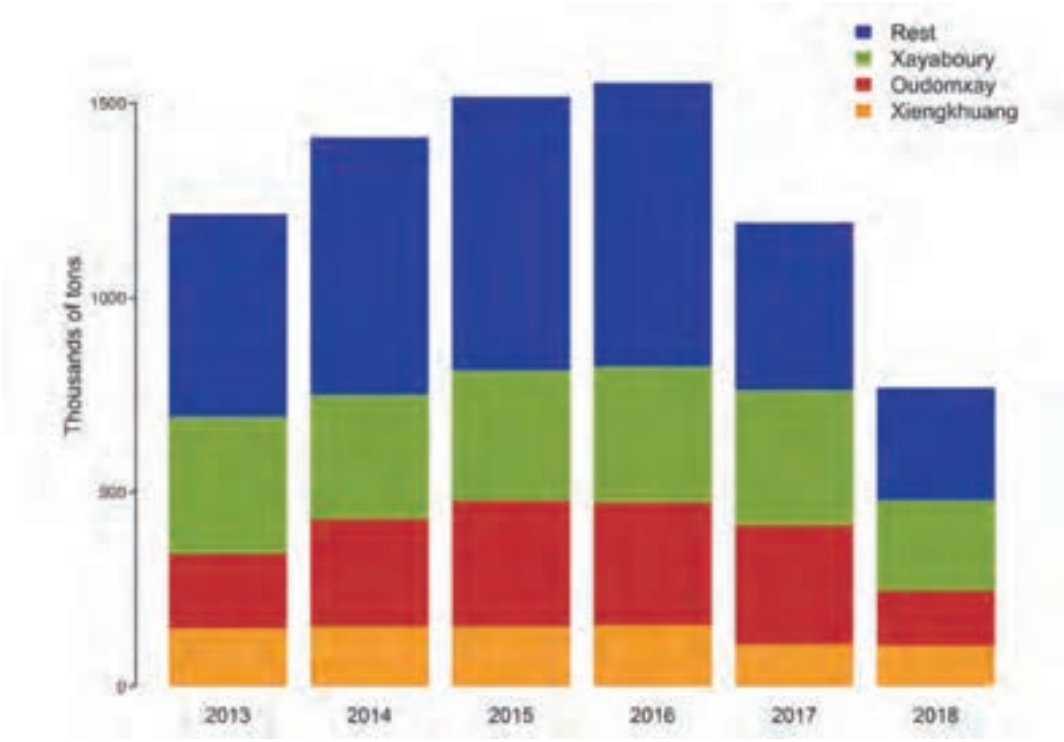
The agricultural sector in Lao People's Democratic Republic constitutes an important component of the economy, as it accounted for 10.3 per cent of GDP and it was the fifth largest[2] contributor to GDP growth on average between 2014 and 2018.[3]

In terms of employment, the Agriculture, Forestry and Fishing sector in 2017 employed 551,000 people, equivalent to 31.3 per cent of the employed population over 15 years old (1,757,733 persons).[4] This number does not include the 2,455,328 people classified as "own-use production workers" which engage in traditional self-use activities outside of the measured labour force. Within this category, many people also work in agricultural activities.

Out of the total employed population, 82.7 per cent worked informally, with informality affecting in particular those workers with secondary education or less.

Reducing rural poverty is an important aspect of meeting Sustainable Development Goal 1 of "No Poverty". Past studies suggest that maize production and its value chain have been important to improve the income of farmers in northern and central provinces like Xayaboury, Oudomxay, and Xiengkhuang, helping to reduce the incidence of rural poverty. For example, in their study of agricultural transition from shifting subsistence-based agriculture to maize mono-cropping, Castella and Nanthavong (2014) find a general improvement in income of villagers in Nong Het district in Xiengkhuang province in the five years up to 2014, as well as an increase in labour requirements, although the authors indicate that these agricultural changes had adverse effects on the environment. Also, in his study of conservation agriculture in Xayaboury province, Lestrelin (2015) finds that the agricultural incomes of farmers in areas with widespread maize cultivation like Boten, Parklai and Kenethao districts increased significantly between 2004 and 2007 as maize cultivation boomed, but then stagnated or fell slightly between 2007 and 2013.

Figure 1: **Maize production in Lao People's Democratic Republic, 2013-2018**



Source: Author, based on data from the Lao Statistics Bureau.

2 Together with Real Estate activities.

3 Source: Central Bank of Lao People's Democratic Republic Annual Report 2018, pp. 20. The data refers exclusively to "Agricultural cropping" and excludes livestock, forestry and fishing. Due to the growth of the services and the electricity sector during the period, the share of agriculture on GDP fell slightly from 11 per cent in 2014 to 9.7 per cent in 2018.

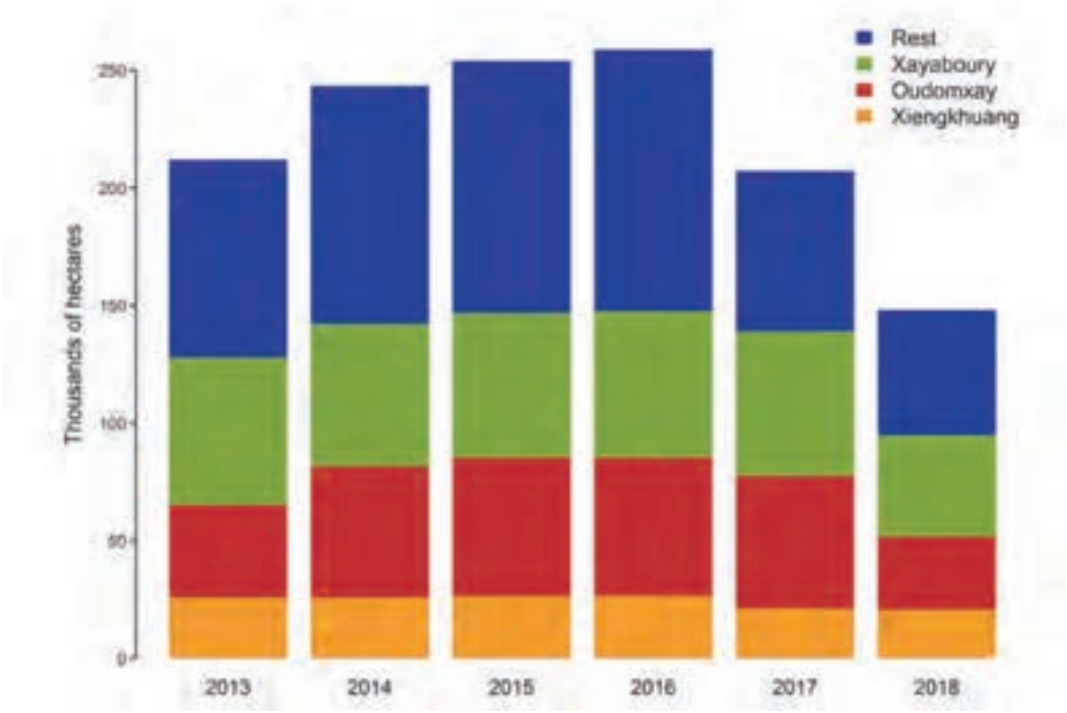
4 Source: Lao Statistics Bureau (2018), "Lao PDR Labour Force Survey 2017", June 2018. Available online at https://www.lsb.gov.la/wp-content/uploads/2017/05/Labor-force_report-22-june_ENG.pdf

While rice production continues to be the principal agricultural product both in terms of area harvested and production,[5] maize is also a very important agricultural commodity in the country, being the second largest agricultural product harvested by area. For this reason, the maize value chain is important for the attainment of SDG 8 of Decent Work and Economic Growth.

The importance of maize as a cash crop in the country came to prominence during the 2000's, as between 2002 and 2008 the yearly growth rate of maize production[6] averaged 40.9 per cent, with a peak in 2005 of 83.1 per cent yearly growth and no year falling below 11 per cent growth. During this period, the amount of land dedicated to maize production also increased substantially, growing at an average rate of 27.4 per cent per year. Information from past studies (e.g. Ministry of Agriculture and Finance, 2006) suggest that such expansion in production in some areas was the result of interest by private traders providing credit and agricultural inputs to farmers, while in others, public sector actors also played an important role. Ministry of Agriculture and Finance (2006) indicates that the Provincial Agricultural and Forestry Office of Oudomxay introduced maize production by farmers in Houne, Beng and Xay districts in the province, as part of a programme supported by the Vietnamese government to promote staple crop production. Castella and Nanthavong (2014) indicate that in Nong Het District in Xiengkhuang province, hybrid maize expanded due to increasing demand from Viet Nam, being introduced by Vietnamese buyers with support from local traders and district extension agents.

More recently, maize production in the country reached a peak of 1.55 million tons in 2016 and then fell to 1.19 and 0.77 million tons in 2017 and 2018, respectively. Similarly, the harvested area[7] of maize reached a peak of 258,910 hectares in 2016, falling to 207,190 and 148,190 hectares in 2017 and 2018, respectively. Importantly, the reduction in maize production registered in 2017 and 2018 is mostly related to the reduction in harvested area,[8] as the yields of maize, after growing consistently from the second half of the 90's, have stayed relatively stable in 2012-2017 at an average of 5.83 tons per hectare and then falling in 2018 to 5.18 tons per hectare.

Figure 2: **Maize harvested area in Lao People's Democratic Republic, 2013-2018**



Source: Author, based on data from the Lao Statistics Bureau.

5 According to the Annual Statistical Yearbook 2018 of the Lao Statistics Bureau, the harvested area of lowland rain-fed rice, dry season rice and upland rain-fed rice in 2018 was 688,000 Ha, 74,175 Ha and 92,430 Ha, respectively, for a combined rice production of 2.92 million tons during the year. Hence, maize production equaled to 26 per cent of rice production during 2018.

6 The data source for this paragraph is FAOSTAT, which coincided at the time of writing with data from the Lao Statistics Bureau for all years except 2018. For 2018 we have used data from the Lao Statistics Bureau.

7 In this study, for data availability reasons, the terms "harvested area" and "planted area" are used indistinctly.

8 While no single explanation could be found for the recent reduction in harvested area and production of maize, factors mentioned by some stakeholders interviewed by the survey team indicated profitability and climate issues. Another possible explanatory factor is the increase in the attractiveness of other products in certain areas, such as cassava cultivation in Xayaboury, which increased between 2017 and 2018. Note that cassava can also be used as an energy source for animal feed.

Combined, Xayaboury, Oudomxay and Xiengkhuang provinces in 2018 produced 62.5 per cent of all the maize produced in Lao People's Democratic Republic and accounted for 64 per cent of the total harvested area with maize. While all maize-producing provinces registered reductions in production during 2018, Oudomxay and Xayaboury province registered the largest reductions in 2018, and Xiengkhuang in 2017. Figures 1 and 2 present the evolution of maize production and harvested area in the country between 2013 and 2018, highlighting the importance of Xayaboury, Oudomxay and Xiengkhuang provinces.

Not only is the importance of maize cultivation heterogeneous across provinces, but also maize yield varies across provinces, as shown by Table 1, which presents data from the Lao Statistics Bureau for the year 2018 for maize harvested and production, and maize yields per hectare for 2016-2018. For example, note that in 2018 Savannakhet province had a smaller harvested area than Saravane province, but produced 49 per cent more maize. Also, note that the maize yield in tons per hectare varies not only across provinces, but also changes over time within the same province. For example, Table 1 shows that maize yields fell substantially in Oudomxay and Xiengkhuang between 2016 and 2018, while the fall in Xayaboury was substantially smaller.

It is also interesting to look at maize in the regional context, as exports constitute an important destination for the maize produced in Lao People's Democratic Republic.

Maize production has increased substantially in the last twenty years in Lao People's Democratic Republic and the neighbouring countries to which they export maize: China, Thailand and Viet Nam, as shown by Figure 3[9]. Between 1998 and 2018 Thailand's production increased 8.4 per cent, China's production increased 93.4 per cent, Viet Nam's production increased two times and Lao People's Democratic Republic's production increased six times, passing from 0.11 to 0.77 million tons during the period. Figure 3 also shows that maize production in this country continues to be much smaller than that of its neighbour trade partners: in 2018 it was 15.3 per cent of Thailand's production of 5 million tons, 15.8 per cent of Viet Nam's production of 4.87 million tons, and only 0.3 per cent of China's production of 257.17 million tons.

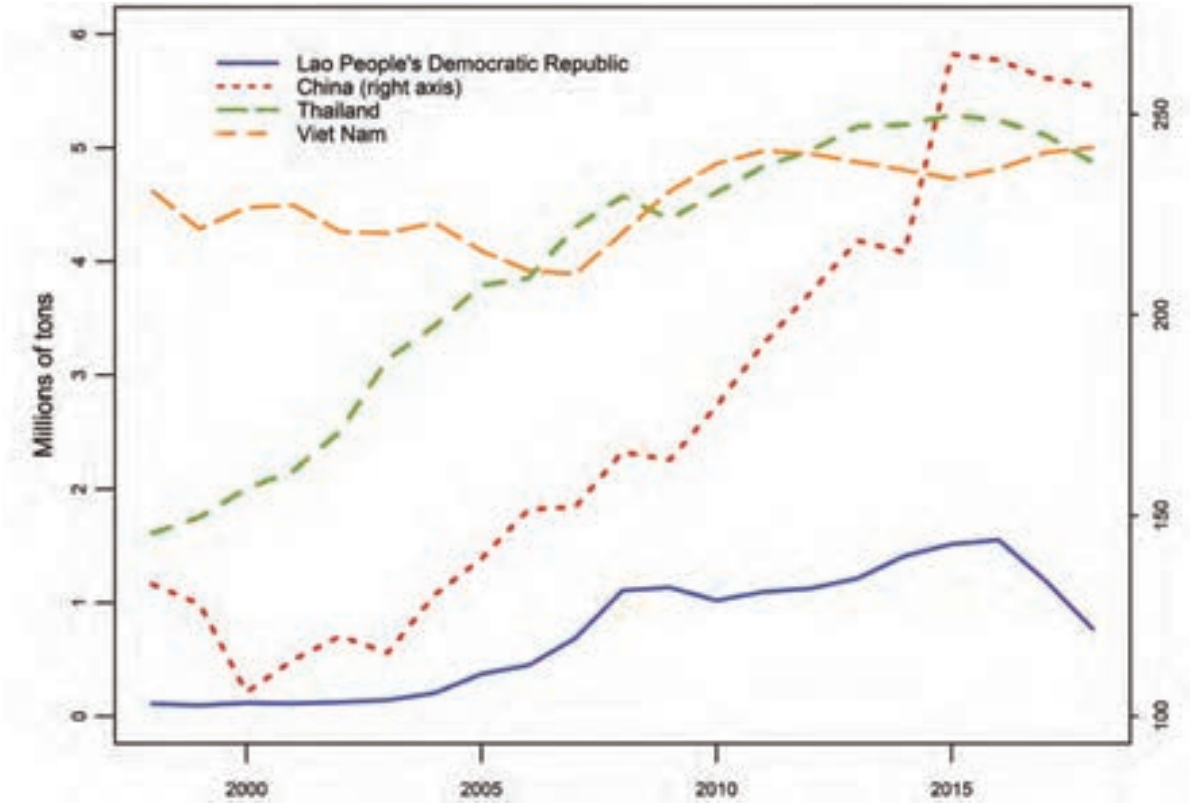
Table 1: **Maize production, statistics in Lao People's Democratic Republic, selected years**

Province	2018 Harvested Area (1 000 hecares)	2018 Production (1 000 tons)	2018 Yield (tons per Ha)	2017 Yield (tons per Ha)	2016 Yield (tons per Ha)
Total	**148.2**	**768**	**5.2**	**5.8**	**6**
Xayaboury	43.1	232.5	5.4	5.7	5.6
Oudomxay	31.1	141.7	4.6	5.4	5.4
Xiengkhuang	20.7	105	5.1	5.1	5.9
Huaphanh	9.6	56.2	5.8	5.8	5.6
Luang Prabang	8.7	33.1	3.8	6.5	6.3
Vientiane	5.9	37.6	6.4	6.2	6.7
Phongsaly	5.8	27.5	4.7	5	6.3
Champasack	4.6	25.4	5.5	5.5	6
Saravane	3.9	20.6	5.3	6.8	7.3
Savannakhet	3.8	30.6	8	10	10.5
Luang Namtha	3.3	15.3	4.6	4.9	6
Sekong	2.3	13	5.7	5.7	7.9
Khammuane	1.6	9.3	5.9	9.4	7.4
Borikhamxay	1.4	9.5	6.6	6.8	6.9
Attapeu	0.7	3.4	4.8	5.4	8.8
Xaysomboon	0.7	3.1	4.6	4.6	5.4
Vientiane Capital	0.6	2.7	4.4	6.7	6.9
Bokeo	0.3	1.3	4.1	5.2	5.2

Source: Lao Statistics Bureau Statistical Yearbooks 2017 (Table 70, pp. 88) and 2018 (Table 80, pp. 100).

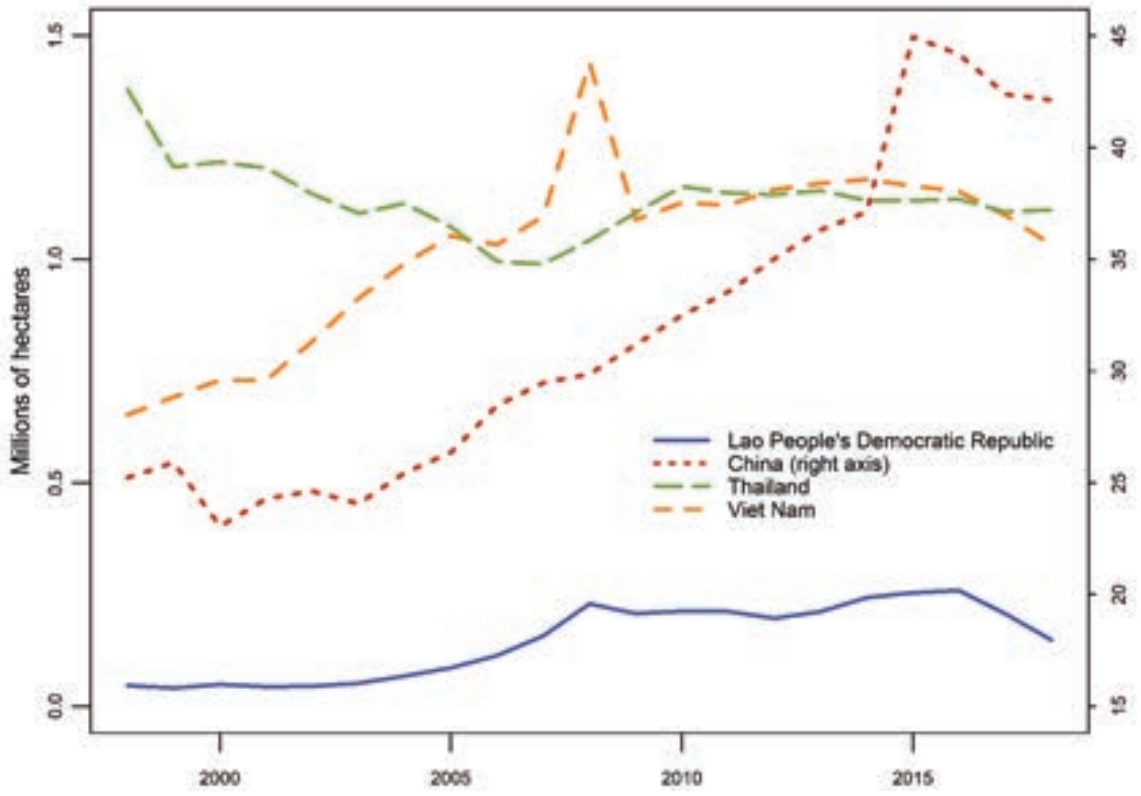
[9] Data source for production, harvested area and yield: FAOSTAT for the period 1998-2017, which coincides with Lao Statistics Bureau data. For 2018, we used data published in the Lao Statistics Bureau Statistical Yearbook 2018, which at the time of writing was different from FAOSTAT data for the year.

Figure 3: **Regional maize production, 1998-2018**



Source: Author, based on data from FAOSTAT (1998-2017) and Lao Statistics Bureau (2018).

Figure 4: **Regional maize harvested area, 1998-2018**



Source: Author, based on data from FAOSTAT (1998-2017) and Lao Statistics Bureau (2018).

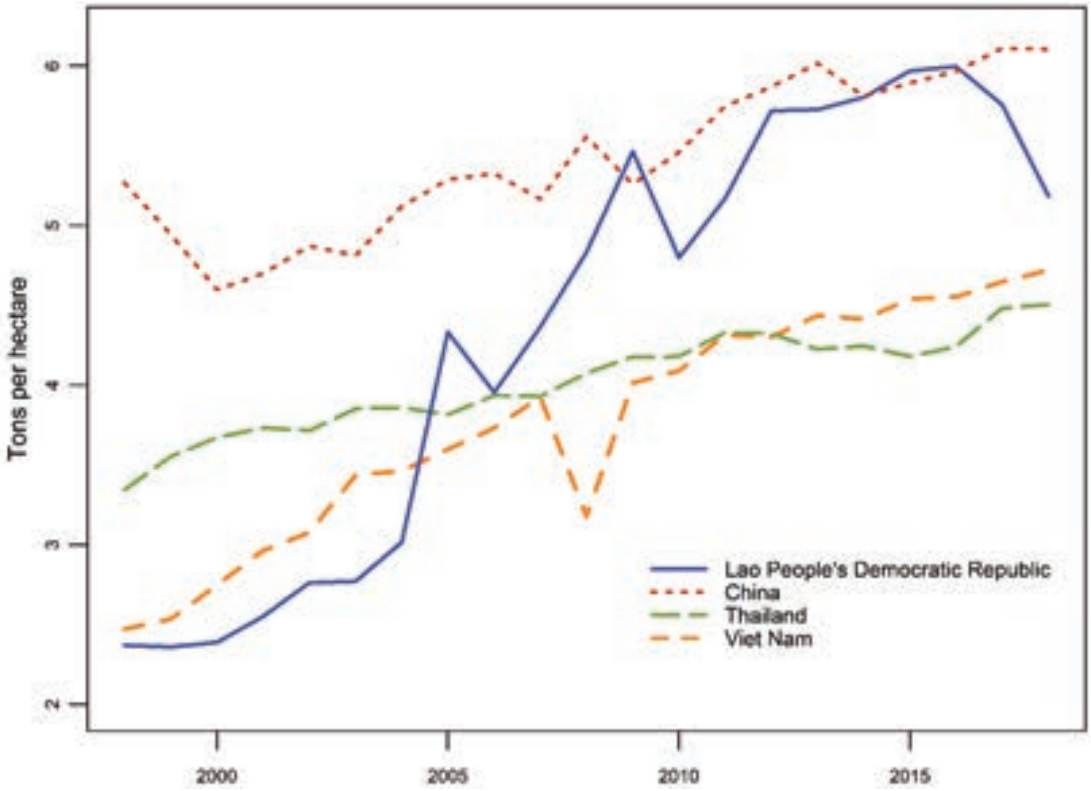
Figure 4 shows that a part of the production increase in China, Viet Nam and Lao People's Democratic Republic was due to an increase in the area under cultivation, which in the latter passed between 1998 and 2016 (at its peak) from 46,400 hectares to 258,910 hectares, an increase of almost five times. This increase in harvested area for maize in the country was faster that the increase in the amount of land dedicated to rice cultivation, a key food staple, which increased by 57.6 per cent to 973.3 thousand hectares during the period.[10]

Beyond the expansion of the area under maize cultivation, in the four countries there were also significant yield improvements during the period, as shown by Figure 5. Note in particular that the yields per hectare during the 1998-2018 period increased 119 per cent in Lao People's Democratic Republic, trailed by Viet Nam (91 per cent increase), Thailand (35 per cent increase) and China (16 per cent increase). Also note that the average yield in the former, although it declined in 2017 and 2018, was still higher in 2018 than in both Thailand and Viet Nam.

The increases in maize yields in Lao People's Democratic Republic have been attributed to the increase in commercial farming, which in turn benefited from increased use of hybrid seeds, notably imported from Thailand and Viet Nam. Commercial farming using hybrid seeds, tillage, herbicides, pesticides and fertilizer is attractive to farmers as it increases yields in the short term and may also reduce labour requirements, although it exposes farmers to land degradation (Castella et al. 2012).

The increases in maize production in the region have taken place in a context of sustained demand for animal feed, despite recent challenges like the swine flu epidemic that affected the region from 2018, and the COVID-19 pandemic in 2020. Maize is an important component of animal feed, notably of swine (see Karimov et al., 2016 for the case of Viet Nam) and poultry. The sustained demand in the region for maize as a component of animal feed derives from the widely documented[11] trend in the last twenty years of increases in the amount of animal protein consumed, in parallel with the observed increase in income per capita of the population. This is indicated by Figures 6 and 7, which show the stock of pigs and poultry in Lao People's Democratic Republic and in its neighbours China, Thailand and Viet Nam, and by Figures 8 and 9, which show the stock of pigs and poultry per capita in the four countries.

Figure 5: **Regional maize yields per hectare, 1998-2018**

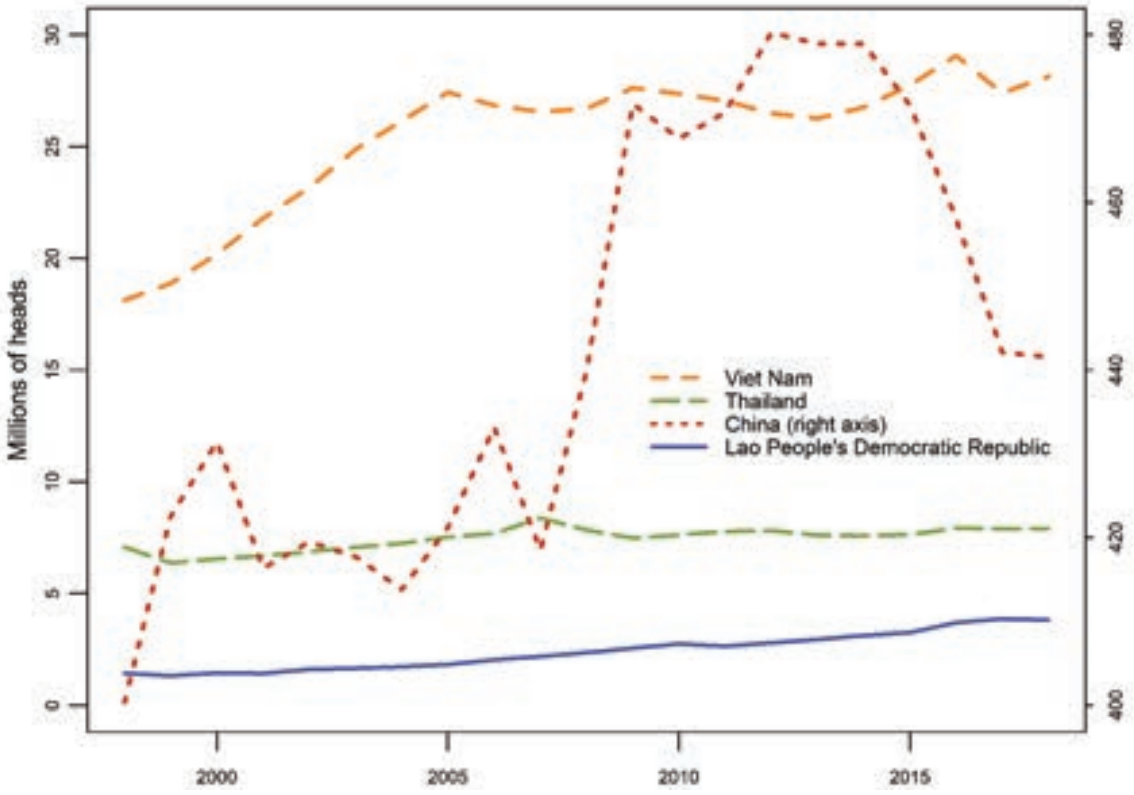


Source: Author, based on data from FAOSTAT (1998-2017) and Lao Statistics Bureau (2018).

[10] Source: FAOSTAT

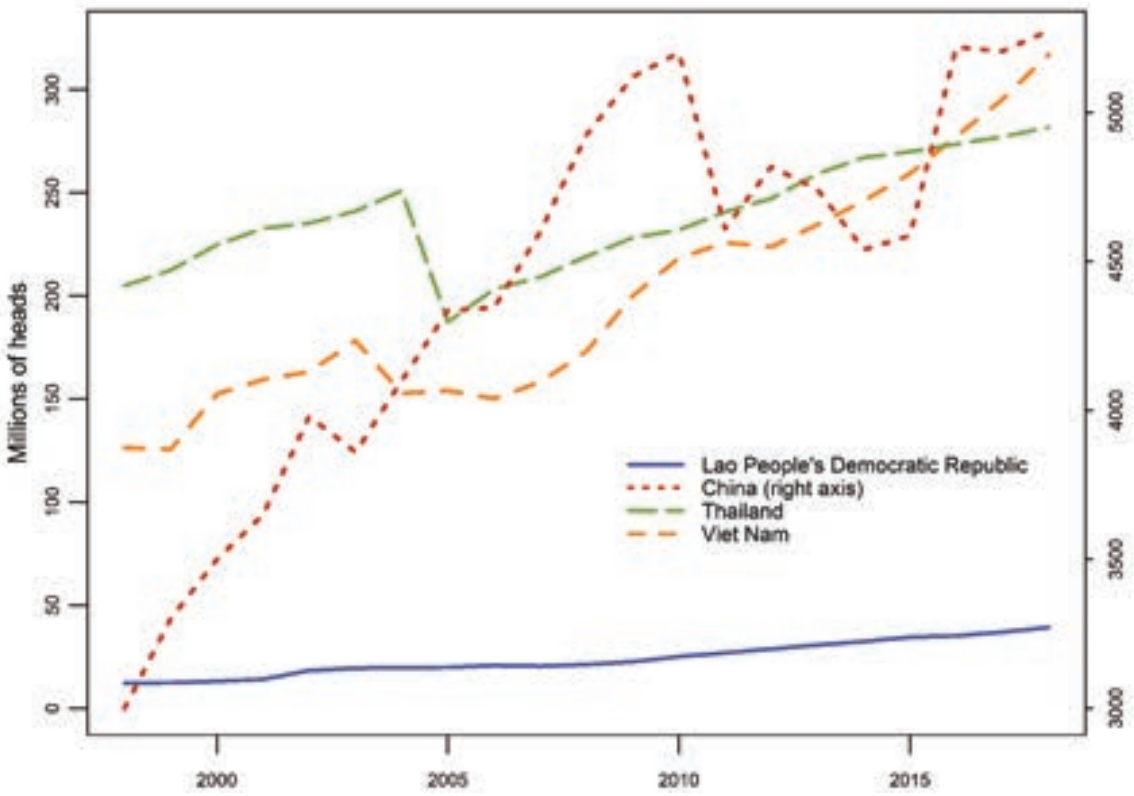
[11] For example, see Lee and Hansen (2019) for more on USDA's projections regarding meat demand in Southeast Asia.

Figure 6: **Regional pig stocks, 1998-2018**



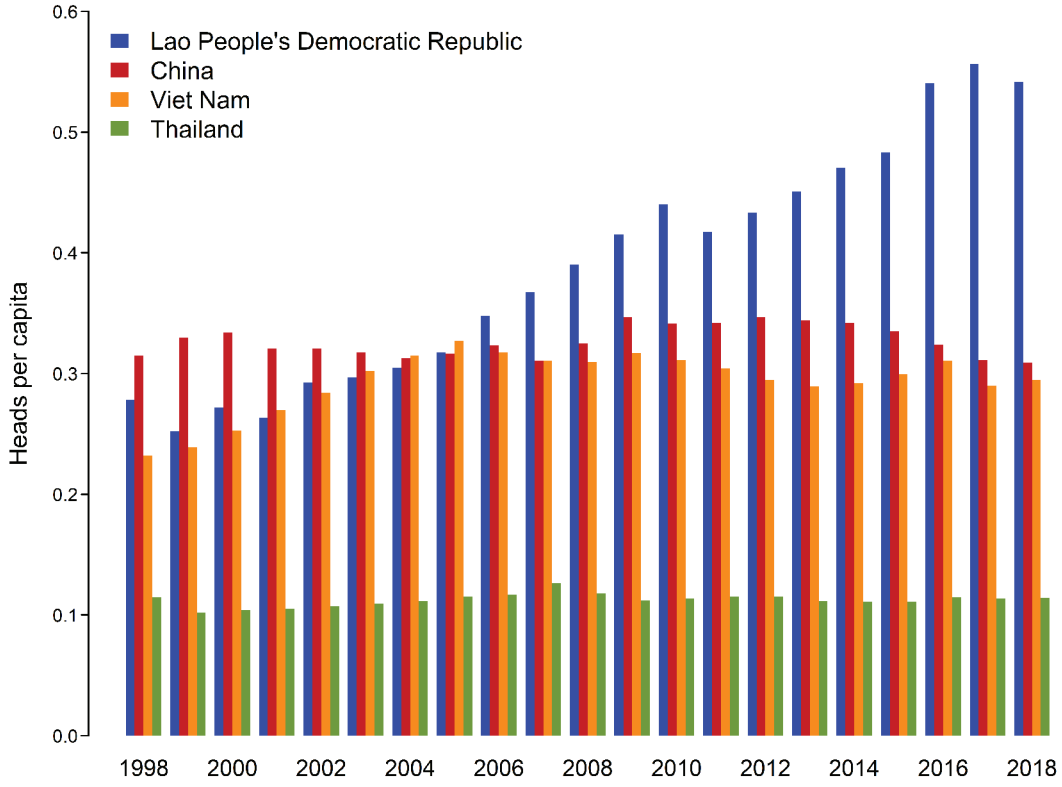
Source: Author, based on data from FAOSTAT.

Figure 7: **Regional poultry stocks, 1998-2018**



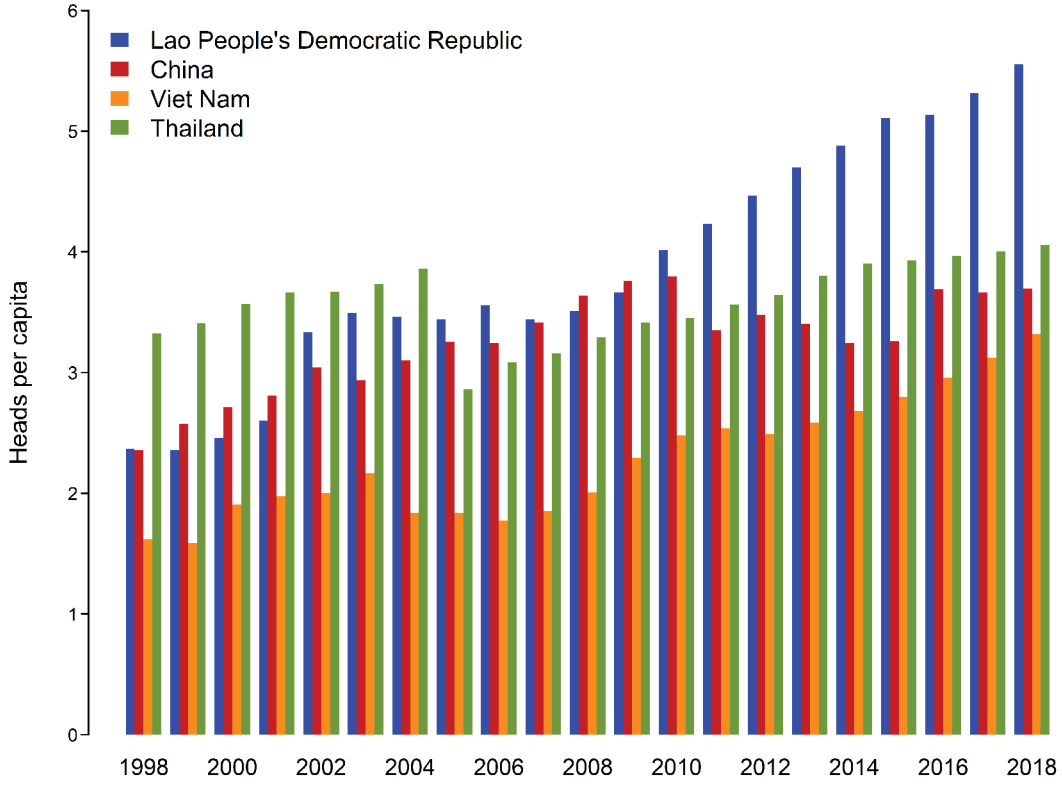
Source: Author, based on data from FAOSTAT.

Figure 8: **Regional pig stocks per capita, 1998-2018**



Source: Author, based on data from FAOSTAT.

Figure 9: **Regional poultry stocks per capita, 1998-2018**

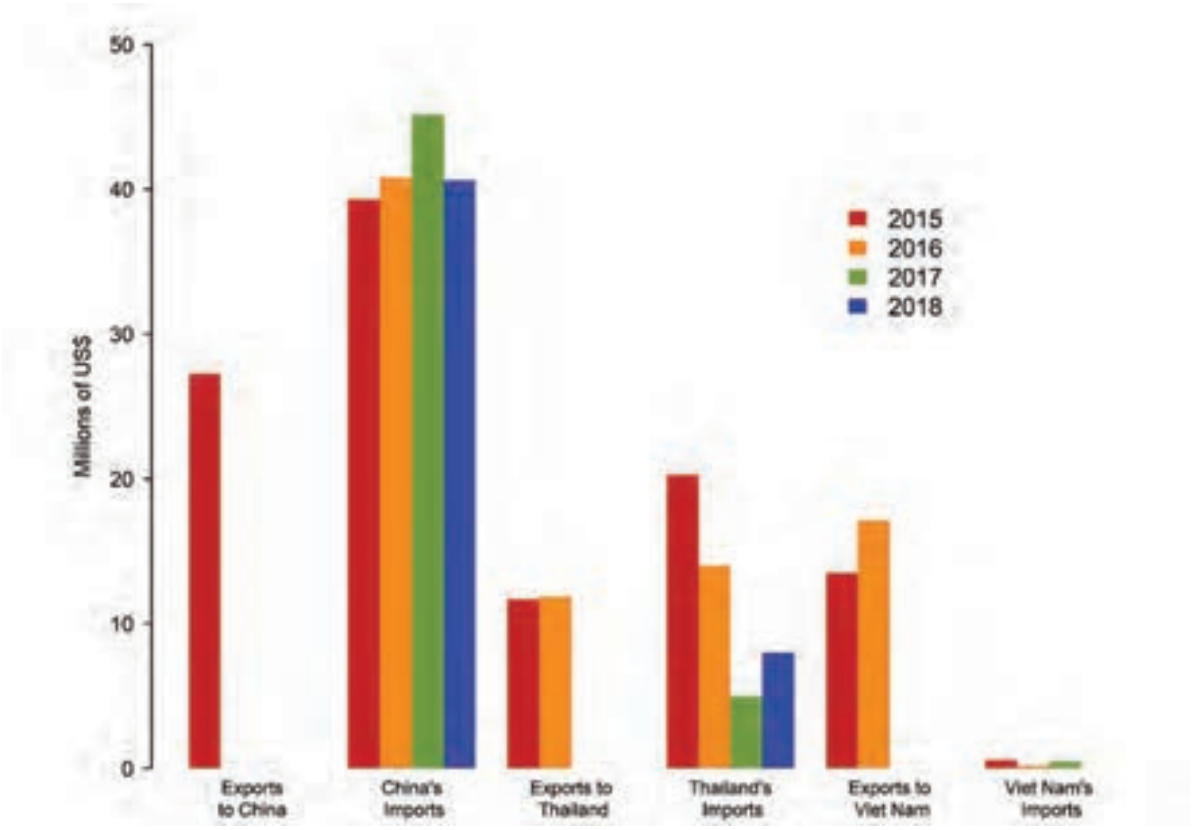


Source: Author, based on data from FAOSTAT.

Lao People's Democratic Republic produces more maize than it consumes, exporting surplus maize to neighbouring countries China, Thailand and Viet Nam. These neighbouring countries are net importers of maize from abroad for supplying their animal feed industries, as according to the Foreign Agricultural Service of the United States Department of Agriculture (USDA), 72.3 per cent of the maize used by Viet Nam's animal feed industry was imported,[12] while in Thailand the need for imported maize in 2020 to supply feed demand was estimated[13] at around 29-41 per cent of the total demand.

Unfortunately, comparable detailed data on maize exports from Lao People's Democratic Republic to China, Thailand and Viet Nam is registered with noise, with several missing values, as shown by Figure 10. This figure which presents the data available in the COMTRADE database for maize exports from Lao People's Democratic Republic and maize imports from the country (as reported by China, Thailand and Viet Nam).[14] Figure 10 highlights the substantive differences reported by exporter and importer countries, as well as missing data challenges.

Figure 10: **Maize trade between Lao People's Democratic Republic and the neighbouring countries, 2016-2018**



Source: Author, based on data from COMTRADE.

12 Source: USDA FAS Grain and Feed Annual for Viet Nam, April 3, 2020, Table 2. Available at https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=Grain%20and%20Feed%20Annual_Hanoi_Vietnam_04-01-2020

13 Source: USDA FAS Grain and Feed Annual for Thailand, March 13, 2020, Section 2.2. Available at https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=Grain%20and%20Feed%20Annual_Bangkok_Thailand_03-15-2020

14 Data corresponds to HS code 100590, "Cereals; maize (corn), other than seed", obtained on March 3rd, 2020 from https://comtrade.un.org/data. COMTRADE at the time reported the last year of export data from Lao People's Democratic Republic was 2016.

Chapter 3

Characterizing the Maize Value Chain for Export in Lao People's Democratic Republic

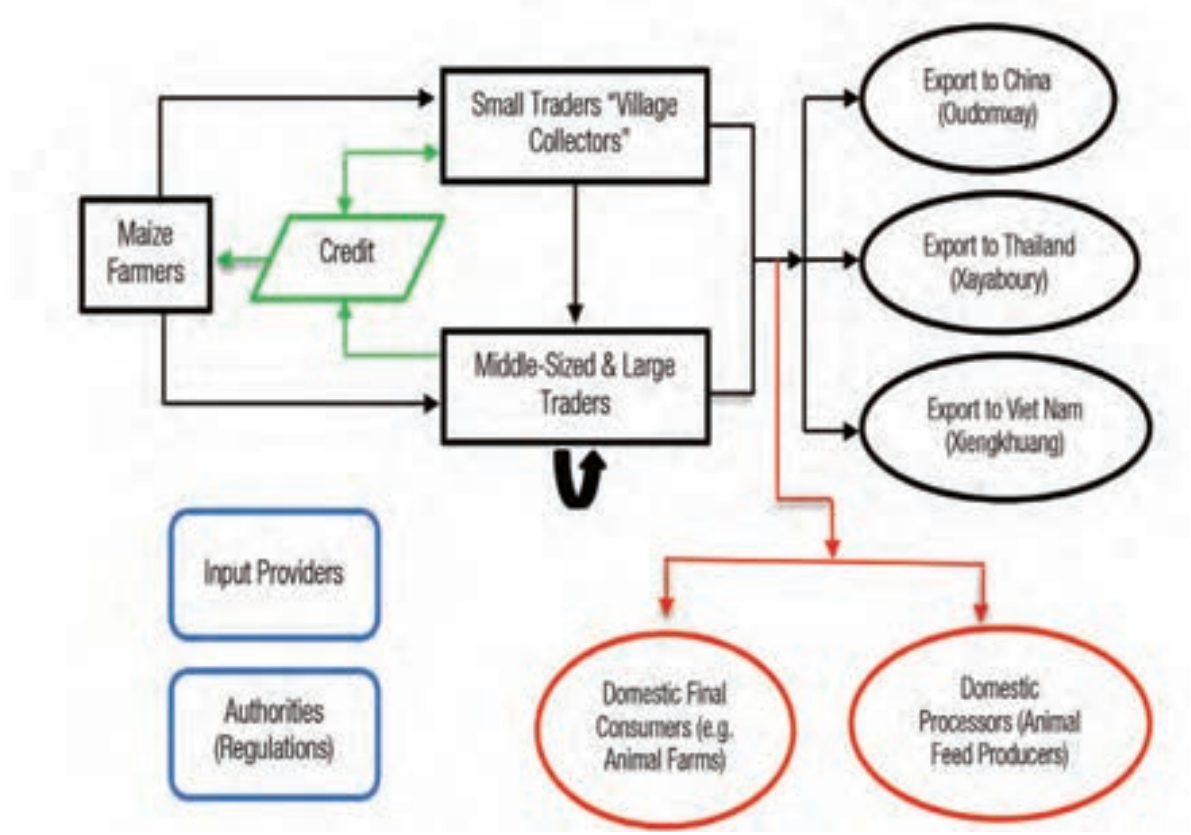
The export-oriented part of the maize value chain focuses on maize after it has been produced and until it is exported[15]. The maize value chain for export in Lao People's Democratic Republic consists of two stakeholder types that are closely interconnected: farmers and traders. An important feature of the value chain concerns heterogeneity of traders, who differ in terms of their size, location, roles they play, export orientation and other characteristics.

Figure 11 presents a simplified diagram of the maize value chain in the country. The export-related components that are the focus of our study are marked in black, the domestic consumers of maize are marked in red, and the stakeholders that influence the whole value chain,[16] both export and domestic, are marked in blue. Credit (both in cash and in species, such as seeds) is provided by traders to farmers and is marked in green.

The production and trading segments of the maize value chain in Lao People's Democratic Republic share many characteristics with the maize value chain in neighbouring North-west Viet Nam as described in Karimov et al. (2016).

In this section, we map in detail maize producers (i.e. farmers) and trader stakeholders of the maize value chain, and we analyse different aspects of the relationships between them, which constitute the core of the maize value chain for export. We also estimate quantitatively the relationship between important stakeholder characteristics and prices obtained by farmers, and on prices obtained, prices paid and sell-buy margins for traders.[17]

Figure 11: **The maize value chain in Lao People's Democratic Republic**



Source: Author.

15 Additionally, there are maize consumers that use maize directly as animal feed (like animal farms) or firms that produce animal feed by combining maize with other feed ingredients (like soya meal). These domestic consumers are not part of the export value chain and are therefore not included in this study.

16 Traders, farmers and consumers of maize use different types of inputs in different moments, including seeds, fertilizers, herbicides, pesticides, machinery, services (such as transport or equipment use), among others. Similarly, regulators at the national and sub-national level affect the prices of inputs and the conditions of functioning of the value chain.

17 Regarding the importance of maize prices for the analysis of the value chain, a key point to consider is that of the reliability and availability of data. When analysing a value chain, one of the most important objectives is to analyse how value-added increases along the chain. Unfortunately, such analysis requires reliable, statistically representative data on costs, which is often only available for repeated surveys conducted by the national authorities over a period of time. In the absence of such information on costs, a valuable alternative is to analyse prices and, if possible, margins for equivalent products bought and sold at different stages of the chain. This is the approach we adopt here, using our survey data for farmers and traders.

To elaborate this section, the primary source of information used was a national field survey of key stakeholders of the maize value chain for export, which was implemented by UNCTAD's consultants in the three most important maize-producing provinces in the country: Xayaboury, Oudomxay and Xiengkhuang during May and June 2019. These three provinces combined, in 2018 accounted for almost two-thirds of all harvested area of maize in the country, as shown in Table 1. More details about the survey can be found in the Appendix.

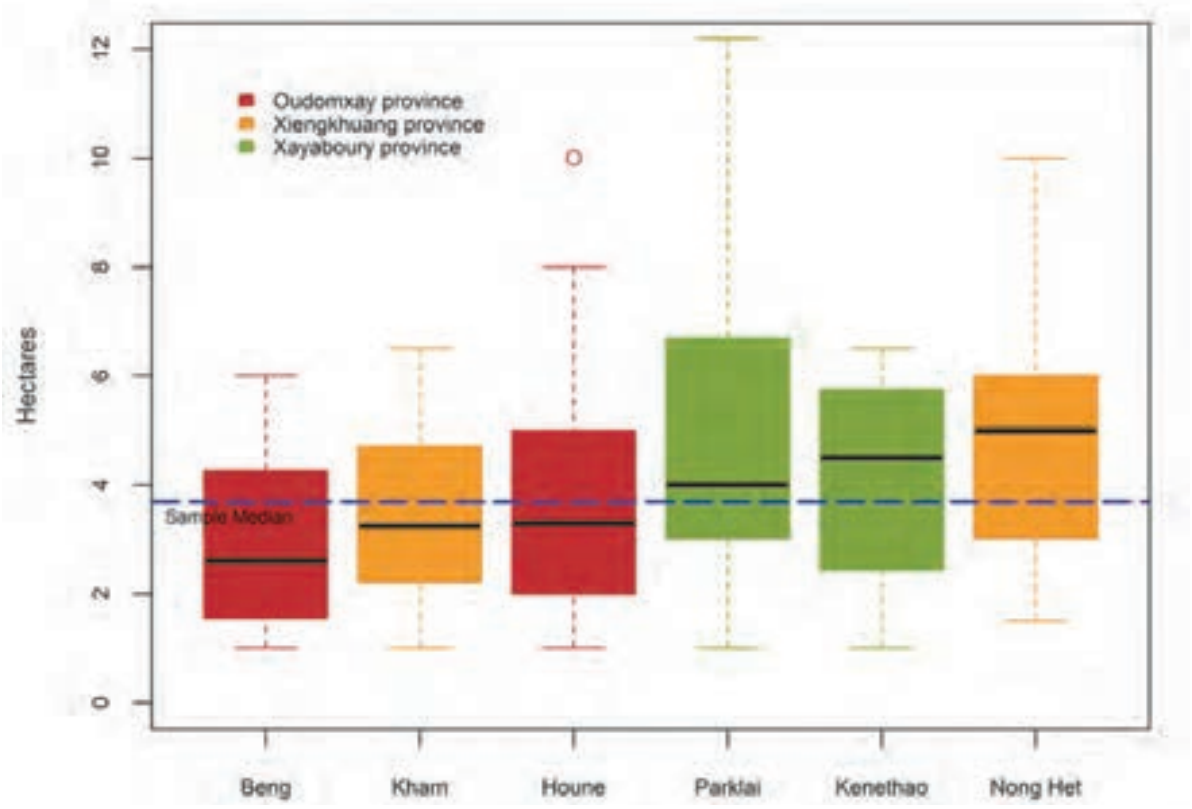
3.1 Production Stakeholders[18]

3.1.1 Income Sources of Maize Farmers and their Vulnerability to Shocks

The summary of the distribution of the cultivated area in each farm by district and province is presented in Figure 12, which is presented using boxplots.[19]

We observe that surveyed farmers were smallholders,[20] with the median farm size for the whole sample of 3.7 hectares (and the mean and the standard deviation were 4.3 and 3.3 hectares, respectively) indicated by a blue dashed line in Figure 13. The data also indicate that there are differences between provinces and districts. In particular, Nong Het district in Xiengkhuang province had the highest median size of 5 hectares, while Beng district in Oudomxay province had the smallest, at 2.6 hectares. Parklai district in Xayaboury province has a higher mean farm size of 5.7 hectares, and the highest dispersion in farm sizes, with a standard deviation of 5.6 hectares, in part due to the presence of five farms larger than 10 hectares, including one of 36.5 hectares.

Figure 12: **Summary distribution of surveyed farm size in six maize-producing districts (in hectares)**



Source: Author, based on UNCTAD survey data.

[18] In this section, all the analysis was conducted employing 175 observations, after removing outliers, except when specified in the text. This dataset includes 56 observations in Xiengkhuang province, 59 observations in Oudomxay province, and 60 observations in Xayaboury province.

[19] Boxplots present summary information about the centre, spread and skewness of a distribution, while also indicating observations that may be potential outliers. The "box" of the boxplot is defined by the first and third quartiles of the distribution analysed and indicate the median with a line within the box. See Fox (2015), pp. 41-44 for further details

[20] For reference, in 2019 the average farm size in the United States, a key maize exporter, was 180 hectares (Source: Statistica, 2020).

Maize was the main crop harvested in the surveyed area, covering 74 per cent of the planted land surveyed, and a median planted area dedicated to maize of 2.8 hectares per farm. As in the case of total farm size described by Figure 12, the highest median maize planted area of five hectares was in Nong Het district in Xiengkhuang province, while the district with the smallest median area dedicated to maize was Beng in Oudomxay province (1.5 hectares).

Rice accounted for 22.5 per cent of the cultivated area surveyed. The cultivation of rice in the different districts varies according to practices and to the geographic conditions of the district. For example, in Nhong Het district of Xiengkhuang province, which is characterised by mountainous and hilly terrain, farmers often produce and sell maize to buy rice for household consumption. In contrast, in Kham district of the same province, where the land is more suitable for growing lowland rice, maize producers often also grow rice to secure household food security. As pointed out by the study of (Viau, Keophosay, and Castella 2009) in nearby Xiengkhor district of Huaphanh province, access of farmers to lowland paddy farming can affect the choice of farmers regarding growing maize and other agricultural products. The remaining cultivated area surveyed (3.5 per cent of the total) included products like cassava, red beans and peanuts. These products were especially found by our survey in Xayaboury province, with cassava grown in Kenethao district, while red beans and peanuts were often found in Parklai district.

In terms of maize yield, results across provinces and districts were heterogeneous, but our survey finds yields per hectare similar[21] to those indicated by the Laos Statistics Bureau (LSB) for 2018. For Xayaboury, we find a median yield of 5.7 tons per hectare (LSB reports 5.4), for Xiengkhuang 5 tons per hectare (LSB reports 5.1) and for Oudomxay we find a yield of 4 tons per hectare (LSB reports 4.6). At the district level, the highest median yields both were found in Xayaboury province: Kenethao and Parklai districts had[22] 6 tons per hectare and 5.5 tons per hectare, respectively, while Kham district in Xiengkuang province also had a yield of 5.5 tons of maize per hectare. The lowest yields were found in both districts of Oudomxay province, as Beng and Houne districts registered 3.7 tons per hectare and 4.1 tons per hectare, respectively. The differences in yield in each district are clearly highlighted in Figure 13, where the blue dashed line indicates the national sample median of 5 tons per hectare.

Maize yield in Lao People's Democratic Republic is determined by many different factors, including climate, terrain and soil fertility. In particular, surveyed producers indicated the importance of farming practices, including the type of seeds used, the use of fertilizer to off-set low soil fertility (especially where maize is a monoculture), and herbicide for maize production. Herbicide in particular can offset labour restrictions/costs of carrying out weeding by hand.

The number of seasons maize is planted also varies across provinces. In Xiengkhuang, there is one production season, and farmers begin maize production activities around May and June, before the start of rain. In Oudomxay province, in some areas of maize production of Houne (especially the area along Xeng River) and Beng districts, maize can be grown two season per year (dry and wet seasons). In these areas, the rainy season production starts at the beginning of May and harvest takes place at the end of August, while the dry season production season starts in October and harvest takes place between February and March.

Maize production in the surveyed districts is commercial, and the type of maize planted by the farmers surveyed was exclusively hybrid maize. The most planted variety and source of hybrid maize seed differed by province, with 15 per cent of farmers declaring using more than one type of seed. In Xayaboury, 77 per cent of farmers reported using Advanta's Pacific 777 (Thailand), while 28 per cent reported using Charoen Pokphand Foods' (Thailand) CP varieties, especially CP 888. In Xiengkhuang, the leading seed varieties were those of Viet Nam's National Maize Research Institute (notably, LVN 10) with 93 per cent of farmers reporting using them, and 21 per cent reporting using Charoen Pokphand Foods' CP seeds like CP 888. In Oudomxay province, 68 per cent of farmers surveyed reported using Viet Nam's National Maize Research Institute seeds, such as LVN 10.

The specific types of seeds used by province depended on price differences among available choices,[23] the associated characteristics of local input markets, as well as real or perceived suitability of the seed to local environmental conditions such as resistance to drought.

21 The results on maize yields presented in this paragraph were calculated on 168 observations, removing five outlier observations, four of which are in Parklai district in Xayaboury province.

22 In Parklai district, our sample has four observations that suggest mismeasurement of maize production (or of area). Including those four observations, the median yield for the district is 6.2 tons per hectare. Figure 13 excludes these four observations.

23 For example, the survey team was informed in Xiengkhuang province that LVN 10 seeds cost much less than those of CP. This helps to explain the fact that 93 per cent of farmers indicating using the first variety versus only 21 per cent using the second one. The survey team also reported observing lower prices for LVN 10 than for CP seeds in Oudomxay, where also this seed variety dominates. Average prices cannot be reported due to data issues.

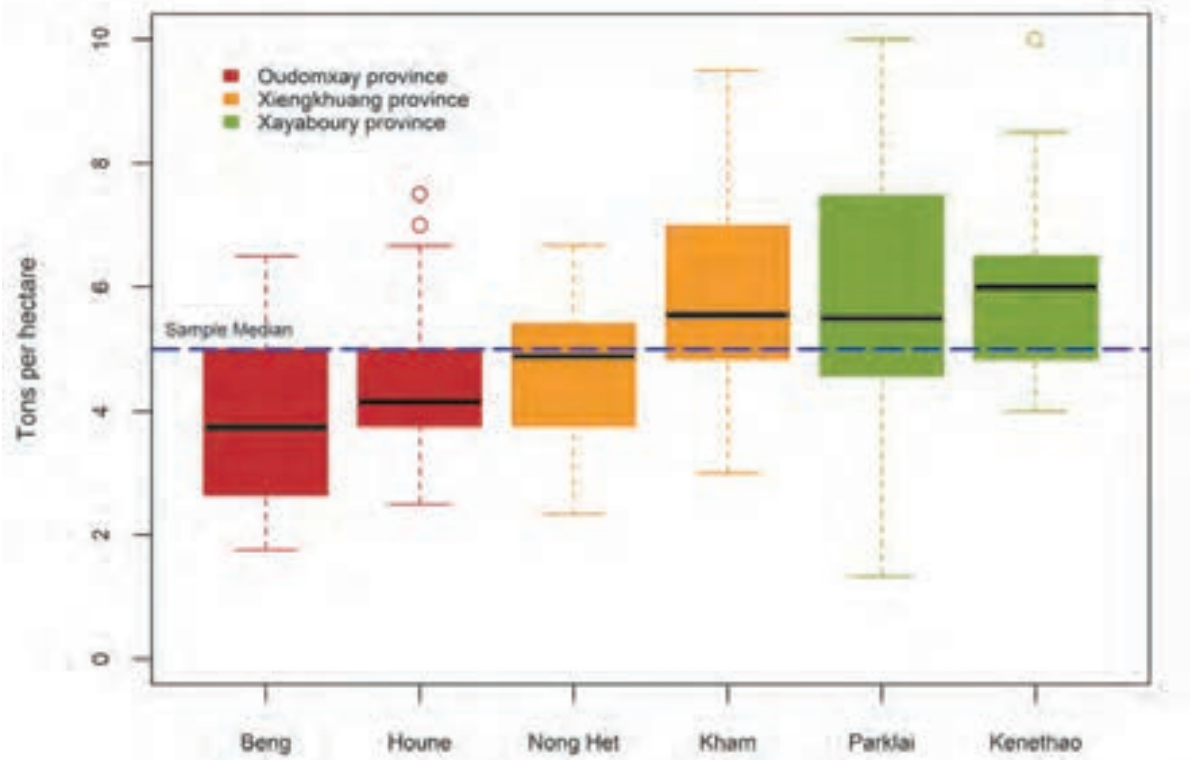
Maize seed availability, prices and types can also be influenced by official action. For example, in Xiengkhuang province the survey team conducting the field survey found that after 2016 the Provincial Agriculture and Forestry Office gave rights of importation and sale of maize seed to only two companies, namely the ***Import-Export Enterprise*** and ***Viengsord Import-Export Enterprise***. According to the PAFO officers interviewed by the survey team, the rationale behind the modified seed import arrangement was to control the quality of maize seed imported, in order to prevent the import of low-quality seeds. These firms are allowed to import 500 tons of maize seed per year and this seed is then distributed to agricultural inputs shops in the key maize production districts in the province such as Kham, Nhonghet and Phoukoud. The price of each maize variety is set by the two importers. Other agricultural inputs retailers are not allowed to import seeds directly, and the District Agriculture and Forestry Offices and the District Industry and Commerce Offices are in charge of monitoring the regulations regarding the import of maize seeds. Previous work, including Enhanced Integrated Framework (2016) also reports differences in seed import regulations in Oudomxay and Xiengkhuang provinces.

In addition to maize and rice, surveyed farmers also sell red beans, peanuts and cassava (especially in Xayaboury province), with several farmers located in Kham district of Xiengkhuang province,[24] indicating that they sell garlic or other vegetables. Additionally, 10 per cent of farmers (all of them located in Oudomxay province[25]) reported selling rubber, even though they did not report growing it.

The share of surveyed farmers indicating they had agricultural income other than maize was 42 per cent, but there were large differences between provinces. The percentage was highest in Xayaboury province with 65 per cent, while it was much lower in Xiengkhuang (34 per cent) and Oudomxay (27 per cent). There were also significant differences within these last two provinces across districts: in Xiengkhuang, the percentage of farmers reporting non-maize agricultural income was 59 per cent in Kham district but none in Nong Het district, while in Oudomxay province it was 35 per cent in Beng district versus 23 per cent in Houne district.

The median farmer in our sample had yearly non-maize agricultural income of LAK 5 million (US$ 580), with

Figure 13: **Summary distribution of surveyed maize yield in six maize-producing districts (in tons per hectare)**



Source: Author, based on UNCTAD survey data.

[24] Fifty-nine per cent of farmers in Kham district reported selling vegetables.

[25] Of the farmers surveyed in Beng district, 65 per cent indicated they sell rubber, pointing out to the regional importance of this crop in the district. Thirteen per cent of farmers in Houne district also reported selling rubber.

significant differences across provinces and districts,[26] The highest median values were registered in Xayaboury province, both in Kenethao (LAK 10 million) and Parklai (LAK 6.8 million) districts. Kham district of Xiengkhuang (LAK 1.5 million) and Beng district of Oudomxay province (LAK 2 million) registered the lowest median non-maize agricultural income among the districts surveyed.[27]

Additionally, more than one third of the farmers surveyed (34 per cent) declared to obtain income from selling livestock. Notably, this includes 81 per cent of farmers surveyed in Kham district and 25 per cent of farmers in Nong Het district of Xiengkhuang province, 34 per cent of those in Parklai district and 31 per cent of those in Kenethao districts in Xayaboury province. On the other hand, in Oudomxay province only 10 per cent of farmers in Beng district and 15 per cent of those in Houne reported obtaining income from selling livestock.

The median yearly income of farmers in our sample obtained from selling livestock was LAK 6 million (US$ 696), while the heterogeneity across provinces and districts was large. The highest median income by district (LAK 13 million) was registered in Nong Het in Xiengkhuang province, in spite of only 25 per cent of the farmers in the district reporting obtaining income from sales of livestock, followed by Parklai district in Xayaboury province (LAK 9 million), while the lowest median income from livestock sales was that of Houne district in Oudomxay (LAK 3 million). With very few exceptions, the numbers of animals sold by farmers were very small,[28] indicating that each animal sold constituted an important component of additional income. Our survey also suggests that maize was used as animal feed by 29 per cent of farmers, with the animals used both for self-consumption and for sale, but the quantities used as a share of the crop were negligible (0.4 per cent of the crop).

Using the prices of maize quoted by farmers and the production of maize reported, we estimated[29] the income obtained from maize sales by farmers. Adding up this calculated income from maize sales, reported income from non-maize agricultural sales, and reported income from livestock sales, we estimated the total yearly income from agricultural activities.

For all farmers in our survey, the median yearly income from agricultural activities was LAK 25.6 million (equivalent to US$ 2,963, or US$ 8.1 a day), while the mean income was LAK 31.2 million (equivalent to US$ 3,622, or 9.9 US$ a day). Figure 14 presents the summary distribution of this estimated income from agricultural activities by district and province, in US$, clearly showing the heterogeneity across districts.

Figure 14 shows that the maize farmers surveyed in Oudomxay province have the lowest agricultural income, with all surveyed farmers in Beng District earning below the sample median. This is explained by the fact that Beng district has the lowest median planted area and agricultural production by farmer, while only 10 per cent of surveyed farmers in the district reported receiving income from livestock sales. On the other hand, Parklai district in Xayaboury and Nong Het district in Xiengkhuang had the highest median income, with around three quarters of the farmers surveyed there having incomes larger than the sample median. This resulted from the combination of larger agricultural production and planted area per farmer, together with the fact that in Parklai district the income from livestock sales of a number of farmers were also important. As shown by Figure 14, the mean agricultural income by surveyed farmer in Parklai district (equivalent to US$ 5,467, or 15 US$ a day) was four times larger than that in Beng district (equivalent to US$ 1,323, or US$ 3.6 a day).

Maize prices are volatile and subject to frequent and persistent shocks, as shown by Figure 15, which presents the recent evolution of both United States (prices for no.2 yellow maize in United States Gulf ports) and Thai maize prices (source: Thai Feed Mill Association. Note in particular the high monthly volatility of the Thai price series, and the large and persistent changes experienced by United States maize prices, which are usually used as international reference prices.

Given this volatility of maize prices, an important research question is the extent to which maize-producing farmers are vulnerable to negative shocks to maize, including negative price shocks and maize-specific diseases and pests. Our estimation of agricultural income presented above allows us to estimate how dependent are maize farmers on income from maize. Figure 16 presents the summary distribution by district of such dependency and shows that the sample median maize dependency is very high at 94.5 per cent (the mean is 81 per cent). Maize dependency is homogenously high in both surveyed districts in Oudomxay province and in Nong Het district in Xiengkhuang province, with mean shares of maize in total agricultural income in all cases

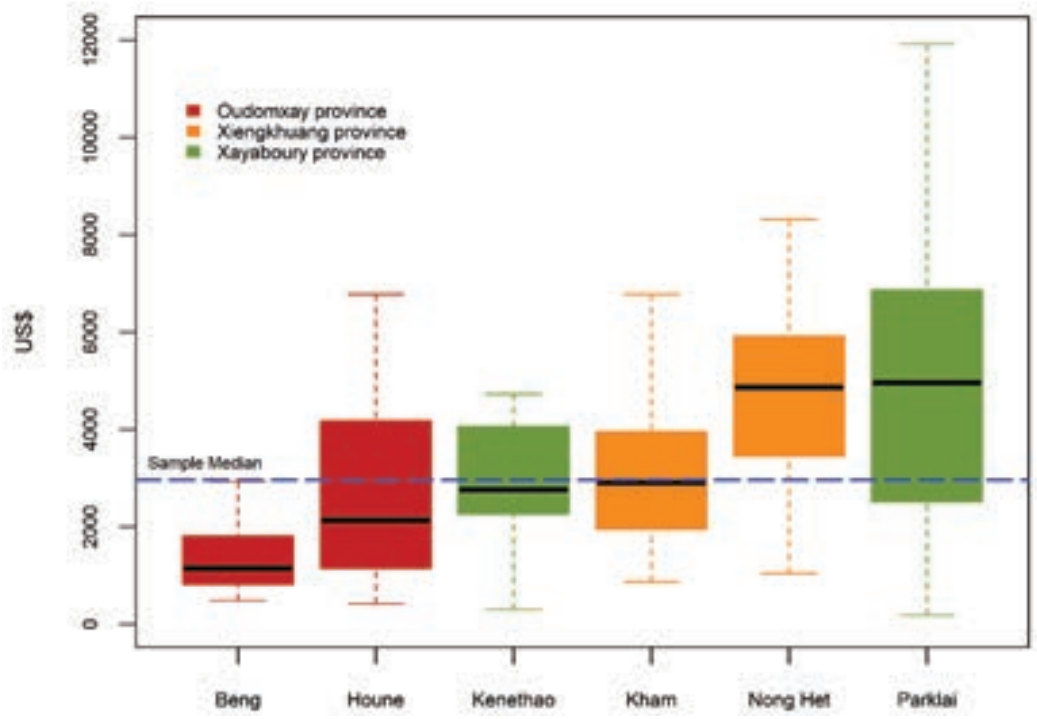
[26] We refer to the median values to account for the presence of a few large observations that impact on the mean. The mean of non-maize agricultural income in our survey was 8.1 million LAK (US$ 941).

[27] There were no observations of non-maize agricultural income reported by maize farmers surveyed in Nong Het district of Xiengkhuang province.

[28] The mean number of cows sold was 0.7 per farmer, while for hogs the mean number was 0.3 per farmer.

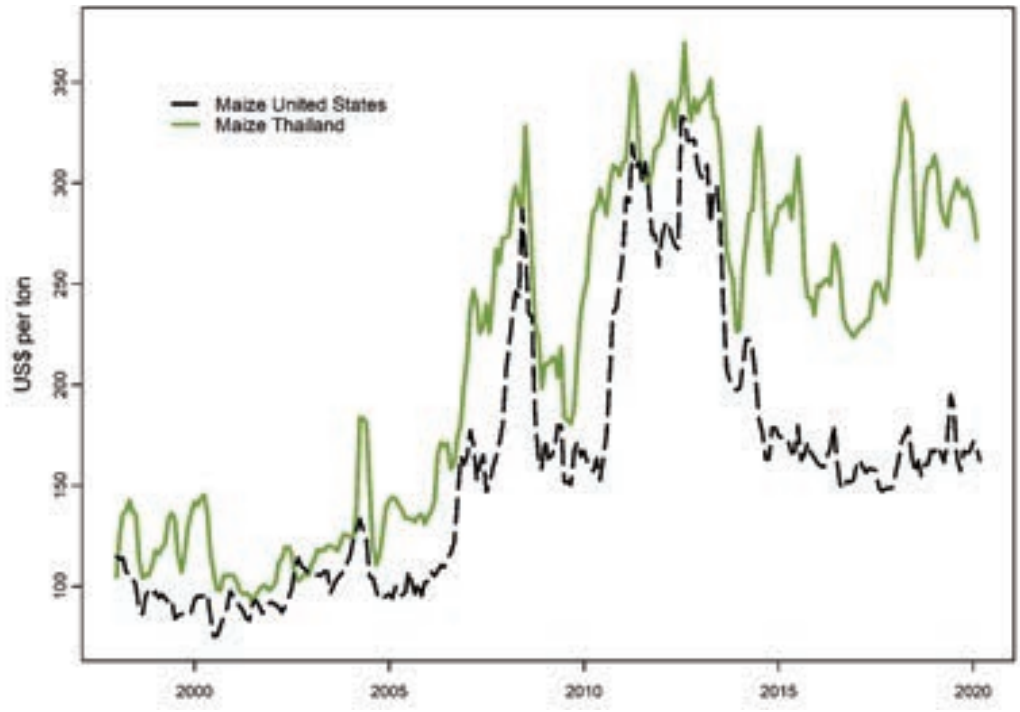
[29] In order to calculate maize revenue, the reported production of each farmer was multiplied by the price per ton reported. When both grain and cob prices were reported, grain prices were used. The calculation using cob prices instead was also made, but it does not affect qualitatively our results.

Figure 14: **Summary distribution of yearly agricultural income of surveyed farmers in six maize-producing districts (in US$)**



Source: Author, based on UNCTAD survey data.

Figure 15: **Monthly nominal maize prices, 1998-2018**



Source: Author, based on data from the World Bank, St Louis Federal Reserve Bank and Thai Feed Mill Association.

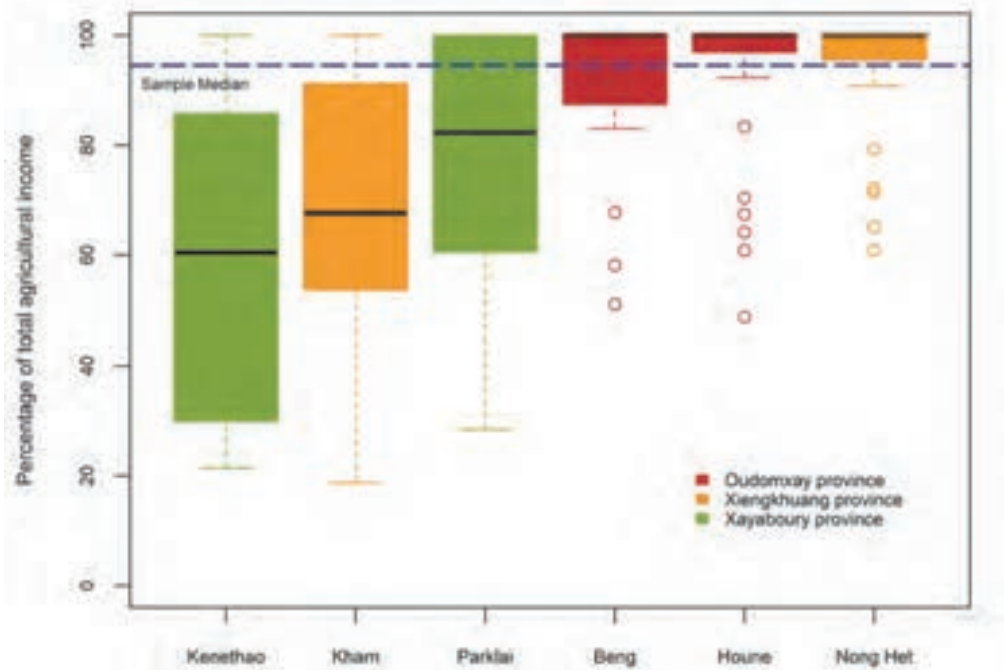
above 90 per cent. Kenethao district in Xayaboury and Kham district in Xiengkhuang province are the least dependent on maize, with mean shares of maize of total agricultural income of 59 per cent and 69 per cent, respectively, while in Parklai district in Xayaboury the mean share was 76 per cent. These three districts also showed substantial heterogeneity in maize dependency across farmers within the district, as indicated by their wide inter-quantile ranges in Figure 16.

Therefore, maize farmers in Lao People's Democratic Republic are very vulnerable to the occurrence of negative shocks to the price of maize. While the expansion of maize production observed in the country increased the income of farmers in the country (Castella and Nanthavong, 2014; Lestrelin, 2015), the downside of more concentration in the production of maize has been higher vulnerability to negative shocks to the latter. Additionally, maize farmers located in districts with the lowest (Beng and Houne) and the second highest (Nong Het) agricultural income in our survey sample are the most vulnerable to maize price volatility and to the occurrence of a negative shock to maize.

Finally, 62 per cent of all surveyed farmers also indicated that their households also receive non-farm income. There was significant dispersion among the different provinces, with 78 and 66 per cent of respondents in Oudomxay and Xiengkhuang provinces, respectively, indicating they had non-agricultural income, versus only 43 per cent of surveyed farmers in Xayaboury. Looking into the types of such non-agricultural household income by province, we observe that income from selling labour dominates the sources of non-farming income in Oudomxay province, with 87 per cent of the cases surveyed in the province that have non-farming income. In Xayaboury province, selling labour also is the largest source (50 per cent of cases) and is followed by business activities (35 per cent). In turn, in Xiengkhuang the main reported source of income was weaving (57 per cent of cases), followed by selling labour (24 per cent) and with other business activities in third place (11 per cent).

While we could not adequately quantify in our survey the value of such non-farm income, preventing us from estimating the total income of a farmer's household (both agricultural and non-agricultural), previous studies carried out in maize producing areas in Lao People's Democratic Republic (e.g. Viau, Keophosay, and Castella, 2009) indicate that such non-farm income is likely to be a small fraction of total income. Under this premise, our conclusion about the vulnerability of maize farmers in the country to negative maize shocks remains qualitatively unaffected.

Figure 16: **Summary distribution of maize income as a share of total agricultural income of surveyed farmers in six maize-producing districts (in per cent)**



Source: Author, based on UNCTAD survey data.

3.1.2 Characterizing Farmer – Trader Relationships

Surveyed farmers sell most frequently to small traders, known as "village collectors", who trade yearly volumes of maize of 1,000 tons or less. 67 per cent of all surveyed farmers declared selling either exclusively (58 per cent of farmers) or partially (9 per cent of farmers) to village collectors. Village collectors live mostly in the same village as the farmer, or in a few cases within the cluster village. Additionally, 21 per cent of farmers sell to district traders from the same district either exclusively (15 per cent of farmers) or partially (6 per cent), while a small number of farmers sell to traders from another village.[30]

Village collectors act largely like aggregators, buying from farmers and selling to larger traders. As village collectors are the type of trader farmers most frequently deal with, relationships with them greatly influence farmer-trader relationships, and possibly are also related to prices and quality of maize sold by farmers. Village collectors may or may not be acting contractually as "agents" for larger traders.

While the ***types*** of traders who interact with farmers are important, so is the ***number*** of buyers, as the more independent selling options farmers have, the more likely it is that they can get better prices for their maize. This is because, in the presence of inelastic supply, geographically-limited number of buyers, and high switching-costs of changing customers (e.g. due to transport costs, reputational issues, or others), producers of maize may be subject in the short-run[31] to substantial bargaining power exercised by their traders (see Dobson and Chakraborty, 2008; Blair and Harrison, 2010; and Mitra et al., 2018). This in turn may result in lower prices than those that would exist under competitive market conditions.

Seventy-six per cent of surveyed farmers reported that only one trader buys maize from them, while observing more than two traders buying maize is very rare (less than two percent of cases in Xiengkhuang province). As shown by Figure 17, this suggests that farmers usually face few choices in selling their maize at the farmgate.[32]

We also enquired into the nature of trader-farmer relationships and their persistence. More than half of those farmers that answered[33] reported that they have a close business relationship with the traders they sell to, while 23 per cent reported having friendship links with the traders. For this last group, three quarters of these traders lived in the same village or cluster village as the farmer.

The median duration of the relationship (with or without an agreement/contract) of each farmer with their most important trader was 3 years, with a mean of 5.6 years, but there was significant heterogeneity across districts and provinces. In particular, while the median duration in Oudomxay was also of three years, in Kham district in Xiengkhuang the median duration was of two years, in Nong Het district in Xiengkhuang and in Parklai district in Xayaboury the median duration was of five years, while in Kenethao district in Xayaboury the median duration of the relationship was of 10 years.[34] Additionally, when traders were asked whether they change suppliers of maize from one year to the next, 36 per cent indicated that they do not, confirming that relationships with suppliers are persistent.

Both these elements, namely the fact that most farmers face few options for selling their maize, and that relationships between farmers and traders are close and persistent, are then important characteristics of farmer-trader relationships in the Lao maize value chain.

There are many possible reasons why we observe few buyers per farmer as well as close and persistent relationships instead of arms-length market relationships between farmers and traders.

One factor influencing the number of possible buyers, is that transport costs impose a barrier for traders to operate far from their location. As pointed out by the theoretical and empirical research on agricultural oligopsony market power (see Rogers and Sexton, 1994; Fackler and Goodwin, 2001; and Graubner, Balmann, and Sexton, 2011), in agricultural markets where producers and buyers (in our case, traders) are geographically separated, the existence of transport costs can give rise to monopsony power by the traders. This is probably more marked in remote areas, with less ready road access, and hence higher transport costs.

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30 Selling all maize to a trader from another village is a practice we registered almost exclusively in Kham district of Xiengkhuang province, where 25 per cent of farmers reported selling only to traders from another village. This was observed only in one case in each of the other five districts surveyed.

31 As pointed out by Dobson and Chakraborty (2008), there may also be dynamic effects of buyer power, potentially including negative effects on quality and process innovation.

32 There are different empirical challenges to surmount in measuring farmer possible choices. Among them, the fact that the timing of traders' buy offers is important, as well as whether this is known ex ante by the farmer or not, and also the fact that traders that a farmer could sell to (i.e. the options available) are not necessarily the same as those that he or she actually sells to. For this reason, this variable as measured in our survey should be considered with care, taking account of these and other caveats.

33 Fifty-one per cent of all farmers gave details on the type of relationship they have with traders.

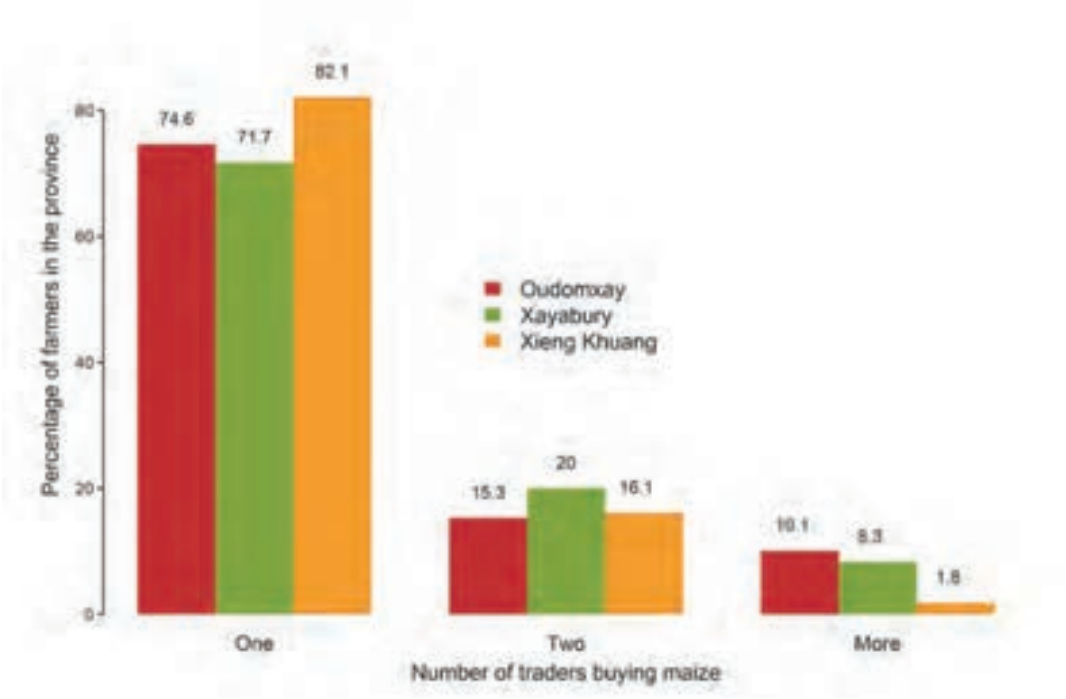
34 However, the sample size of usable answers in this district was the smallest, at 16 answers.

A second potential reason is that farmers may need to incur search costs for finding new traders. There may be uncertainty about relevant but *ex ante* unobservable characteristics of traders, such as reliability at payment time, or "mark-up" with reference to competitive prices (i.e. how large is the discount that traders apply to the maize prices paid to farmers, combined with how is quality of maize measured and priced by the trader). These search costs in the face of unobservable characteristics of traders result in the "reputational capital" of the incumbent trader being important, reducing the probability that farmers may seek out alternative options for selling their maize.

Another possible reason for the observed persistency of farmer-trader relationships is related to the existence of agreements between farmers and traders. Farmer-trader agreements can be used to insure farmers against price volatility, to secure inputs necessary for maize production, and to secure for traders' maize supplies in advance of the harvest. 29 per cent of surveyed farmers reported having an agreement with a trader (mostly of an oral nature), with important differences among provinces. For example, in Oudomxay 51 per cent of farmers reported having an agreement, while this share fell to 28 per cent in Xayaboury and only 5 per cent in Xiengkhuang. Interestingly, these agreements in 90 per cent of cases did not fix the price of maize in advance.[35] Similarly, even though 49 per cent of the traders surveyed reported having an agreement with suppliers,[36] only 1 per cent of those traders reporting agreements indicate that the price of maize is fixed in the contract. This indicates that such agreements between farmers and traders are only in very few cases a source of insurance for farmers against price volatility.

Farmer-trader agreements and the observed close and persistent farmer-trader relationships can facilitate farmers obtaining credit in species (and, less frequently, also cash advances) for producing maize. The provision of credit in species by buyers of agricultural products is very extended around the world and has a role in addressing moral hazard issues better than cash loans, as indicated by Conning and Udry (2007). Viau, Keophosay, and Castella (2009) also note that Vietnamese traders buying maize from farmers in Xiengkhor district in Huaphanh province provided hybrid seeds on credit to farmers, while Boundeth et al. (2013) report that in Bokeo province it was common practice for traders to provide credit to farmers for the acquisition of inputs, and that such credit provision was positively and significantly correlated with maize production in the province.

Figure 17: **Number of traders buying maize from surveyed farmers**



Source: Author, based on UNCTAD survey data.

35 This means than less than 3 per cent of surveyed farmers reporting having an agreement with fixed prices with a trader. Instead, 70 per cent of the farmers with an agreement explicitly indicated that the price of maize was market based.

36 We note that the number of traders that report agreements and the number reported by farmers differ, probably due to sample heterogeneity.

As rural credit provision can be very dependent on reputational capital for sustainability over time, the need to create reputational capital for obtaining credit may be an important component behind the observed persistency of farmer-trader relationships. Specifically, and following (Vega-Redondo 2003), each season farmers and traders play a repeated game: in the first period of the season (sowing time) farmers borrow inputs from traders and then decide whether to repay them in the second period (harvest time), while traders decide at sowing time whether (and how much and for what price) to lend inputs to farmers, in the expectation of being paid during harvest time. Such repeated games lend themselves to having both types of players rely on the past observed behaviour of their business partners (i.e. reputation) to make predictions about future behaviour, and repeated cooperation can lead to an equilibrium where principal-agent problems are addressed.

Indeed, our study found that traders commonly supply inputs to farmers. More than one third of all surveyed farmers (35 per cent) reported either receiving specific inputs from a trader or having to repay them at the time of selling maize to a trader, but there was significant variation across provinces. This number climbed to 58 per cent of the farmers surveyed in Oudomxay province, 35 per cent of those in in Xayaboury and 11 per cent of those in Xiengkhuang. Interestingly, note that we showed that maize farmers in Oudomxay province have the lowest total agricultural income in the whole sample.

Of the farmers reporting receiving specific inputs or paying for inputs, 82 per cent reported having an agreement with traders. These agreements were almost exclusively (96 per cent) of an oral nature. Of the farmers that declared receiving specific inputs or paying for them at maize sale time, 89 per cent of them received seeds from traders, 36 per cent received chemicals like herbicides, 28 per cent received equipment use services (or equipment) and 26 per cent received fertilizer.

Data from surveyed traders confirms the information gathered from farmers regarding the importance of trader-farmer relationships for the provision of inputs by the former to the latter. In 74 per cent of cases, traders reported having provided some form of input to farmers, including seeds (74 per cent of traders), chemicals like pesticides and herbicides (30 per cent) and fertilizers (16 per cent). Additionally, 10 per cent of traders[37] also provide land preparation services to farmers. Traders indicated that they deduct the mentioned inputs provided from payments to the farmers when buying maize. Additionally, 35 per cent of the traders surveyed indicated that they provide farmers with cash advances,[38] which they later deduct. Interestingly, the provision of inputs in species or cash credit by traders in 65 per cent of cases corresponds to traders that reported having an agreement with farmers, indicating that in one third of cases the farmer-trader agreements are implicit.

Insufficient primary information was obtained during the elaboration of this study regarding the marks-up charged by traders for provision to production inputs to farmers in Lao People's Democratic Republic. However, recent studies like Enhanced Integrated Framework (2016) suggest that these marks-up are significant.[39]

Of the farmers receiving inputs, 51 per cent declared that they were charged interest for those loans by traders, at a rate that on average was 2.7 per cent per month (median 2.5 per cent), with a standard deviation of 0.5 per cent per month.[40] For a 10-month seasonal lending period this amounts to a total interest rate for the period of between 28 per cent (if we calculate it using the median) and 31 per cent (if we use the mean). When asked about the interest rate that they charged, we obtained responses from 38 per cent of surveyed traders, and they indicated that the monthly interest they charged was on average 2.6 per cent per month (median, 2.5 per cent) for the whole sample.[41] This matches the data gathered from farmers regarding the cost of financing inputs and the important role played by traders.

From informal discussions between stakeholders and the survey team, we learnt that in some cases, the business negotiation for the provision of credit in species (inputs) takes place between the producer and the representative of a trader or buyer that is based at the village. The trader or buyer representative registers the name of the producer who requires inputs and credit for maize production, the amount required, and

37 This was observed in particular in Houne district in Oudomxay province, where more than half (53 per cent) of all small traders surveyed in the district reported providing such services.

38 Surveyed traders specified that the credit deduced is *separate* from the deductions for seeds, fertilizer or herbicides provided to farmers.

39 Enhanced Integrated Framework (2016) indicates that traders in Oudomxay province charged a price mark-up of 25 per cent for providing seeds to traders.

40 Eighteen per cent of all surveyed farmers indicated the interest rate they were charged for inputs. For farmers in Oudomxay, the mean and median monthly rate was 2.5 per cent, while for Xayaboury the mean monthly interest rate was 2.9 per cent, and its median 3 per cent. There was no data about interest charged in Xiengkhuang.

41 In Oudomxay province, traders reported a mean monthly interest rate of 3.5 per cent (median, 2.75 per cent), in Xayaboury the monthly reported mean was 2.4 per cent (median 2.5 per cent) and in Xiengkhuang the mean was 2.4 per cent (median 3 per cent) per month. The share of traders surveyed who provided the interest rate charged in each of the three provinces was 25 per cent, 82 per cent and 15 per cent, respectively.

the type of inputs and credit needed, and subsequently sends this information to the traders or buyers that they represent. In turn, the trader or buyer then provides the village-based representative with cash and/or inputs as required, for the representative to distribute to the farmers requesting them. These trader or buyer representatives receive a commission for their services

Additionally, some traders also provide financing for roads, which are a public good for maize-producing villages. In 12 per cent of cases, surveyed traders indicated that they participated in the construction of roads to the maize fields or villages, principally by paying for road construction, and then they recovered their investment from farmers, for example via deductions of their maize price paid. Trader participation in road construction was most prevalent in Kenethao district in Xayaboury (25 per cent of traders), in Nong Het district in Xiengkhuang (23 per cent of traders), and in Parklai district in Xayaboury (15 per cent of traders). In two villages visited during the field survey (Kormon village in Nong Het district, Xiengkhuang province, and in Numyon village, Houne district, Oudomxay province), the Village Heads indicated that maize roads had been constructed by one or several buyers. Viau, Keophosay, and Castella (2009) also documented traders lending money to village communities for the construction of roads in several villages in Xiengkhor district in Huaphanh province. Such road construction made the cultivation of maize in fields previously difficult to access possible, increasing the attractiveness of maize as a cash crop.

All this suggests that traders in the country buying maize play not only a role as providers of inputs to farmers, but also one of financing them by providing financial services, and sometimes also financing the construction of roads to villages or maize fields. The existence of close and persistent relationships between farmer and traders is then instrumental in the sustainability of the (largely) oral contracts between the two types of stakeholder, as it reduces the hidden-information (i.e. principal-agent) and hidden-action (i.e. moral hazard) problems faced by traders/lenders.

In order to obtain price information for decision-making, farmers reported that the main source of price information was prices in nearby markets, followed by information gathered from neighbours. Only in a few cases (9 per cent of all farmers) did farmers report also obtaining price information from traders. This suggests that market information obtained from sources other than traders may be considered more useful by farmers, maybe due to the perceived incentives of the latter to use information strategically. This may be particularly important for the majority of farmers, who have few trader options to whom they sell.

Finally, according to our survey of both farmers and traders, the latter are not significant sources of either technical advice or training for farmers, with only 6 per cent of traders reporting doing so and 1 per cent of farmers reporting receiving it. This role is under the responsibility of Provincial or District Agriculture and Forestry Offices instead.

3.1.3 An Econometric Analysis of Maize Sales by Farmers: The Role of Farmer Characteristics

Maize farmers differ from one another in characteristics like their location, the type of maize they sell, and others. In this section we analyse whether these differences among farmers are statistically associated with the different prices that they obtain for their maize.

Figure 18 shows the monthly pattern of maize sales as reported by the farmers in our sample. We observe that the months with the highest reported sales activity, measured as the share of surveyed farmers reporting sales in each month, are January, February and March, while those with the lowest level of activity are June, July and August.

An important factor that determines sale prices for maize in Lao People's Democratic Republic is whether it is sold in cob or in grain form. Our sample data suggests that 32 per cent of farmers sell their maize only in cob form, that 49 per cent sell it only in grain, while 19 per cent of farmers sell both cob and grain maize. Interestingly, there are significant differences across regions in our sample about whether farmers sell maize in cob or grain. For example, most farmers in Xayaboury province sell their maize only in cob form (82 per cent), while most farmers in Xiengkuang (86 per cent) and 61 per cent of those in Oudomxay sell their maize only in grain form. Farmers are paid for their maize almost exclusively in cash.

Despite the cyclicality of maize sales shown in Figure 18, it was only possible to obtain for analysis "average" sales prices as estimated by farmers for maize. For the survey period, corresponding to the marketing year[42]

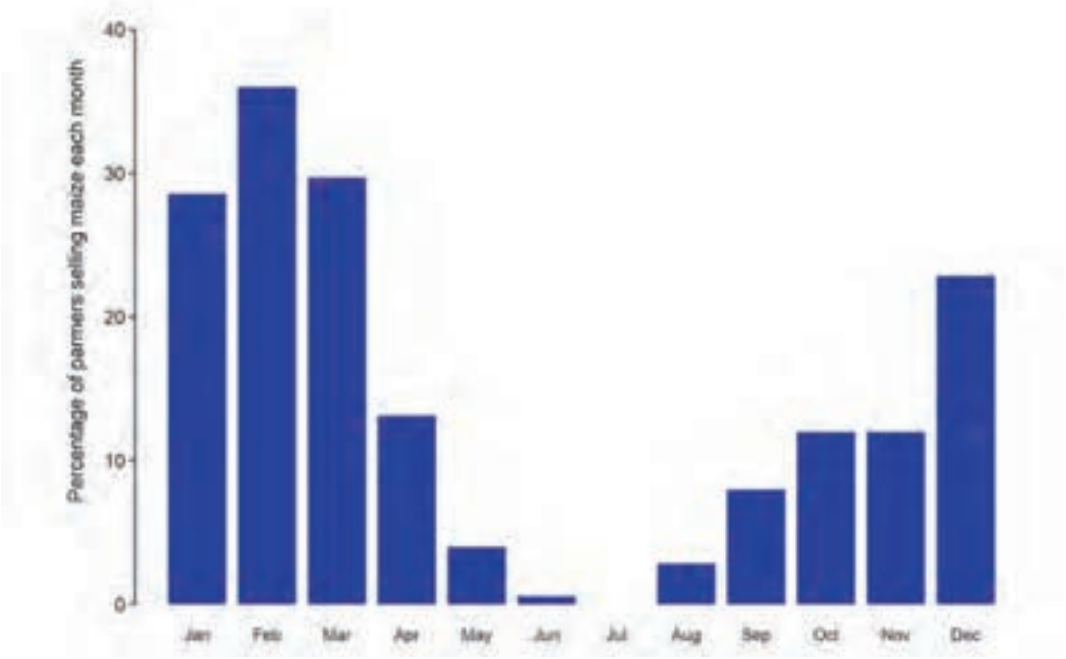
[42] A marketing year is a period of one year, straddling two calendar years, which is used for reporting and analyzing the production and sales of an agricultural commodity like maize. The United States Department of Agriculture measures the maize market year of the United States from September to August. For Lao People's Democratic Republic, survey data used in this report suggests that the marketing year for maize goes from August to July.

2018-2019, in the whole sample of the three provinces surveyed the median and mean prices of maize in cob were LAK 1,045 per kg and LAK 1,134 per kg respectively, while the median and mean prices of maize in grain were LAK 1,600 per kg and LAK 1,602 per kg respectively. The whole sample difference[43] in price between maize sold in cob and maize sold in grain form was of LAK 468 and 555 per kg using the mean and median prices, respectively. However, we observed differences in the prices of maize in Xayaboury with respect to the other two provinces. We already mentioned that there are differences in the form of maize sold in Xayaboury (mostly in cob) with respect to Xiengkhuang and Oudomxay, where maize is mostly sold in grain. The mean price of maize in cob in Xayaboury during the period (LAK 1,225 per kg) was higher than in Oudomxay province[44] (LAK 939 per kg), in particular in Parklai district, and that in Xiengkhuang province (LAK 1,018 per kg), while the dispersion of prices (measured by its standard deviation) was also higher than in the other provinces. The mean prices for maize in grain in Oudomxay and Xiengkhuang were similar, at LAK 1,604 and 1,638 per kg, respectively, and higher than in Xayaboury (LAK 1,428 per kg).[45]

In addition to whether maize is sold in cob or grain forms, there are other possible farmer characteristics associated with maize sales prices received by farmers, such as:

- Geographic factors
- Whether farmers are members of a producer group (i.e. a "cooperative")
- Whether farmers have dedicated storage facilities to store their maize
- Whether farmers store maize, and for how long
- Whether farmers receive inputs from traders
- The wealth of farmers

Figure 18: **Yearly sales cycle of maize of surveyed farmers**



Source: Author, based on UNCTAD survey data.

[43] Given the fact that 19 per cent of farmers sell both in cob and in grain, and that we obtained insufficient information about how to weight prices in those cases between maize in cob and in grain, there are two different ways of calculating price statistics by geographic area. We have presented here the calculation based on taking this 19 per cent of observations both for the calculation of cob and grain means and median prices. If we use these observations only for grain, and use for cob only those that only sell in cob form , the difference between the means of cob and grain prices is of 355 per kg as the mean cob price is LAK 1,247 per kg instead of LAK 1,134 per kg.

[44] The sample sizes for calculating cob prices were 58 observations in Xayaboury, 23 observations in Oudomxay but only eight observations in Xiengkhuang, as most surveyed farmers sell maize in grain in this province.

[45] In Xayaboury, we only observed 11 observations of farmers selling maize in grain.

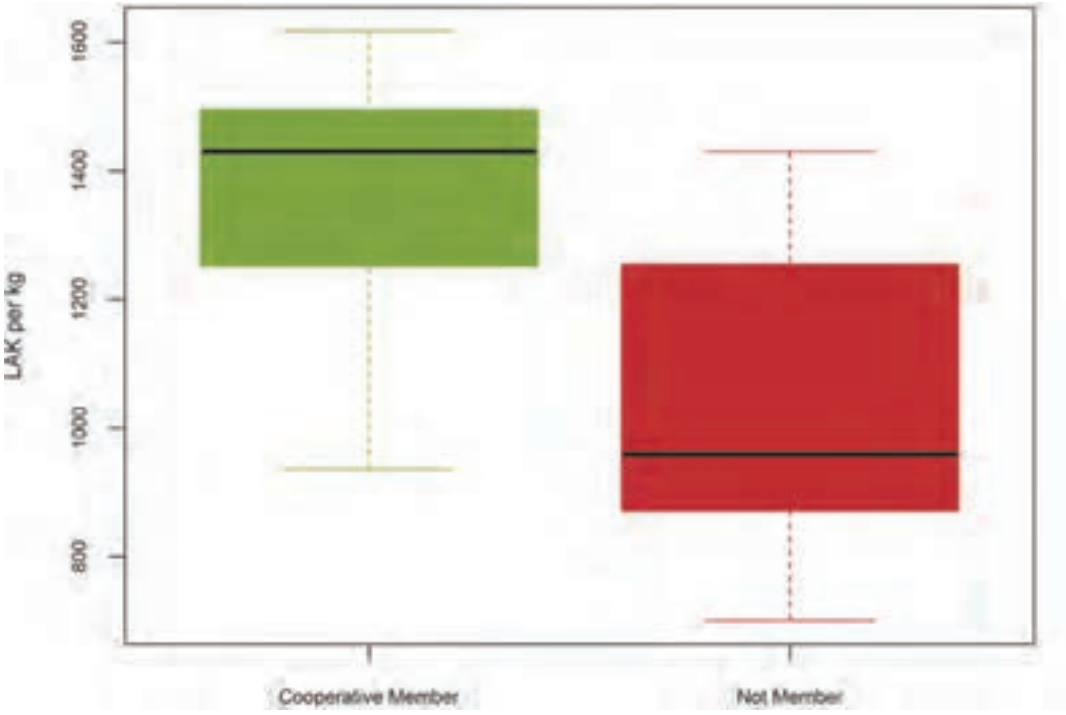
Controlling for *geographical factors* can help to elucidate the effects of unobserved variables that may be geographic-specific, such as established local practices, local regulations (like seed import practices, as we saw above), local infrastructure conditions such as roads, and others.

A number of previous studies of maize farming in Lao People's Democratic Republic (e.g. Castella and Bouahom, 2014), have claimed that *cooperatives* (i.e. producer groups) can play a positive role in different aspects of the development of agriculture in the country. Twenty-one per cent of all surveyed farmers declared being members of a cooperative, with 95 per cent of those located in Xayaboury province (58 per cent of all the farmers in Xayaboury province).

Seventy percent of surveyed maize farmers members of a cooperative indicated that the most important purpose of the latter had to do with influencing their dealings with traders, including negotiating with them or collecting and selling maize to them. Therefore, one would expect *a priori* to see higher prices for farmers who were members of a cooperative. Figure 19 below shows a comparison of the summary distribution of prices for maize sold in cob in Xayaboury province, where cooperative membership was the highest among our surveyed farmers. Note that the graph suggests the existence of significant differences between the prices paid to cooperative members versus those that are not members.

Maize producers in Lao People's Democratic Republic sell maize in three different ways. First, farmers can pre-sell maize before it is harvested. The price obtained by farmers selling under this modality often entails an important discount.[46] Second, producers can sell maize immediately after the harvest without drying. Farmers selling shortly after the harvest minimize the risk of fungi and pests attacking maize and avoid the need for storage and its associated costs and risks.[47]

Figure 19: **Summary distribution of surveyed maize prices sold *in cob* in Xayabury province, by cooperative membership (in LAK per Kg)**



Source: Author, based on UNCTAD survey data.

[46] As an indication of the discount due to such advance sales, during its visit to Xayaboury province the survey team reported that the advanced sell price in 2018-2019 for maize was around LAK 1,000 per kg. While this price was not obtained using the same methodology as the rest of the survey, making comparison impossible, note that our survey indicates that the average price of maize sold only in cob in the province was LAK 1,225 per kg (median LAK 1 300 per kg), suggesting that advance sales incur an important reduction in price for producers.

[47] As UNCTAD's survey obtained only average prices for the whole season, it was not possible to relate prices obtained by farmers to the abundance of maize in the market, as indicated for example by Figure 18. Prices obtained by farmers are often related to the relative abundance of their product in the relevant geographical market.

In the third modality of sales, producers ***can store and sell dried maize.***[48] Selling dried maize often means that producers will not harvest maize in the early harvesting season, but rather leave the cobs in the field for the sun to dry them. Alternatively, farmers can harvest maize and then let it dry and store it.[49] This requires farmers having access to storage facilities.

The degree of humidity is an important determinant of the quality of maize sold and we would expect ***a priori*** that those farmers storing and selling dry maize fetch higher prices. Adequate storage can reduce the incidence of problems like insects, rodents and fungi damaging stored maize, and which can also negatively affect the sales price of maize. Furthermore, the capacity to store maize also tends to improve a farmer's bargaining position, as they can in principle decline an immediate sale opportunity in expectation of improved prices in the future.

Nevertheless, the reasons for selling maize immediately after the harvest, or after drying vary for each farmer and period, and do not always involve a strategic decision by the farmer based on expected price differentials. In some cases, maize is left to dry in the fields due to lack of access (some roads become impassable in bad weather, especially in hilly terrain) or insufficient labour available for harvesting. For this reason, survey questions about "drying maize" may mean different things and are often difficult to interpret. It is also important to note that leaving maize in the field for a long period of time can be risky for producers, as maize can be affected by problems like fungi and pest attacks which can result in lower quality for maize and hence lower prices.

Twenty-two per cent of surveyed farmers reported holding no dedicated storage facilities for maize, while the remaining 78 per cent reported holding storage facilities for maize mainly made of wood (such as bamboo). As the decision to store maize is separate from the availability of storage facilities, farmers were also asked how long they stored maize, with 60 per cent of farmers providing the number of days that they store maize. The only district reporting limited availability of storage facilities was Kenethao district in Xayaboury province, where 38 per cent of farmers indicated having such storage. All other districts had much higher availability of storage, ranging from 77 per cent of farmers in Houne district in Oudomxay province to 92 per cent of farmers in Nong Het district in Xiengkhuang province.

Additionally, as we mentioned above, many farmers receive inputs from traders as credit, to be paid in cash or via a discounted maize price, at the moment of selling maize. One would expect that the prices received by farmers would be smaller if the effect of credit on received prices is significant and if payment of inputs via a discounted maize price is frequent. In particular, such an effect on maize prices received by farmers may be higher the stronger the bargaining power of traders with respect to farmers. As we mentioned in the previous section, farmers' bargaining power is influenced by the number of options available to farmers, search costs and other factors.

Finally, one could expect ***a priori*** that wealthier farmers would have stronger bargaining power, being able to obtain higher prices for their maize. The reason for this is that wealthier farmers can draw upon their assets to offset an ***ex post*** liquidity shock, or to wait or search for more trader options to sell their maize, thereby allowing them to delay the sale of maize.

We now test formally the relationship between the prices of maize sold by farmers (both in grain and in cob) and the following variables: (i) the geographic location of farmers, (ii) whether the farmer belongs to a cooperative, (iii) whether storage capacity is available, (iv) the length of maize storage, if any, and (v) whether a farmer receives one or more inputs from traders, such as seeds, chemicals or others. Farmer wealth, measured as the size in hectares of their cultivated farm area, was tested but its coefficient was found not to be significantly different from zero[50] and is therefore not included in the analysis below.

In order to use the data of prices sold in cob, we constructed a "selling price" variable that used prices of maize in grain when available, and maize in cob when the former were not available.[51] To account for the fact that cob prices were used in some observations of sale prices, we included a dummy (i.e. a 0/1 indicator) variable for it in each model, using a different dummy per province (either Xayaboury or Xiengkhuang, as no observations

[48] As indicated by Semple et al. (1991), aflatoxins can become a problem after 72 hours for maize stored wet. Therefore, storing maize for longer usually requires maize farmers to dry maize. Hence, the length of maize storage can also largely account for the effects of drying maize on prices.

[49] It was not possible to distinguish in our survey between these two different forms of drying.

[50] This might be due to the fact that, after removing one outlier, the farm size in the data sample was homogenously small, with a mean of 4.2 hectares and median of 3.9 hectares, and a standard deviation of 2.3 hectares. Only three observations had a size larger than 3 standard deviations over the mean.

[51] This is a relevant point only for the 19 per cent of observations where both cob and grain sales prices were reported by farmers, but where we cannot weight the share of maize sold for each price.

of buying in cob in Oudomxay were included in the dataset used). The survey sample used for estimation[52] of Model 1 was 168 observations and 105 observations were used to estimate Model 2.

The models presented in Table 2 are those for which robust results could be provided. First, we estimated a model (Model 1) including all variables, assuming that if an individual observation for storage length in days is missing,[53] the storage time in days is zero. Model 2 includes the same variables as Model 1, but all observations where the length of storage measured in days was missing were eliminated. The results[54] of the estimation, using Ordinary Least Squares[55] are presented in Table 2.

In the first place, the results of our analysis presented in Table 2 indicate that geographic factors at the provincial level[56] affect maize prices sold by farmers, with prices being lower in Xayaboury (XY) than in Oudomxay (OD) or Xiengkhuang (XK) provinces, even after controlling for whether farmers sell their maize in grain or cob form. As expected, selling in cob form results in much lower prices with respect to selling in grain in both Xayaboury and Xiengkhuang.[57] Our sample used for estimation did not contain observations of farmers selling maize in cob form in Oudomxay province.

In the second place, Table 2 indicates that cooperative membership raises the prices of maize sold, even after controlling for province location (we mentioned the fact that cooperative membership in our sample is almost exclusively concentrated in Xayaboury province) and controlling for the fact that almost all cooperative members reported selling maize in cob. This confirms previous work indicating the importance of cooperative membership in strengthening bargaining power of farmers in Lao People's Democratic Republic (SADU, 2012).

In the third place, both models suggest that having storage capacity and increasing the length of maize storage each is individually correlated with higher prices of maize sold by farmers, as expected. Given that storing maize for longer requires drying maize, the effect of the storage length coefficient is then partially due to the increased quality of maize being sold, i.e. dry maize, in addition to potential positive increases in farmer bargaining power with traders. Both models, which treat missing values of storage length differently, show that the coefficients of having storage and the length of storage are both significant, positive and distinct. This reinforces the hypothesis presented above that storage may give farmers additional options in terms of selling maize, increasing their capacity to obtain higher prices. Storage can also be associated with higher quality of maize, as storing maize for longer periods require drying it.

Finally, receiving inputs from traders is linked to lower prices obtained by farmers for maize. Given that farmers obtain such inputs on credit from traders, and pay for them at harvest time, our finding suggests that farmers get a lower price from all their maize sold, instead of obtaining the market price for maize and paying a certain quantity of maize or providing cash to cover the cost of the inputs/credit received from traders. Also, note that the effect on prices is small (in the order of LAK 55-67 per kg), and much smaller than the positive effect of having storage capacity and selling in grain instead of in cob form.

In summary, the results in Table 2 confirm the importance of investment by maize farmers in capital goods such as storage facilities, of storing maize (which, other than for very short time periods, involves drying maize), as well as cooperative membership, in order to obtain better prices by strengthening bargaining power. It also suggests that the input financing relationship between farmers and traders is also associated with farmers receiving lower prices for maize, although the effect seems to be small.

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52 From the complete 175 available observations of prices, one observation for storage availability was missing, and six outlier observations were eliminated. This does not include the missing data of the storage length variable, mentioned below.

53 This variable had 63 additional missing observations with respect to the data used in Model 1.

54 Among other quality-of-fit test, the Durbin-Watson test was applied to the residuals of both models. For Model 1, this test had a p-value of 5.6 per cent, so for robustness, we also used the correction proposed by Arellano (1987) to calculate the corresponding variance-covariance matrices and p-values. The results did not change qualitatively.

55 To check the robustness of our results, we also calculated these models using an MM estimator (see Fox, 2015), obtaining similar results.

56 We chose to estimate our models using provincial-level instead of district-level dummy variables because it is difficult to argue that differences in unobserved (or mis-measured) variables between districts within the same province would justify reducing the degrees of freedom of the estimation. Additionally, regulations and other variables not explicitly included in the model usually vary at the provincial rather than district level.

57 As few farmers reported selling in cob in Xiengkhuang province, the size of the coefficient of the cob dummy for this province should be taken with care. This contrasts with the large number of observations of farmers selling in cob in Xayaboury province. Hence, the difference in sizes of the coefficients between the two provinces is less important than the fact that both are statistically significantly different from zero.

Table 2: **Econometric analysis of maize prices received by farmers**

	Model 1	Model 2
Province OD (baseline)	1459***	1484***
	(37)	(62)
Province XK	-12	-25
	(33)	(42)
Province XY	-216***	-317***
	(53)	(77)
Sells cob in XK	-545***	-577***
	(82)	(99)
Sells cob in XY	-227***	-135
	(57)	(89)
Coop. Member	179***	175**
	(47)	(75)
Has storage capacity	190***	150***
	(33)	(51)
Storage length (in days)	0.60**	0.95*
	(0.28)	(0.51)
Receives inputs	-55*	-67*
	(28)	(39)
R^2	0.64	0.53
Adj. R^2	0.62	0.49
Num. obs.	168	105
RMSE	155	162

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

3.2 Trader Stakeholders

3.2.1 Characterizing Trader Types and Functions in the Maize Value Chain: The Role of Trader Size

In Lao People's Democratic Republic, traders carry out different functions in the maize value chain. Importantly, small traders, defined as those that sell up to 1,000 tons of maize a year, can be distinguished from larger traders in terms of the functions they perform.

In this section, we show that trader size is a key variable to characterize and analyse the Lao maize value chain due to the positive relationship between trader size and: (i) trader age (i.e. survival); (ii) trader dependency on maize income; (iii) the sources of maize of traders; (iv) the availability of dedicated storage capacity and the length of storage of maize; (v) the size of the transport capital stock; (vi) the quality of maize traded; (vii) the types of inputs received from buyers; and (viii) whether they are exporters or not.

Our survey indicates that maize sales by volume are unevenly distributed across traders. While only 35 per cent of all surveyed traders declared trading more than 1,000 tons of maize per year, this group of traders handle 81 per cent of the declared maize volume traded in the survey. In particular, 14 traders (9 per cent of the total number of traders) declared trading more than 3,000 tons per year and sell 49 per cent of all maize volume traded in our survey.

The remainder of this study refer to those traders selling up to 1,000 tons of maize per year as "small traders", those selling 1,001 – 3,000 tons of maize per year as "middle-sized" traders and those selling more than 3,000 tons of maize per year as "large traders".[58]

Trader Size and Trader Age

Trader size is positively correlated to the survival duration of traders, measured by how long traders have been operating, as shown by Figure 20. Surveyed traders indicated on average having operating for nine years, with a standard deviation of 5 years. Small traders had a mean age of 8 years and a median age of 6, while middle-sized traders had a mean and median age of 11 years, and larger traders had a mean and median year of 14 years. Across different provinces, this phenomenon is maintained: the median age in years of traders is positively correlated with trader size. Regarding the direction of causality between trader size and survival time, it is possible that the relationship is bi-directional: as traders get larger, they are more likely to survive over time, and as they survive longer, they become larger.

Trader Size and Dependency of Maize Income

In our survey, the share of maize income as a percentage of yearly turnover is also positively correlated with trader size. The median dependency on maize sales for income for small traders surveyed was 50 per cent, while for middle-sized traders it was 70 per cent, and for larger traders it was 75 per cent of yearly turnover. In all three provinces surveyed, small traders had lower maize dependency when compared with middle-sized and large ones as a group. Small traders in Xayaboury were the ones with the lowest maize dependency, at a mean of 42 per cent and a median of 30 per cent, while the group of middle-sized and large traders in Xiengkhuang were the most dependent on maize sales, with a mean dependency of 73 per cent of income and a median of 80 per cent. Figure 21 shows this relationship between dependency on maize income and trader size.

Twenty-eight per cent of all traders surveyed indicated trading other agricultural products in addition to maize. We found important differences across provinces: while only 7 per cent and 14 per cent of surveyed traders in Oudomxay and Xiengkhuang, respectively, declared trading products other than maize, 73 per cent of those surveyed in Xayaboury declared doing so, especially trading cassava, beans (including red beans) and nuts (peanuts). This matches the products planted by traders mentioned in Section 3.1. Additionally, 40 per cent of all the traders surveyed indicated that they also engage in non-agricultural activities, such as selling labour, or having other businesses.

Trader Size and the Aggregator Role of Small Traders

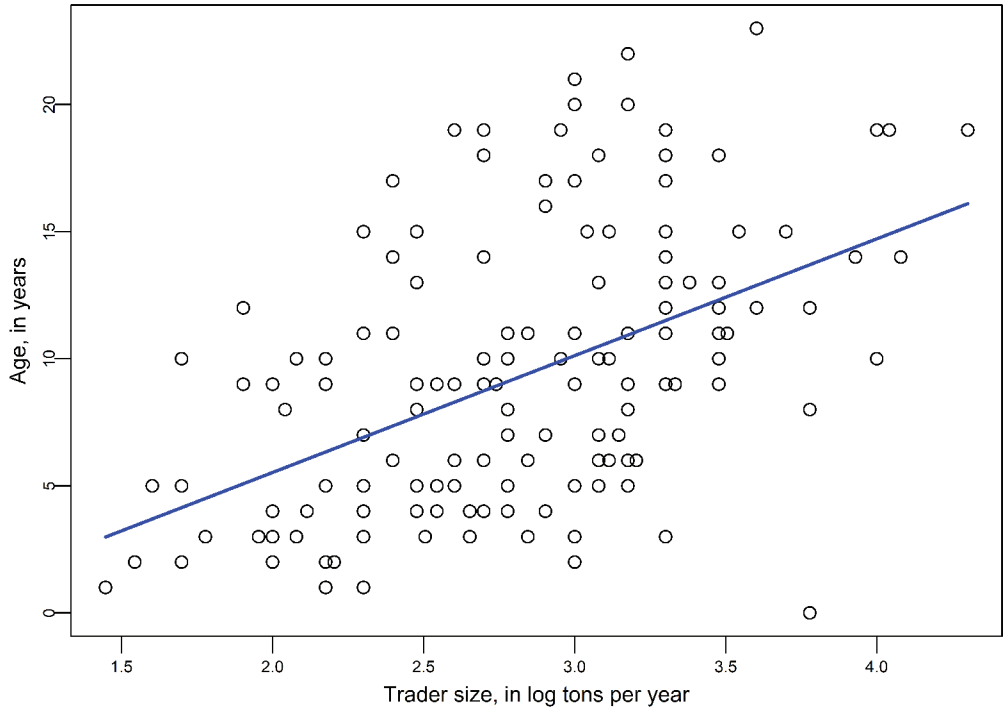
Traders differ in terms of who they buy maize from: 76 per cent of surveyed traders reported buying only or mostly from farmers directly, while the remaining 24 per cent indicated that they bought only or mostly from other traders. A key point is that small traders are more likely to buy directly from farmers, while middle-sized and large traders are more likely to buy from other traders, indicating a two-tiered nature of the Lao trader market. Specifically, 85 per cent of small traders in our sample indicated buying mostly or exclusively from farmers, in contrast to middle-sized and large traders, who declared doing so in 65 per cent and 57 per cent of cases, respectively.

This is repeated across all three surveyed provinces, even though the share of small and larger traders buying from farmers differs across provinces. Specifically, among middle-sized and large traders as a group, those in Oudomxay are the ones that buy the most from other traders (55 per cent of them do so), while 24 per cent and 41 per cent of these larger traders buy from other traders in Xiengkhuang and Xayaboury provinces, respectively. By contrast, small traders in all three surveyed provinces buy mostly directly from farmers: 96 per cent of those in Xayaboury, 86 per cent of those in Xiengkhuang and 76 per cent of those in Oudomxay province buy maize directly from farmers.

The finding that larger traders are more likely to buy from other traders indicates an important role played by small traders: that of providing ***aggregation***, acting as intermediaries between larger traders and farmers. If smaller traders aggregate maize bought from farmers and then sell it to larger traders, the use of storage capacity for these small traders is different than for larger traders: according to this hypothesis, smaller traders accumulate maize mostly in order to sell to larger traders, rather than using storage capacity strategically to profit from market fluctuations. If this hypothesis is correct, one would expect small traders to have less storage capacity and store maize for shorter periods of time in their aggregation function for larger traders.

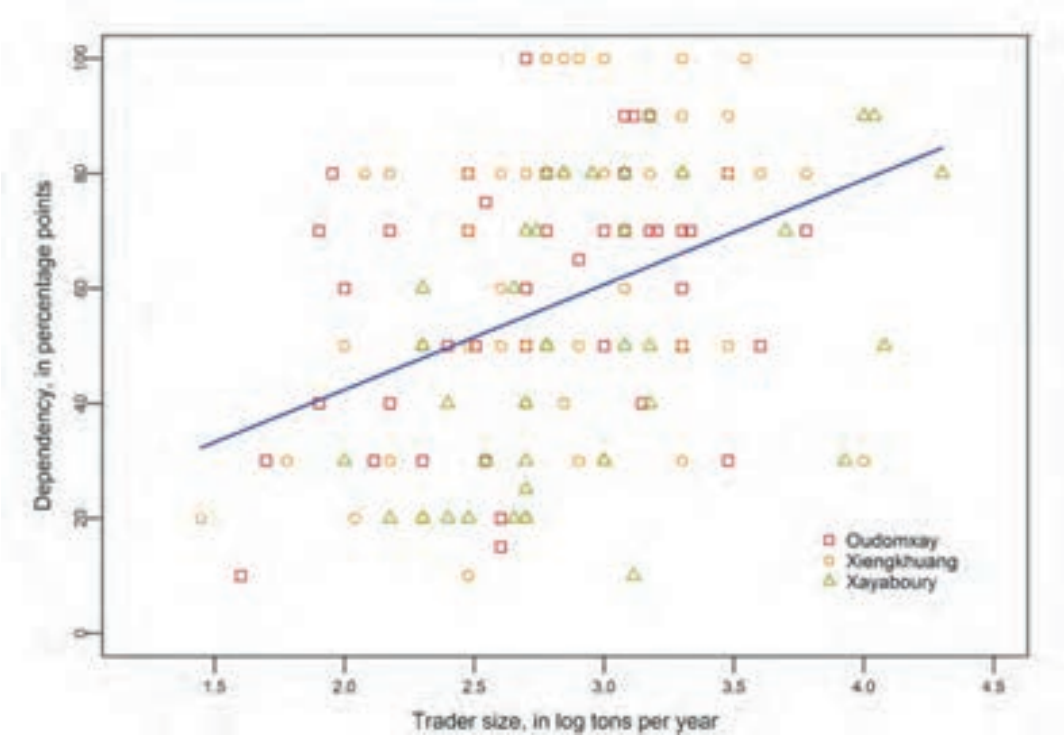
[58] In this section, all calculations were conducted using 155 observations, after removing outliers, unless specified in the text. This dataset includes 53 observations for Xiengkhuang province, 45 for Xayaboury and 57 observations for Oudomxay. Traders can also be divided into two groups according to their size: 101 observations were small traders ("village collectors"), 40 observations were middle-sized traders, and 14 observations were large traders. As in the case of farmers, all traders surveyed declared trading only hybrid maize.

Figure 20: **Trader age (in years) and trader size (in log tons sold per year)**



Source: Author, based on UNCTAD survey data.

Figure 21: **Dependency of maize income (in percentage of turnover) and trader size (in log tons sold per year)**



Source: Author, based on UNCTAD survey data.

In total, 61 per cent of surveyed traders indicated that they had storage capacity for maize. However, the share of traders declaring owning storage capacity is much higher for larger traders than for small ones: while only 51 per cent of small traders indicated having dedicated storage capacity, this share increases to 80 per cent and 86 per cent for middle-sized and large traders, respectively. Our data indicates that there are differences across provinces.[59]

Analysing our data about the average duration of storage use indicates that the installed capacity is not used for long periods of time. The mean number of months that traders store maize was 3.6 months, while the median was 3 months. Additionally, the size of traders is also positively correlated with the duration of maize storage, something that occurs in every province surveyed: while larger traders have a median storage time of 6 months, middle-sized and small traders had a median storage time of maize of 4 and 3 months, respectively. Only 3 per cent of all traders (almost exclusively large ones) declared storing maize more than 6 months.[60] This also confirms the idea that small traders play an important aggregator role for large traders.

Trader Size and Transport of Maize

Another important role that traders play is that of transportation of maize between producers (or other traders) and consumers of maize. According to our survey, 92 per cent of traders indicated that they transport maize. Of middle-sized and large traders as a group, almost all (96 per cent) declared transporting maize, while this share fell slightly to 89 per cent for small traders. This pattern was repeated across all three provinces.

Of the traders that declare transporting maize, 88 per cent only use their own vehicles, 10 per cent use both their own vehicles and rent other vehicles, and only 2 per cent exclusively rent vehicles only. This highlights the importance of ownership of transport stock for entry into the trader market. Vehicle ownership is high across all provinces: 96 per cent of traders in Xiengkhuang, 88 per cent in Oudomxay and 84 per cent in Xayaboury. In the whole sample, 93 per cent of large and medium traders declare owning at least one vehicle, while that number is still high (88 per cent) for small traders. The most common types of vehicle owned by the traders surveyed were trucks of ten and more wheels ("large trucks"), observed in 57 per cent of traders, followed by trucks of six wheels ("small trucks"), reported by 46 per cent of traders.

In particular, most large traders (93 per cent) and middle-sized traders (83 per cent) own one or more of the "large trucks", in comparison with 42 per cent of small traders. There are different types of trucks included within the "large truck" group. First, there are twelve-wheel trucks, often having a 10-12-ton load capacity, that are used to transport maize from village collectors to larger traders (including those traders that have drying facilities). There are also 22-wheel trucks that are often used for longer-distance travel, including transporting maize to Laotian animal feed factories within Lao PDR (for example, located in Vientiane) or for export. These trucks are frequently bought second-hand and modified locally, and reportedly have a loading capacity in the 20-40 ton range.

Regarding ownership of "small trucks" of six-wheels, ownership is extended across different sizes of traders, as 50 per cent of large traders, 43 per cent of middle-sized traders and 48 per cent of small traders surveyed declaring they own at least one such truck. A type of six-wheel truck, locally called "Lod Yean", is often used by small traders to carry out maize collection from a farm.[61] This modified truck, which often has a 6-10-ton capacity, can tolerate very rough road conditions to pick up maize from difficult-to-access places.

Tractors, which are useful to prepare land for farmers and to access difficult-to-access fields, are by far more likely to be owned by small traders than by middle-sized or large traders.[62]

Another finding is that the transport stock of traders also increases with trader size. While the mean[63] transport

[59] The share of traders indicating having storage capacity is smaller in Xiengkhuang province for all trader sizes. In Xayaboury and Oudomxay provinces, all large traders report having storage capacity for maize, as well as 90 per cent and 94 per cent of middle-sized traders, versus 50 per cent and 54 per cent of large and middle-sized traders in Xiengkhuang. Similarly, only 22 per cent of small traders surveyed in Xiengkhuang report having storage capacity for maize, while 65 per cent of those in Oudomxay and 68 per cent of those in Xayaboury do so.

[60] The positive correlation between storage time and the log of trader size is still positive and significant (with a p-value of 5.8 per cent) even if we restrict the analysis to observations of storage time up to 6 months.

[61] In addition to small traders working for themselves, there are also in some locations a number of agents who provide transportation services to traders who own the cargos that the agents transport. These agents have usually a "Lod Yean" vehicle and transport maize bought by traders from farmers charging a service fee per kilogram of maize transported.

[62] Nineteen per cent of surveyed small traders declared owning at least one tractor, versus 10 per cent of middle-sized traders and 14 per cent of large ones.

[63] The median assessed value of the transport stock for small, middle-sized and large traders was LAK 206, 440 and 632 million, respectively.

capital stock for all traders was of LAK 408 million, small traders had on average LAK 306 million, middle sized traders LAK 501 million (63 per cent more than small traders) and larger traders had LAK 817 million (1.7 times more than small traders). Similarly, using the number of vehicles owned also shows how much the volume of the transport capital stock increases with trader size. While the average trader had 1.9 vehicles of all types, small traders had an average of 1.5 vehicles, middle-sized traders had 2 vehicles and larger traders had on average 5 vehicles. This result is important because large differences in the size of the capital stock between small and larger traders might contribute to creating barriers to entry into the different segments of the market where traders of different sizes operate.

Trader Size and Maize Quality

Surveyed Traders indicated that the humidity of maize is its key quality determinant, together with the presence of contaminants such as weevils or fungi. Surveyed stakeholders clearly indicated that price and quality of maize are closely and positively linked.

Traders have an important role to play in relation to the quality of maize. This has two dimensions: carrying out processes that preserve or improve the quality of maize sold, and quality control of maize bought.

In terms of the preservation or improvement of maize quality there are indications that these processes change in type depending on the size of traders.

First, traders shell maize to obtain grain maize from cobs, as 52 per cent of traders in our survey indicated that they own a shelling machine. Shelling often takes place at the "village collector" (small trader) level or other traders that buy maize directly from farmers. As larger traders tend to buy more frequently from other traders than small traders, the percentage of larger traders that own shelling machines is correspondingly smaller: 36 per cent of large traders declared owning a shelling machine, while 49 per cent of "village collectors" and 65 per cent of middle sized traders declared owning one. It is also common for traders owning a shelling machine to offer shelling services. Often, small traders owning a shelling machine go to a maize-producing village to collect maize, carrying a mobile shelling machine. Subsequently, local labour is hired in the village to transport maize, to shell it and then to load it into the trader's vehicle.

Second, while small and medium-sized traders play an important role in shelling maize, larger traders are more likely to carry out cleaning, sorting and drying of maize using machinery. Traders indicated that drying and sorting maize are necessary to improve the quality of maize, in line with the importance of reducing humidity and avoiding contamination by fungi or pests. In our sample, 27 per cent of traders indicated that they carry out one or more of the functions of cleaning, sorting and drying maize, and the share of traders engaging in these roles increased with the size of the trader: 64 per cent of large traders, 38 per cent of middle-sized traders and 18 per cent of small traders declared carrying out these functions. This correlation of trader size with these functions is qualitatively matched by our data on which traders declare having cleaning/sorting and drying machinery of their own, even if the rate of response to these questions was smaller.

In terms of quality control, the role of the traders is also important, as more than half of traders surveyed indicated that it is traders who control quality, more often than buyers or farmers. In many cases, the first quality check of maize is carried out by the trader (often, a "village collector") when he/she checks the maize that a farmer has for sale for moisture content and contamination (for example, by weevils). The price offered by traders to farmers for maize is conditional on its observed quality. Interestingly, the existence of agreements between farmers and traders only plays a small role regarding quality control, as our survey of traders indicated that only 11 per cent of the agreements contain provisions on quality, mostly based on the humidity content of maize.

Similarly, there are also indications that as maize moves along the value chain, the importance of quality increases both in terms of the prices obtained by traders selling maize, and because the minimum quality levels of maize accepted also increase. For example, while only 9 per cent of small traders surveyed reported that they have had to reject maize bought due to quality problems, this share increased to 15 per cent of middle-sized traders and 36 per cent of large traders.

Sales to some large domestic buyers like animal feed processing factories and animal farms often require traders undergoing a quality inspection of their maize before delivering it. A low moisture content and showing no signs of having pest contaminations like weevils or fungi are required. Stakeholders interviewed in Xiengkhuang and Xayaboury indicated that Vietnamese and Thai buyers match price to quality when buying, but the requirements in terms of moisture content or weevils vary.

Trader Size and Input Provision to Farmers

As discussed in Section 3.1.2, traders play an important role as providers of financing input provision to farmers. Traders provide inputs such as seeds, fertilizers, herbicides, pesticides and also soil preparation services[64] on credit, and charge interest on those loans. Our survey analysis finds that traders of different sizes also receive inputs from their buyers, which in some cases they use to forward to their own suppliers. Interestingly, these inputs are provided by buyers in many cases without the existence of a formal agreement/contract, which was only reported in 14 per cent of cases[65] for all traders, and 10 per cent and 15 per cent in the case of small and middle-sized traders, who more often receive inputs in species from buyers.

Indeed, 10 per cent of small and 8 per cent of medium-sized traders indicated receiving inputs in species from their buyers, including fuel, seeds, herbicides, pesticides and bags, while 18 per cent of small traders, 28 per cent of middle-sized traders and 14 per cent of large traders reported receiving cash advances from their buyers.

These observations reinforce our previous characterisation of the traders' segment of the Lao maize value chain as multi-tiered, suggesting that while obtaining cash advances is useful to all sizes of traders, small and middle-sized traders in some cases act as intermediaries for the advance provision of inputs (like seeds) in species between their customers and the farmers producing maize, while in other cases traders provide those inputs directly to farmers, as suggested by the analysis in Section 3.1.2.

Trader Size and the Geographic Scope of Maize Sales by Traders: Integration into Regional Value Chains

Fifty-three per cent of all surveyed traders declared exporting maize. Exporters can be separated into the 30 per cent of all traders who declared exporting only maize, and the 23 per cent of traders who declared exporting both maize and other products, notably cassava, beans and peanuts.[66] The share of surveyed traders exporting maize was 45 per cent, 54 per cent and 62 per cent in Xiengkhuang, Oudomxay and Xayaboury provinces, respectively.

There is a positive relationship between trader size and their exporter status.[67] In line with the two-tiered structure of the trader segment of the value chain, which distinguishes between small traders and other traders, 86 per cent of large traders and 70 per cent of middle-sized traders are maize exporters,[68] in comparison with only 28 per cent of small traders, which instead mostly sell domestically, including to other traders. Figure 22 presents the summary distribution of trader size, measured in logarithms of the tons traded per year, according to whether they are maize exporters or not, disaggregated by province. Note that exporters are larger than non-exporters in all surveyed provinces.

The relationship between trader size and whether they export also emerges from the analysis of the location of traders' main customers.[69] Only 15 per cent of traders selling more than 1 000 tons of maize per year have only domestic customers, while this share is 68 per cent for small traders. This confirms the two-tiered nature of the trader market, with small traders aggregating for larger traders.[70]

Geography seems to determine to a large extent the neighbouring country to which maize traders in Lao People's Democratic Republic export to. In Oudomxay, 42 per cent of maize traders surveyed reported exporting to China. In Xayaboury province, 45 per cent of maize traders in our survey reported exporting to Thailand. In Xiengkhuang, 45 per cent of traders indicated a specific destination for their exports of maize: 28 per cent export only to Viet Nam, 15 per cent to both Viet Nam and China, and 2 per cent only to China.

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64 Village collectors who provide soil preparation services, often to be paid by the farmer at harvest time with maize (as other inputs provided), usually have at least one tractor and they contract their services to farmers, either driving the tractor themselves or hiring a driver to provide the service. This service can also be provided on credit in some locations.

65 In those cases where an agreement between a buyer and a trader were reported, it often involved a contract with a large domestic buyer like Thai multinational Charoen Pokphand Foods, who is an important producer of animal feed in Lao People's Democratic Republic.

66 Xayaboury province in particular registered the largest number of traders exporting multiple agricultural products.

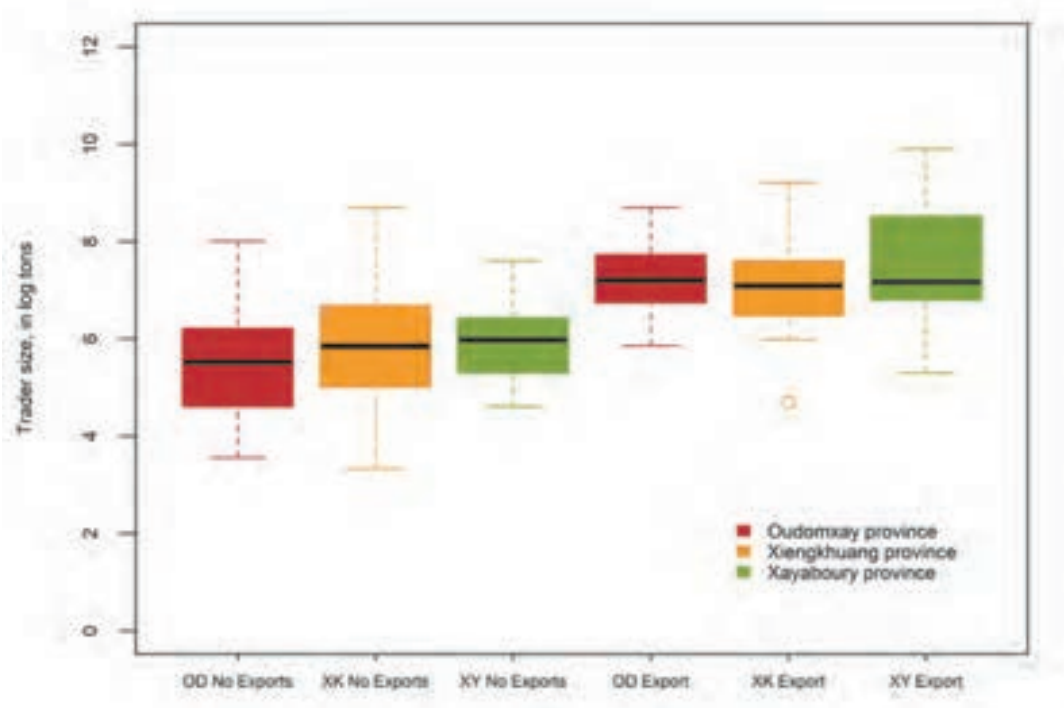
67 While 53 per cent of all traders declared exporting maize, only 44 per cent of all traders indicated specific countries to where they export maize.

68 The analysis considers a trader an exporter if he declared a specific country to which he or she exports maize.

69 When traders were asked where their three most important buyers of maize (if more than one) were located, 23 per cent of traders indicated that their buyers were all abroad, 27 per cent declared that they were both based domestically and abroad, while the remaining 50 per cent of responses indicated that they were all based in the country. As this means that 50 per cent of traders have foreign clients, this matches the information obtained from asking traders if they export maize.

70 This is reinforced by analysing if the "most important" customer is in Lao People's Democratic Republic or abroad: 79 per cent of small traders have a main domestic customer, while for middle-sized and large traders the shares are 33 per cent and 29 per cent, respectively.

Figure 22: **Distribution of trader size (in log tons sold per year) by surveyed province and exporter status**



Source: Author, based on UNCTAD survey data.

Similar information about the main destination for maize exports was obtained independently from UNCTAD's farmer survey. In Oudomxay province, 83 per cent of farmers reported that they believed that at least part of their maize was sold in China.[71] In Xayaboury province, 58 per cent of farmers indicated that they believed the destination of their at least part of their maize was Thailand, especially in Parklai district, while in Xiengkhuang province 54 per cent of farmers, especially those in Nong Het district, indicated their belief that at least part of their maize was sold by traders in Viet Nam.[72]

Xayaboury province has two international border crossings that connect the province to Thailand. The Phou Doo international border crossing is located around 25 km from the centre of the Parklai district, and is located in Bouamlao-Thakeo village, where there is maize production and trade. This border crossing is smaller than the one in Nam Huerng,[73] which is located in Kenethao district, 4 km from the centre of the district.

Maize from Xiengkhuang provinces is exported through the Nam Kun international check point, which is located in Nhonghet district and is the only international crossing point of Xiengkhuang province into Viet Nam. Oudomxay province has no international border crossing point and therefore, maize is exported to China through the Boten International border crossing located in Luang Namtha province.

3.2.2 An Econometric Analysis of the Prices of Maize Sold, Bought and Traders' Sell-Buy Margins

As in the case for farmers, in this section we analyse whether differences among traders are statistically associated with the different prices that they obtain for their maize, with the prices they pay for maize, and with sell-buy margins.

As shown in Figure 23, there is significant cyclicality in maize trading activity during the calendar year. Figure 23 shows that the month with peak reported maize sales activity is February, and the month with the lowest level of sales activity is July. This pattern echoes that reported for farmers (Figure 18) but is noticeably less concentrated in the peak month of February.

71 The survey team received indications from informal discussions with traders in Oudomxay province that Thailand and Viet Nam are irregular markets for Oudomxay maize, while China is a regular market.

72 Traders indicated to the survey team that the Nge An province in Viet Nam has in the past been an important market.

Analysis of the Prices of Maize Sold

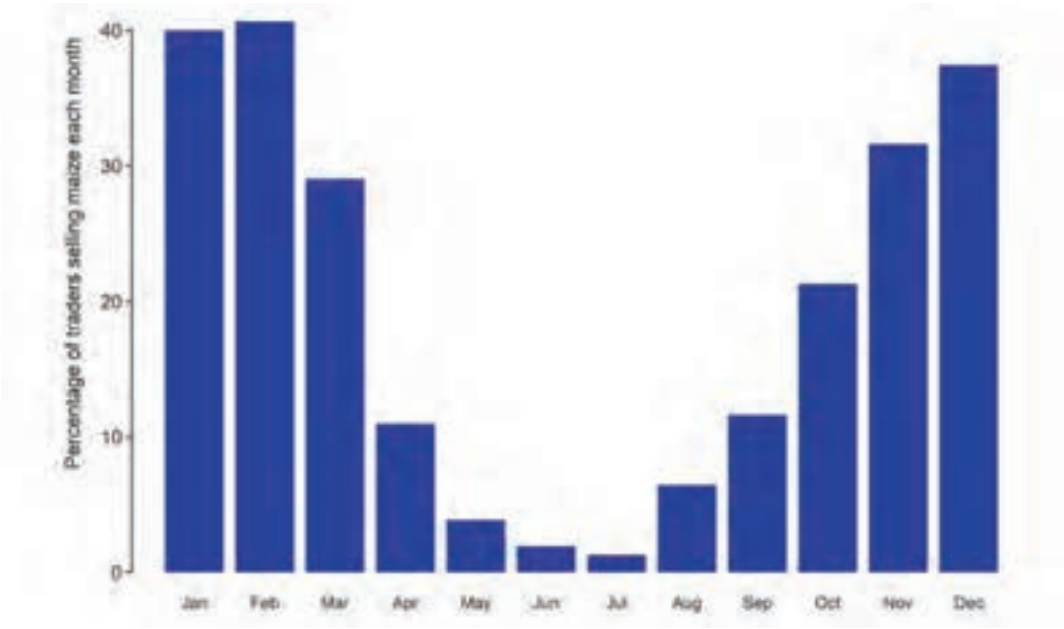
As we mentioned when analysing maize producers (in Section 3.1), maize is sold in Lao People's Democratic Republic in cob or in grain form. In Section 3.2.1 we also showed that an important role of (especially small) traders is that of aggregating maize and shelling it. This explains why the number of surveyed traders that reported selling maize only in cob form is small (13 per cent of traders) and the mean and median size of traders selling maize only in cob is also small, at 1,053 and 475 tons per year, respectively. Another 15 per cent of traders reported selling maize both in grain and cob forms, while 67 per cent of traders reported selling maize only in grain form.[74] Maize in cob form can be seen as an input, to be converted into dry maize in grain form, which is then exported or consumed by domestic users of maize.

Surveyed traders reported receiving average prices for their best-quality maize of LAK 1,918 per kg for maize in grain (median LAK 1,950 per kg), with a standard deviation of LAK 226 per kg. When looking at Oudomxay province, maize in grain[75] sold for an average price of LAK 2,026 per kg (median LAK 2,000 per kg), with a standard deviation of LAK 169 per kg. In the other two provinces surveyed, prices were lower. In Xiengkhuang province, the mean price of maize in grain was LAK 1,876 per kg (median LAK 1,800 per kg) and a standard deviation of LAK 219 per kg, while in Xayaboury province the mean price of maize in grain was LAK,1 781 per kg (median LAK 1,800 per kg) and a standard deviation of LAK 242 per kg.

Multiple factors may influence the different prices obtained by traders when selling maize.

The geographic area of operation of a trader can be an important determinant of sales prices for different reasons. In particular, it can affect the costs of operation of traders, for example by influencing transport requirements (which are dependent on the characteristics of the terrain , the distances covered, the quality of roads, among other factors), the prices of inputs (like labour), fees, local taxes and other costs that are geographically linked. World Bank (2018), for example, shows that the costs of transport in northern routes in Lao People's Democratic Republic are usually higher than those of southern routes, as well as heterogeneous. Also, during the conduct of the survey, differences were found in regulations across maize-producing and exporting provinces in Lao People's Democratic Republic regarding fees, export procedures and regulations affecting inputs like seeds, which can also potentially affect prices.

Figure 23: **Yearly sale cycle of maize of surveyed traders**



Source: Author, based on UNCTAD survey data.

74 Five per cent of traders in our sample did not report prices of maize sold neither in cob nor in grain form.

75 Maize in cob sold for an average LAK 1,410 per kg (median LAK 1,430 per kg) in Xayaboury province (where 72 per cent of all observations of traders selling at least partially in cob were observed), with a standard deviations of LAK 307 per kg. There were only 11 and 1 observations of maize sold in cob by traders in Oudomxay and Xiengkhuang, respectively, and the mean price for Oudomxay was LAK 1,389 per kg (median LAK 1,300 per kg), with a standard deviation of LAK 428 per kg.

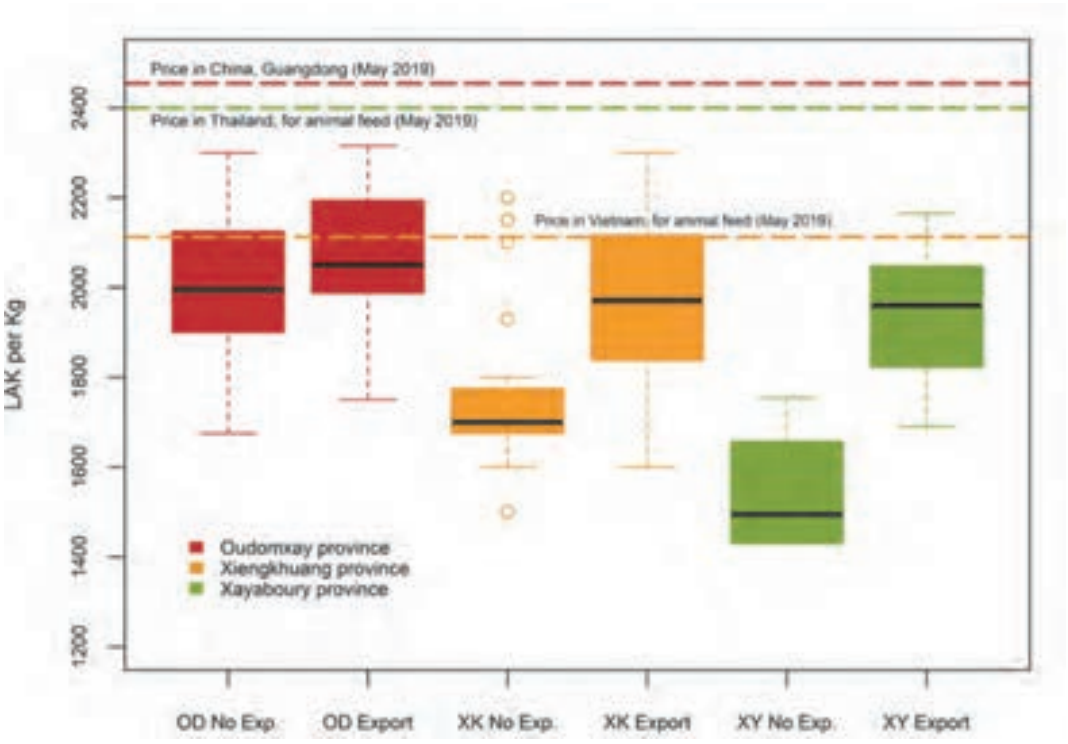
We show in Section 3.2.1 that the trader market for maize is two-tiered, with small traders often aggregating maize and selling to other traders instead of selling maize to final domestic or foreign consumers. Hence, we can expect ***a priori*** the sale prices of maize of intermediary (small) traders to be lower than prices obtained by traders selling to final consumers, as each trader adds their own margin to the final consumer price. This would suggest that using disaggregated data on the type of customer of each trader transaction could identify the effects of the two-tiered nature of the maize market on prices. Unfortunately, such disaggregated data is not available.

Our survey data suggests that there is also a positive link between the quality of maize and its price: 66 per cent of the traders surveyed reported that there is a quality premium for maize, which was LAK 356 per kg on average during the survey period (median LAK 300 per kg), with some variation across provinces.[76] As dry maize uncontaminated by fungi, weevils, etc, sells for a higher price, traders who have access to equipment to dry, sort, clean and bag maize can increase their sales price by processing maize.

Also, having adequate and sufficient storage capacity as a share of their expected yearly trading volume can allow traders to pick when to buy and sell maize, according to market demand and supply.

It is also possible that different prices exist in alternative destination markets of maize consumption. Such differences are supported by trading barriers that exist between markets, including barriers to market entry, transport, regulations, and others. We might consequently expect that exporters of maize obtain different prices than traders who sell only domestically, and that such differences might also vary with the country of export. Figure 24 presents the summary distribution of sales prices of maize in grain according to whether traders declare exporting or not, by province. The data shows that traders reporting exporting received a higher median price in each province that those who did not report exporting. The Figure also presents data indicating that prices in the main export markets of Xayaboury (i.e. Thailand) and Oudomxay (i.e. China) provinces where higher than those in the main export market of Xiengkhuang province (i.e. Viet Nam) at the time of the survey.

Figure 24: **Summary distribution of maize prices sold in grain (in LAK per kg), by province and exporter status of traders**



Source: Author, based on UNCTAD survey data.

[76] For Xayaboury province the mean reported quality premium was LAK 297 per kg (median, LAK 247 per kg), for Xiengkhuang LAK 397 per kg (median LAK 320 per kg) and for Oudomxay LAK 346 per kg (median LAK 200 per kg).

Ideally, we would measure econometrically the effects of all of the factors discussed above, testing for potential relationships between them. However, such an exercise is not possible using the data available.

Following extensive experimentation, the econometric specification that we report here includes a key set of explanatory variables for which robust relationships with price could be obtained. This specification focusses on three key explanatory variables: trader province location (Oudomxay (OD), Xayaboury (XY), and Xiengkhuang (XK) provinces), trader size (measured as the number of tons of maize sold yearly, in log units), and an indicator variable to account for export activity.

In particular, trader size can account for the two-tiered nature of the trader market, for quality differences and for the length of storage. Specifically: (i) in the absence of reliable and disaggregated data about to whom a trader sells maize at each price, trader size can proxy for the fact that small traders are more likely than larger traders to aggregate maize and sell it to other traders; (ii) quality increases as maize moves downstream from farmers to consumers, passing from smaller to larger traders who maintain or improve quality by drying, cleaning and sorting maize. We also showed that ownership of machinery to dry, clean and sort maize, increasing maize quality, is positively correlated with trader size; and (iii) our data shows that trader size is also positively correlated with storage time.[77]

Results of estimating this model using Ordinary Least Squares on our sample population of 111 observations[78] are reported in Table 3. The baseline case for the province dummies used was Oudomxay province (OD). Figure 25 presents the observations of sales prices of maize sold in grain and trader size by province in different colours, marking with a full point the observations corresponding to an exporter and with an empty point those corresponding to a non-exporter, as well as the fit lines for each province for observations selling maize in grain.

The residuals from the model are well behaved in terms of normality, outliers, influence, analysis of variance and homoskedasticity, but they present autocorrelation. Therefore, we used the correction proposed by Arellano (1987) to calculate the corresponding variance-covariance matrices and p-values presented in Table 3.

Table 3 and Figure 25 confirm the importance of the geographic location of traders for understanding differences in the prices of maize sold by them, even controlling for trader size and for whether traders export or not: traders in Oudomxay province sell maize on average for higher prices than those in Xiengkhuang and Xayaboury provinces. As discussed above, these geographic effects reflect a range of underlying factors, including disparities in local domestic markets, transport costs, and regional regulatory variation.

Furthermore, our results confirm the existence of a positive and significant relationship between the size of traders and the sales prices they obtained for maize during the sample period. Interactions between province and trader size also indicate that this relationship varies across provinces. In particular, as trader size increases, traders based in Oudomxay province have a smaller increase in sales prices than those of Xayaboury and Xiengkhuang provinces. As we mentioned above, trader size should be interpreted here as a proxy for a range of factors, including length of storage, maize quality, and the "aggregation" role of small traders in the maize value chain, in addition to any direct effects that trader size might have on the sales price of maize.

[77] This correlation is especially high in Xayaboury province, where it is 76 per cent, while for the whole trader sample it is 46 per cent

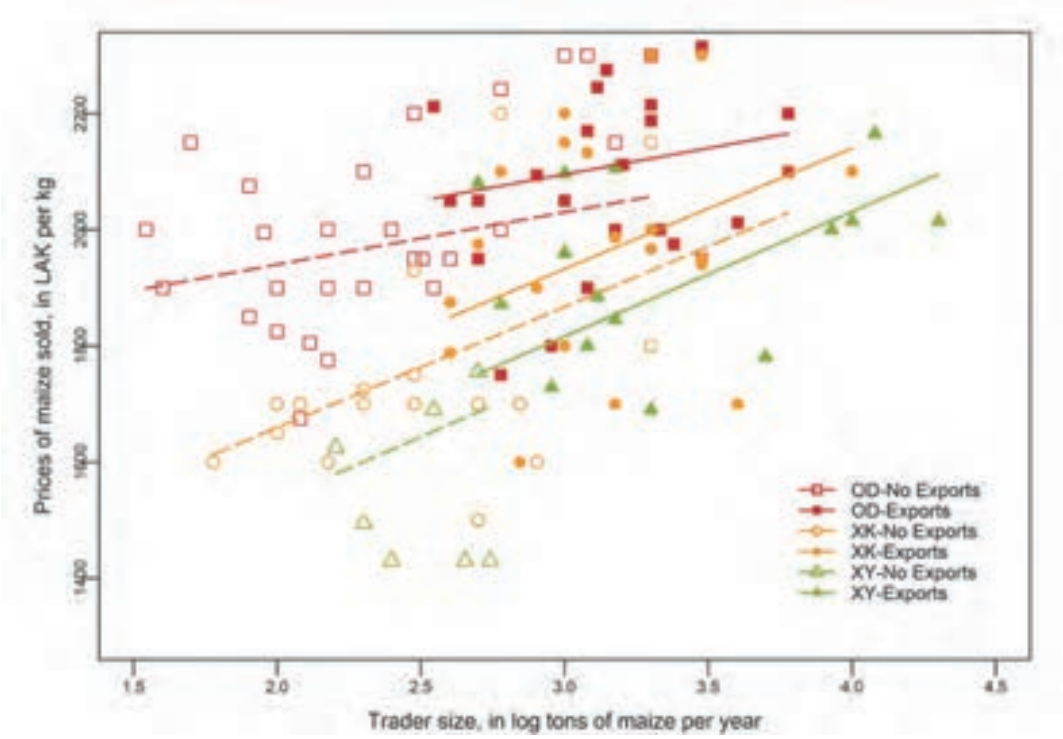
[78] Five observations were identified post-fit as anomalous due to model-conditional high leverage and influential data and were not included in the estimation of the model in Table 3. As a robustness measure, a regression using an MM estimator was used on the data including the anomalous observations, obtaining qualitatively similar results, with the two differences being that the exports dummy is statistically significantly different from zero at 5 per cent significance and the coefficient for trader size of Oudomxay is smaller and marginally not significant.

Table 3: **Econometric analysis of maize prices (sold in grain) received by traders**

	Model 1
Province OD (baseline)	1760***
	(114)
Province XK	-516***
	(147)
Province XY	-654***
	(195)
Trader Size (in log tons per year) * OD	39*
	(21)
Trader Size (in log tons per year) * XK	51**
	(24)
Trader Size (in log tons per Year) * XY	54**
	(27)
Exports	65
	(48)
R^2	0.46
Adj. R^2	0.43
Num. obs.	111
RMSE	163.8

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

Figure 25: **Prices of maize sold in grain (in LAK per kg) and trader size (in log tons per year)**



Source: Author, based on UNCTAD survey data.

Finally, although the estimated coefficient of the indicator variable for export activity is positive (as expected) in Table 3, it is not statistically significant. This is in stark contrast to the substantive selling price premia enjoyed by exporters, as displayed in the simple averages reported in Figure 24. One possible reason for the lack of significance in the influence of export activity on trader selling prices is the high degree of correlation with trader size: as only larger traders typically engage in export activity, part of the price premium associated with export is identified as an effect of trader size. Furthermore, Figure 25 shows that traders in Oudomxay that do not export report higher sales prices than small traders in the other two provinces. It is unclear why that is the case using the current available data, but one possible explanation is that higher export prices push up domestic prices in the province, due to arbitrage.

Analysis of the Prices of Maize Bought

While the price of maize sold is important for traders' profitability, the prices for which they buy maize are no less important.

Traders in Lao People's Democratic Republic buy maize both in grain and in cob form. In the whole three-province sample, maize in grain form was bought for an average of LAK 1,635 per kg (median LAK 1,650 per kg), but there were differences among provinces. In Xayaboury province, the mean price paid by traders for maize in grain form was an average of LAK 1,585 per kg (median LAK 1,644 per kg), in Xiengkhuang province LAK 1,626 per kg (median LAK 1,600 per kg) and in Oudomxay province LAK 1,671 per kg (median LAK 1,700 per kg). By contrast, maize in cob form was bought for an average price in the whole sample of LAK 1,152 per kg (median LAK 1,075 per kg), also with differences across provinces, as in Xayaboury province the average price was LAK 1,212 per kg (median LAK 1,261 per kg) and in Oudomxay province the average was LAK 1,102 per kg (median LAK 1,075 per kg), with traders in our sample not reporting buying maize in cob in Xiengkhuang province.

As in the case of sales prices, both geographic factors and the size of traders can also potentially be related to buyer prices for maize paid by traders.

In the case of geographic factors, similar reasons of transport costs, regulations, and other local conditions affect buying prices as well as selling prices, as discussed above.

In the case of the relationship between trader size and prices for maize paid by traders, there are three potential reasons why there might be a positive relationship between both variables. The first two are the same as in the case of maize sales prices: the two-tiered nature of the trader market, and quality differences as maize moves from small to large traders. As large traders buy from small traders who aggregate maize for them, they would pay a higher price in order to avoid incurring the effort of finding smallholder farmers selling them maize, negotiating with them, controlling quality in the farm, picking it up, storing it, shelling it, and other functions carried out by small traders. Also, higher buying prices need to be paid for higher quality maize which is dry and free of pests and other damage.

The third potential reason, which does not invalidate the previous two, is that smaller traders may pay less than larger traders if they have buyer power locally when they buy maize directly from farmers. Two elements in our data provide support for this hypothesis, which however we cannot model directly due to data issues.

First, as we showed in section 3.1.2, close to three-quarters of farmers surveyed reported selling to only one buyer (see Figure 17), which is usually a small trader, and for farmers to sell to more than two traders is extremely rare. While this is in no way conclusive evidence about the number of traders farmers ***can*** sell to, it suggests that the effective number of sales options farmers have is likely small, due to distance, access, relationship, informational cost, availability of transport and other reasons. Such a situation strengthens the bargaining power of small traders who buy directly from farmers, or of larger traders who have agreements/contracts with small traders who buy directly from farmers and act as the agents of large traders.

Second, the importance of the role of traders as providers of productive finance either in kind (e.g. seeds) or in cash, as we reported in section 3.1.2,[79] also suggests another way in which small traders may exercise buyer power over farmers. If traders have market power in the provision of input loans to farmers, they can potentially leverage that market power in the market for inputs finance into paying lower prices for maize. One way they could do so is if the relationship with a trader due to the latter's provision of finance acts like a "sunk cost": search, reputational and other mentioned costs of finding a new trader to sell part of the maize would incur additional costs, giving the lending trader bargaining power in buying maize cheaper as he or she is the

[79] Among other things, we indicated that three-quarters of traders supplied inputs to farmers.

incumbent. Another way in which lending traders could theoretically lower buying prices for maize is if traders "tie" provision of finance to selling maize to them at harvest time at a lower price. In this way, as it is well known (see McAfee, McMillan, and Whinston, 1989, and specially, Elhauge, 2009), market power could be leveraged into the tied market (i.e. maize), allowing the provider of finance to capture more of the surplus from maize via paying lower prices. However, our study found insufficient evidence regarding whether such tying takes place in the country, and if it does, how extended it is. In general, such tying would be difficult to enforce due to the dynamically inconsistent incentives of farmers.[80]

Therefore, the "aggregation" role that small traders play could then be a source of bargaining power in their favour and might result in lower prices being paid by small traders for maize bought.

Finally, it is also possible that exporting traders pay higher prices for maize bought. Exporting traders, in order to secure sufficient maize to sell to clients abroad for high prices (e.g. in China), could be willing to pay higher prices in order to be sure to meet demand, so the price of maize for both small traders and, to a lesser degree, farmers, would also bid up in the province.

Table 4 present the results of estimating using Ordinary Least Squares the relationship between the prices of maize bought by traders and trader size, controlling for province, the form of maize bought (i.e. in grain or in cob) in each province,[81] and a dummy variable measuring whether the trader reports exporting. The same 111 observations employed for estimating the model for sales prices in Table 3 above were used. The baseline case for the province categorical variables used was again Oudomxay province.

To address the fact that some traders buy maize in grain, some buy maize in cob form, and others buy in both forms, we constructed a "buying price" variable that used prices of maize in grain when available in the data, and prices of maize in cob when the former were not available. This "buying price" variable was the dependent variable used in both models in Table 4.

In Table 4, Model 1 tests the relationship between prices paid for maize by traders and trader size, the latter measured as the logarithm of the yearly quantity of maize sold by each trader. The model controls for provincial location, for whether the form of maize bought was cob or grain, and for whether the trader exports. While Model 1 includes different slopes of the correlation between trader size and prices of maize bought, Model 2 includes a common effect of trader size for all provinces, while also excluding the variable for exports, which is not significant in Model 1 with a large p-value.

Figure 26 presents the observations of prices of maize bought and trader size with each province in different colours, marking with a full point the observations where traders buy only maize in cob and with an empty point those corresponding to maize bought in grain form, as well as the fit lines corresponding to each province for observations buying maize in cob (full line) or in grain (dotted line) form.

The residuals from both models are well behaved in terms of influence, analysis of variance and homoskedasticity, and autocorrelation. In terms of normality, we could not reject the null hypothesis of normality for the standard Shapiro-Wilks test.

Table 4 confirms that, controlling for the form of maize bought and geographic location, trader size is positively and significantly correlated with the prices of maize bought by traders.

Model 1 in Table 4 suggests that the relationship between trader size and the price of maize bought is not significantly different across provinces, while the exporter categorical variable is also not significant. Model 2 indicates that once a common trader size covariate for the whole sample is included and the insignificant exporter dummy variable is excluded, each province categorical variable has coefficients that are significantly different from zero, although the differences between provinces are small (e.g. LAK 119 per kg between Xayaboury and Oudomxay).

Table 4 also confirm that buying maize in cob is significantly and negatively related to prices for maize bought, as expected, as buying in cob lowers the prices paid by traders substantially. Also note in Figure 26 that most traders reporting buying only in cob are generally small, especially in Oudomxay province,[82] showing the role of small traders in shelling maize.

[80] Specifically, as payment takes place after harvest time, farmers have an incentive to side-sell as much as possible at a higher price, in a context where the size of the harvest is non-verifiable by the lender. One would expect that, if tying does take place, it is limited to the amount of the loan and interest advanced.

[81] We used a different dummy variable per province buying in cob form, to account for the probability that the factors that influence the cob - grain price differential is not only technical (i.e. the cost of using a shelling machine), but also related to geographic factors.

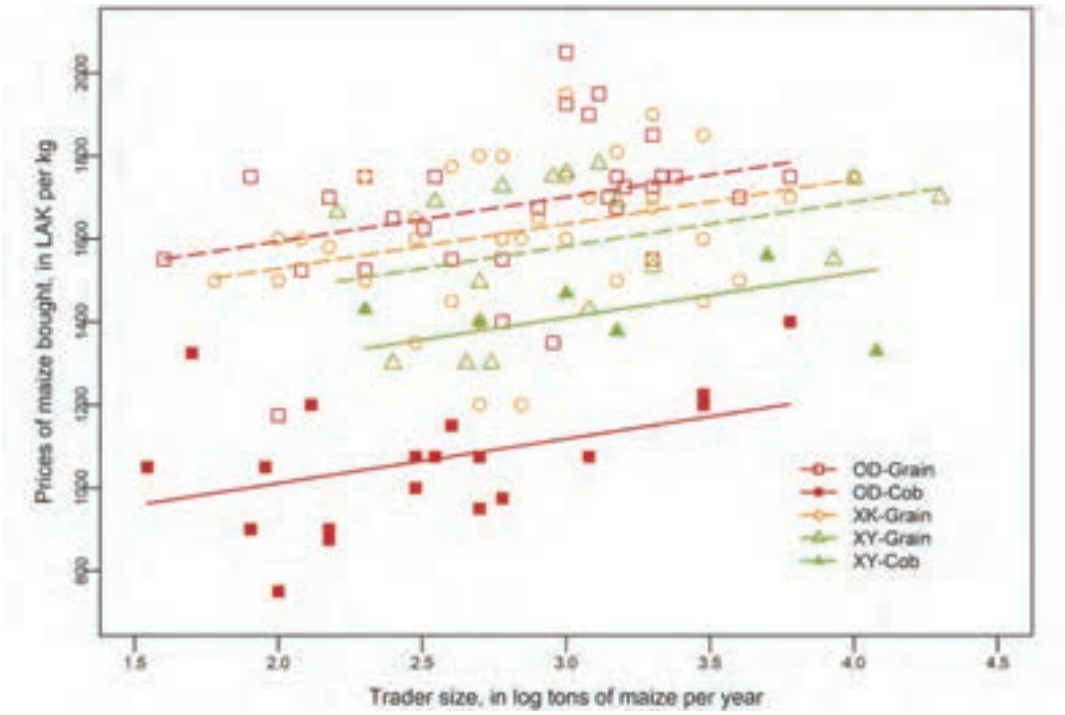
[82] Note that our data assigns an observation to "buying in cob" only when the trader did not report grain prices bought. We use grain prices when both cob and grain prices were reported by a trader. This means that the effect of cob prices in our model, due to lack of data to weight how much of maize is bought in cob, is biased downwards.

Table 4: **Econometric analysis of maize prices paid by traders**

	Model 1	Model 2
Province OD (baseline)	1361***	1380***
	(131)	(84)
Province XK	25	-65*
	(190)	(39)
Province XY	64	-119**
	(223)	(50)
Trader Size (in log tons per year) * OD	46**	
	(21)	
Trader Size (in log tons per year) * XK	-14	
	(28)	
Trader Size (in log tons per year) * XY	-27	
	(32)	
Trader Size (in log tons per year)		47***
		(12)
Buys Cob in XY	-174**	-172**
	(78)	(77)
Buys Cob in OD	-577***	-583***
	(49)	(48)
Exports	42	
	(41)	
R^2	0.68	0.68
Adj. R^2	0.66	0.66
Num. obs.	111	111
RMSE	161.54	160.68

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

Figure 26: **Prices of maize bought (in LAK per kg) and trader size (in log tons sold per year)**



Source: Author, based on UNCTAD survey data.

As the categorical variable for separating exporters from non-exporters is not significantly different from zero, the hypothesis that exporters may be willing to bid up prices of maize paid in order to secure demand loses force. Instead, as we showed that storage time and trader size are positively correlated, it is possible that the large traders that (largely) export may be instead buying maize when it is abundant and cheap, and storing it in order to meet their needs.

These qualitative results of our OLS model are confirmed implementing a robust regression procedure using the MM estimator with all available observations.

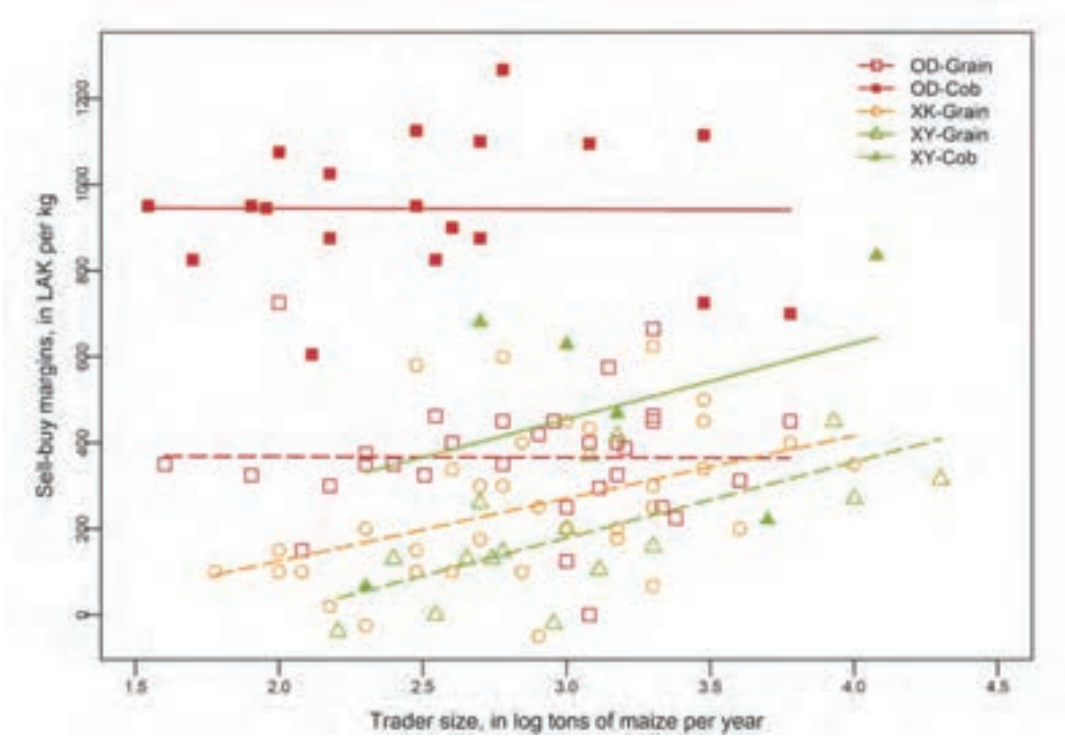
Analysis of Traders' Sell-Buy Margins

We conclude our quantitative analysis of maize trader prices by combining the analysis of sales and buying prices of traders in an econometric exercise, in order to assess whether there is a relationship between traders' maize margins (i.e. the difference between prices of maize bought and sold) and geographic factors, trader size and whether traders are exporters. The results of this exercise, which used the same 111 observations, excluding outliers, of the sale and buy prices models, are presented in Table 5. As in the case of the models for sell and buy prices, the baseline case for the province dummies used was Oudomxay province. Figure 27 shows maize sale-buy margins and trader size, with colours indicating the different provinces, full points indicating maize bought in cob form, and the fit lines corresponding to each province and maize form.

Table 5 shows that there is a positive and statistically significant relationship between trader size and maize margins in Xayaboury and Xiengkhuang provinces, but not in Oudomxay province, where the coefficient is not significantly different from zero. As indicated by Figure 27, this result for Oudomxay province is due to the high sale prices obtained by small traders in Oudomxay, even if they declare not to export, possibly due to arbitrage reasons.

The size of the relationship between trader size and price margins are very similar in Xayaboury and Xiengkhuang provinces. Note that the relationship between an increase in traders' size for Xayaboury and Xiengkhuang provinces is stronger for margins (Table 5) than for sale prices (Table 3), showing the reinforcing effect on margins of the fact that maize prices paid by traders increase slower than prices obtained from selling maize, as trader size increases.

Figure 27: **Maize sell-buy margins (in LAK per kg) and trader size (in log tons sold per year)**



Source: Author, based on UNCTAD survey data.

As shown by Table 5, the size of the province categorical variables indicates that margins are significantly smaller in Xiengkhuang and in Xayaboury provinces with respect to those registered in Oudomxay. We showed in Figure 25 that sale prices are on average higher for all traders in Oudomxay, while Figure 26 showed that the differences in buying prices were smaller.

Traders who bought maize only in cob form, as expected, had significantly higher margins than those buying maize in grain form (which is more expensive), especially in Oudomxay province, but also in Xayaboury province.

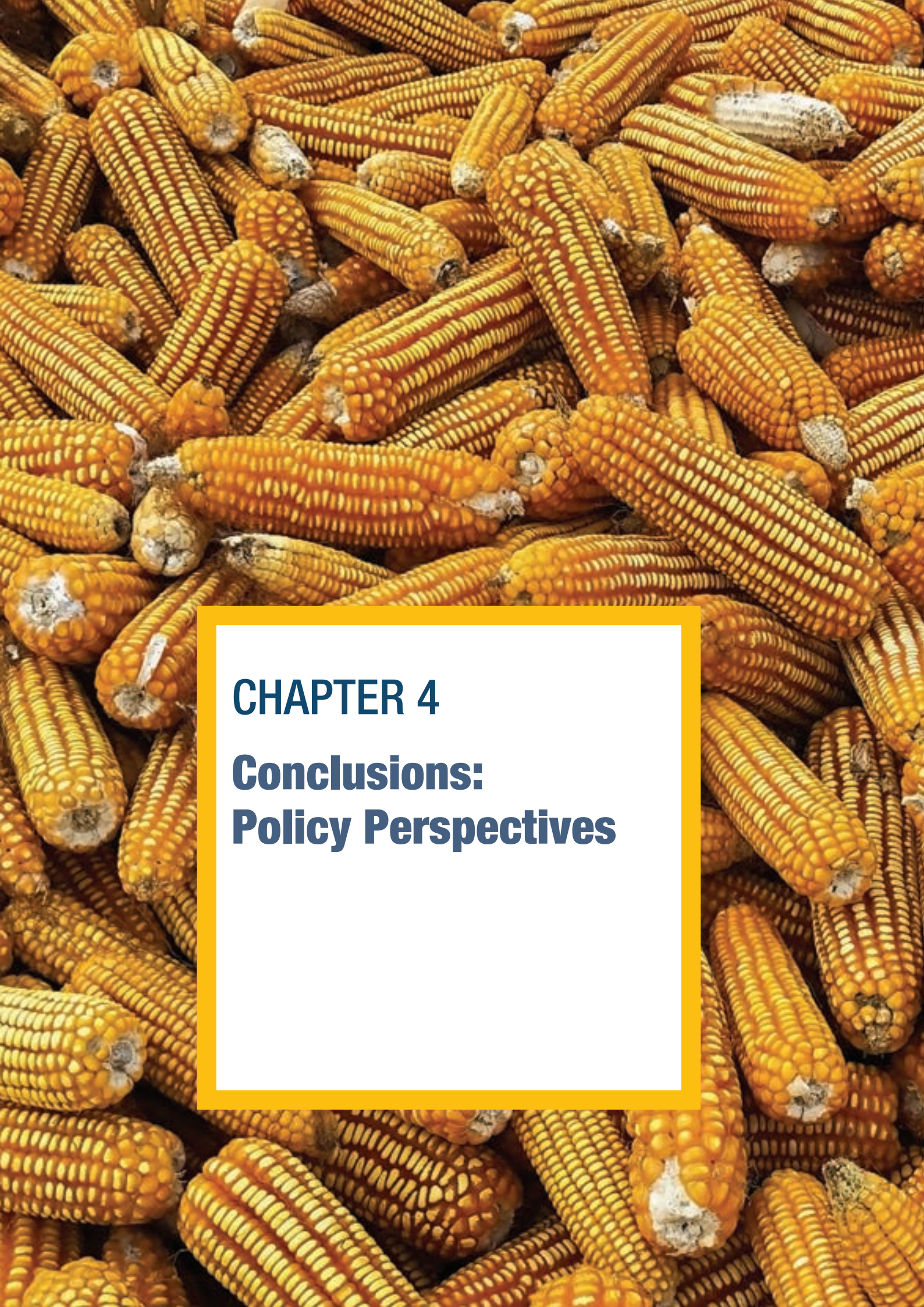
The coefficient of the exporter categorical variable is not significantly different from zero, so price margins are not significantly correlated with the export status of traders.

In summary, this section has shown that there are significant differences in prices and margins across provinces, while trader size is positively and significantly related to the prices of maize sold, to the prices of maize bought and to the sell-buy margin, controlling for the form in which maize is bought (i.e. in cob or grain). This shows that trader size is a key variable in terms of income performance in Lao People's Democratic Republic, possibly due to the two-tier nature of the trader market, the process though which maize quality is improved or maintained along the value chain, the relationship between trader size and storage use, and the possibility that local market power allows small traders to buy maize cheaper.

Table 5: **Econometric analysis of traders' maize sale (in grain) buy margins**

	Model 1
Province OD (baseline)	395***
	(127)
Province XK	-542***
	(184)
Province XY	-726***
	(216)
Trader Size (in log tons per year) * OD	-6
	(20)
Trader Size (in log tons per year) * XK	65**
	(27)
Trader Size (in log tons per year) * XY	78**
	(31)
Exports	19
	(40)
Buys Cob in XY	273***
	(76)
Buys Cob in OD	576***
	(48)
R^2	0.75
Adj. R^2	0.74
Num. obs.	111
RMSE	156.9

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



CHAPTER 4

Conclusions: Policy Perspectives

In this study, we have explored the maize value chain for export in Lao People's Democratic Republic, using primary data derived from a bespoke survey of stakeholders in the three largest maize-producing provinces in the country: Oudomxay, Xayaboury and Xiengkhuang. As we have detailed in Sections 2 and 3, the maize value chain in these key maize-producing provinces are integrated into the maize value chains of neighbouring China, Thailand and Viet Nam. This shows the importance of studying and addressing existing issues in the Lao maize value chain not only for rural development in the country, as indicated by previous studies, but also due to the importance of maize as an export good for both the country and its regional partners.

The Government of Lao People's Democratic Republic is committed to diversifying its trade and productive sectors, to backstop the target of annual GDP growth of at least 7.5 per cent set in the 8th National Socio-Economic Development Plan for 2016-2020, and to meet the Sustainable Development Goals. As part of these diversification and upgrading efforts, which can also have several other positive effects in the areas of poverty reduction, gender equality and others, the development of the agri-food sector appears prominently in strategic development plans of the country.

In light of the analysis of the value chain of maize conducted in this study, different issues emerge that are relevant for policy action. This section enumerates selected challenges that our study identifies for the maize value chain in the country and proposes policy actions that might help to meet those challenges. Such policy actions would be complementary to current efforts by the Association of Southeast Asian Nations to foster regional trade and better link regional value chains. This is in addition to the boost that regional infrastructure has received as a result of the Belt and Road Initiative.

4.1 Improve Coverage of the Maize Value Chain with Disaggregated, Reliable and Frequently Updated Statistics, Regulatory, Monitoring and Other Data

A significant challenge encountered while conducting this study was the lack of disaggregated, reliable and updated statistics that could be used to analyse the maize sector, with the notable exception of production volumes and harvested area. Improved data availability is consequently necessary for effective sectorial policy design and implementation, as well as for timely evaluation of the effects of policy reforms.

Data challenges appear at different levels.

First, information about the maize sector, including regulatory issues, is widely dispersed along both functional and geographic dimensions. In particular, there is no official public sector office responsible for compiling and curating the available data for the Lao maize sector, including past studies conducted on the sector. This makes data gathering more difficult and hinders data comparability, negatively affecting the capacity of the authorities to design, implement and monitor sectorial policies at the national and sub-national level. Furthermore, lack of adequate and timely access to information at the national level can hamper addressing the different challenges identified by sub-national authorities working closely with local stakeholders, including farmers or traders. Two concrete examples illustrate the issues at hand.

During the implementation of our survey in Oudomxay, Xiengkhuang and Xayaboury provinces, the survey team found indications of the existence of heterogenous regulatory requirements across different provinces, which are relevant for the maize value chain. These include export fees charged in Xiengkhuang and Xayaboury provinces, the registration requirements for exporters, different regimes for the import of seeds, among others. To our knowledge, there is no centralized repository of the existing regulatory information for the maize value chain in the country.

Additionally, up-to-date information about the existence, and implications of specific issues affecting maize traders seems to be scattered and insufficient, potentially negatively affecting coordinated policy responses. For example, our survey team interviewed different stakeholders that reported that exports of maize to Yunnan province in China during the period of the survey (market year 2018-2019) had only been authorized between September and December. In our survey, 43 per cent of the traders interviewed in Oudomxay province reported explicitly exporting to China. Out of these traders in Oudomxay exporting to China, 36 per cent reported that quantitative restrictions were a regulatory issue they faced when trading maize. It was not possible to obtain more information, including official confirmation from the authorities in Lao People's Democratic Republic, about the existence or nature of temporary maize trading restrictions to China, beyond the information gathered by

our survey team during the field survey. Phouyyavong and Talje (2006) also reported restrictions in the sale for maize in China in their study of Namor District, Oudomxay province, conducted in 2005.

Secondly, as we showed in Section 2, trade statistics from COMTRADE and UNCTADStat, which are sourced from official statistics, present not only limited disaggregated data availability,[83] but also differ significantly when compared with the mirror statistics of other countries. This raises important questions concerning their comparability.

In order to address the above cited issues, different policy actions could be considered.

First, a permanent focal point for gathering and curating available data could be established at an existing national institution, such as the Ministry of Industry and Commerce or the Ministry of Agriculture and Forestry. This could not only enhance monitoring and policy design and implementation in the sector, but also facilitate official coordination for policy purposes at both the national and sub-national level. Additionally, it would make identification of new challenges at the local level faster and more reliable, allowing the authorities to coordinate responses to events that are time sensitive.

Second, data collection, aggregation and communication activities (notably including electronic availability of data) in charge of the authorities should be strengthened in all areas, notably including in statistical offices. This applies to both the national and sub-national levels, as information at the provincial level can be useful to the authorities to estimate the impact of provincial-level policies such as export fees and other charges. This applies to both statistical information like trade data, and to sector-specific information, such as the one gathered and presented by this report.

4.2 Enhance the Access by Farmers and Traders to Productive Finance

In Section 3 we indicated that maize-producing farmers obtain finance from traders for production, both as inputs in kind and as cash advances, with traders recovering the principal loaned and interest accrued at the time when they buy maize from farmers.

On the one hand, this role performed by traders is essential. Trader-provided finance makes the production of maize possible for those farmers who would otherwise find it difficult or impossible to buy the necessary inputs or services for production, such as seeds, herbicides, pesticides and fertilizer, and ploughing of land. Hence the existence of trader finance positively affects farmers' capacity to produce maize and can therefore have a positive effect on their incomes. In general, the provision of rural finance in developing countries, and especially in Least Developed Countries like Lao People's Democratic Republic, is very challenging, as reported by several previous studies (e.g. Conning and Udry, 2007), and lack of rural finance is one of the factors behind the gap between potential and observed agricultural production.[84]

On the other hand, our study shows in Section 3 that the role played by traders in providing inputs to farmers may be associated to: a) small traders paying less for maize than larger traders (Section 3.2.2), and b) farmers receiving lower prices for their maize when they receive inputs from traders (Section 3.1.3).

Additionally, in Section 3.1.3 we mentioned that farmers who sell maize before harvest time do so at a discount. One possible reason why farmers are willing to accept such discounts is related to binding necessities for cash for both productive and personal reasons. Therefore, improved access in affordable terms to finance could mitigate the impact of such necessities, allowing farmers to hold on to maize for longer and so obtaining better prices. As we showed in this study, storing maize is correlated with higher maize prices for farmers.

This study also highlights the need to conduct a wider comparative study about the actual costs, terms and conditions of rural access to finance for farmers in maize-producing areas in Lao People's Democratic Republic, updating previous work on this subject (e.g. Coleman and Wynne-Williams, 2006). This would allow the authorities to assess whether the risk-adjusted interest rates and loan conditions indicated by our study are adequate for the conditions in which loans take place. Section 3.1.2 of our study reported that in Oudomxay and Xayaboury provinces the mean interest rate for a 10-month lending period were in the 28 per cent - 31 per cent range.

[83] For example, in March 2020, the last available yearly data for disaggregated COMTRADE data of Lao People's Democratic Republic was 2016.

[84] According to GIZ (2012): "The severely limited access to formal financial services for the rural poor remains one of the biggest challenges within the Laotian economy", pp 1.

For reference, GIZ (2012) reported that Lao village banks provided credit at a monthly interest rate of around 3 per cent, which matches closely mean monthly interest rates reported in our survey as reported by farmers (2.7 per cent) and traders (2.6 per cent). However, in the absence of additional information, it is not possible to assess the risk -adjusted cost of trader-provided finance to farmers. For example, missing important information for further policy action relates to the existence or not of collateral for the loans, the contingencies in case of non-payment, the size of loans in relation to observable assets, and what are the factors that condition loan size and availability across the population of maize farmers, according to geography (e.g. province, district) and other farmer characteristics.

Conditional on this additional information, different policy interventions may be considered, depending on whether the issues are the availability of loans, their size, their cost, their conditions, or some combination of these considerations.

Additionally, our study finds that trader size is positively and significantly correlated with the prices of maize sold by traders and the margins that they obtained between maize bought and sold, while traders' size is in turn positively correlated with the time that maize is stored. As storage allows traders to buy maize cheaply during harvest time, when it is abundant, and sell it later for a higher price, it can be an important component of trader competitiveness. However, this requires traders to be able to finance the acquisition of large quantities of maize in a short period of time, necessitating either access to large amounts of retained earnings or external finance. In this way, improving the access of traders to finance can allow them to make better use of their storage capacity and increase their profits by arbitraging between low prices at harvest-time relative to other periods, also carrying out a stabilizing role for maize prices during the year.

The challenge for farmers and traders to obtain affordable finance has been reported by several previous studies of maize and other agricultural products, such as Coleman and Wynne-Williams (2006), Enhanced Integrated Framework (2016), SADU (2012) and GIZ (2012).[85] However, the challenge of increasing the availability of rural finance in Lao People's Democratic Republic remains. Boundeth et al. (2013) finds a positive and statistically significant relationship between maize production in Bokeo province and credit access, controlling for other factors.

In this context, it is important for donors and international organizations to continue to support existing official efforts to foster sustainable rural finance, especially in areas vulnerable to ecological degradation and climate change. In particular, enhanced support for commercial microfinance initiatives could be strengthened, while fostering expanded maize smallholder membership of successful cooperatives can be combined with fostering the latter's access to formal finance by the Agricultural Promotion Bank.[86]

4.3 Fostering Smallholder Maize Farmers' Earnings

As we show in Section 3.1, differences among farmers regarding cooperative membership and post-harvest practices like storing maize are important factors correlated with the prices obtained by them for their maize. This heterogeneity among the conditions under which farmers operate, to the degree that they are determined by factors outside of farmer control, are potential reasons for policy intervention.

Regarding post-harvest practices like drying and storing maize, in addition to the positive relationship we find between farmers received maize prices and both availability of storage facilities and storage length (which involves drying maize), it is well-known that improving farmers' access to adequate storage has additional benefits for farmers, notably by reducing post-harvest losses. While it is unclear what percentage of maize gets spoiled post-harvest in Lao People's Democratic Republic, post-harvest losses have been estimated by Gómez et al. (2011) at between 15 per cent and 50 per cent for developing countries in general. Gómez et al. point out that farmers with high post-harvest losses also usually have associated food quality problems (e.g. microbial hazards, such as aflatoxin that often affect improperly dried maize) that reduce the prices that farmers

[85] For example, SADU (2012) mentions that "Lack of access to affordable, timely and appropriate finance was identified as a key constraint that must be addressed. If Lao farmers and traders are not supported to access investment finance, they will not be able to benefit from improved market opportunities and access", p. 9. Enhanced Integrated Framework (2016) also flagged the restriction presented by insufficient finance for traders/ processors of maize in Oudomxay province, which led them to low capacity utilization (42 per cent) due to lack of maize to process. Phouyyavong and Talje (2006) indicate the challenge posed by lack of finance for maize farmers in Namor District in Oudomxay to hire labour for maize cropping.

[86] This not-for-profit Lao development bank, created in 1993, has one head office, 17 branches and 98 service units across the country, and was created to provide finance to the agricultural and forestry sectors. see www.apb.com.la .

obtain for their products. As indicated by Phouyyavong and Talje (2006), among maize farmers in Namor District in Oudomxay province it was common to suffer fungus and insect losses during storage.

Adequate post-harvest practices in the maize value chain benefit from the existence of different enabling factors, which include access to farming best practices, local availability of suitable inputs, affordability of storage, access to finance and others, all of which can be strenghthened through adequate policy intervention.

Different initiatives around the world have been undertaken to foster smallholder farmers' access to adequate, sustainable and affordable storage options, as a result of extensive studies on these topics. For example, Shukla et al (2019) use experimental data from India to assess the viability of hermetic plastic bags for storage, and found that while an average farmer recovered the full cost of a hermetic bag in one agricultural season, farmers were often not prepared to pay for such prices upfront due to uncertainty about the effectiveness of the technology, which dissipated as farmers had experience with the storage technology. Kumar and Kalita (2019) review the literature on the grain postharvest losses in developing countries and discuss possible interventions to reduce such losses, notably reviewing different policy measures capable of fostering adoption by smallholder farmers of hermetic storage. Key elements identified in different studies on post-harvest practices are the need to promote the adoption of technologies that are affordable, that meet robust cost-benefit analysis by farmers, are well adapted to local conditions, are accompanied by technical training from agricultural extension services, and for whose acquisition credit is available.

Our findings about the positive and significant relationship that exists between cooperative membership and farmer sales prices of maize also reinforces the conclusions of previous work about the important role that producer cooperatives can play in supporting farmers. Starting with the conceptual characterization of the roles of modern producer cooperatives presented by Bonin et. al (1993), cooperatives can play different roles in terms of: (i) improving sales conditions, via increased bargaining power and the capacity, in some cases, for carrying out the "aggregation" role otherwise played by small traders, thereby reducing the number of intermediaries; (ii) input acquisition in bulk, thereby potentially negotiating better input prices for members; (iii) obtaining productive credit for members; and others.

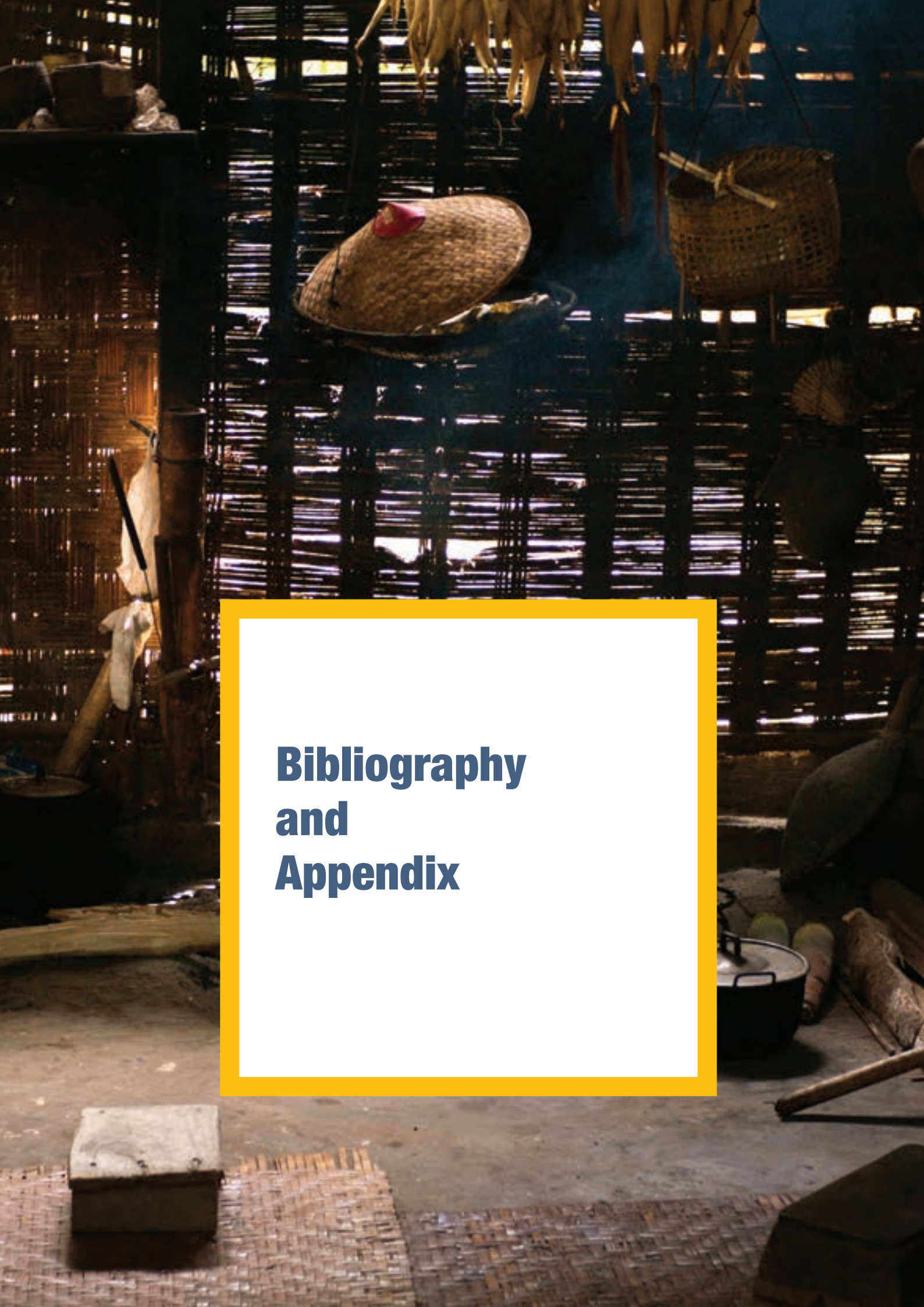
For example, the Smallholder Agricultural-Market Development in the Uplands project (2003-2012), supported collective action in Lao People's Democratic Republic in order to ***"…increase farmers' bargaining power […] reduce transaction cost, secure access to new technologies, [and] add value."*** [87] Boundeth et al. (2013) find that membership of a producer group is positively and significantly correlated with maize production in Bokeo province in Lao People's Democratic Republic. The study by Bernard et al. (2010) of cooperatives selling staple crops in Ethiopia found that cooperatives that pursue a wide range of activities may be affected in their membership structure (i.e. the characteristics of their members, which has implications for the functioning of the cooperative) and on the capacity of the cooperative to provide marketing services to its members.

Hence, previous research on the positive roles of production groups ("cooperatives") and how to foster their marketing services, highlight that different characteristics of cooperatives are important for their success in meeting their objectives. These characteristics include the nature of their objectives, the incentives of their members,[88] regulatory environment and management of these organizations.

Therefore, all this suggests the need for the authorities in charge of fostering the benefits from rural producer groups in Lao People's Democratic Republic, to foster information exchange and to design joint strategies with other officials in charge of fostering the maize value chain.

87 See SADU (2012), pp 7.

88 In particular, to what degree the incentive structure introduced by internal rule design and enforcement addresses existing asymmetric information issues, unobservable actions, non-verifiability and other challenges.



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Appendix: Details of the Field Survey data Used

The field survey that is the source of the analysis in Section 3 was conducted by a team of national consultants, who visited the three most important maize-producing provinces in Lao People's Democratic Republic: Xayaboury, Oudomxay and Xiengkhuang in May–June 2019. The location of these provinces is shown in Figure A1.

Figure A1: **Map of Lao People's Democratic Republic**

Source: Author, based on Wikimedia Commons.

The survey interviewed 181 farmers in fifteen villages of six districts of these three maize-producing provinces, who reported cultivating 771 hectares in total. Specifically, the geographical distribution of the farmer sample in each province, district and village is presented in Table A1.

The survey method involved using questionnaires designed to answer the research questions, applied to a stratified sample, in order to include a representative number of subjects from each identified stakeholder group. The survey team worked with the provincial and district Agriculture and Forestry offices in each province in order to select the district and villages to be surveyed, according to relevance and representativity criteria.

Similarly, the survey interviewed 167 traders of different types in seven districts of the three provinces, as specified by Table A2. The survey team worked with the Industry and Commerce offices in each province to identify the farmers and traders to interview. The individual traders interviewed were identified endogenously from the interviews with the producers, as well as matched with a list of names of traders that was obtained from the industry and commerce office at the district level.

Additionally, officials from the provincial and district Agriculture and Forestry offices and the Industry and Commerce offices were interviewed in each province; as well as the village heads of 12 villages, and officials in three border points (two in Xayaboury province and one in Xiengkhuang).

Table A1: **Number of farmer observations in UNCTAD's survey, by village, district and province**

Village	District	Province	Observations
Numtouy	Beng	Oudomxay	11
Phukha	Beng	Oudomxay	4
Samkang	Beng	Oudomxay	5
Bouamlao	Houne	Oudomxay	8
Numyon	Houne	Oudomxay	20
Oudom	Houne	Oudomxay	12
Houaylord	Kenethao	Xayaboury	8
Houaypet	Kenethao	Xayaboury	6
Nongkhuay	Kenethao	Xayaboury	2
Bouamlao-Thakeo	Parklai	Xayaboury	19
Palai	Parklai	Xayaboury	26
Leang	Kham	Xiengkhuang	20
Naoung	Kham	Xiengkhuang	16
Korhard	Nong Het	Xiengkhuang	10
Kormon	Nong Het	Xiengkhuang	14

Source: Author based on UNCTAD survey data

Table A2: **Number of trader observations in UNCTAD's survey, by village, district and province**

District	Province	Observations
Beng	Oudomxay	26
Houne	Oudomxay	31
Xay	Oudomxay	1
Kenethao	Xayaboury	17
Parklai	Xayaboury	35
Kham	Xiengkhuang	30
Nong Het	Xiengkhuang	27

Source: Author, based on UNCTAD survey data.

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