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Price volatility across scales and farmer maneuvering in Lao cassava markets

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ABSTRACT

Lao PDR is undergoing a rapid agrarian transformation, underpinned by a growing commercial production of commodity crops such as cassava by smallholder farmers. The global nature of commodity crop markets increases the exposure of potentially vulnerable smallholder farmers to global price dynamics. We apply a cross-scalar and mixed-methods approach to investigate the role of institutional structures and the global-regional-domestic context in local price formation mechanisms at the farm gate. We focus our analysis on policy shocks created by the Chinese government's temporary purchase and storage policy (TSPS) for maize, and the experience and price risk mitigation strategies of smallholder cassava farmers in Lao PDR during this period. We find that the price level and volatility experienced by farmers are shaped by local-level market structures as much as global price dynamics and regional trade integration, demonstrating the importance of institutions across scales in price formation and transmission.

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Price volatility; price transmission; price risk mitigation; cassava; Lao PDR

1. Introduction

Lao PDR has been undergoing a rapid agrarian transformation from subsistence to commercial, market-oriented agricultural production (Rigg, 2012). Commercializing agriculture is a central tenet of the socioeconomic development plan for rural development and poverty reduction by the Government of Lao PDR (GoL) (GoL, 2015). This has been pursued via trade liberalization policies, including the New Economic Mechanism introduced in 1986, in combination with efforts towards regional and global economic integration, including membership in the Association of Southeast Asian Nations (ASEAN), the ASEAN Free Trade Area (AFTA), and the World Trade Organization (WTO) (Fane, 2006; Rigg, 1997). Agricultural policies encourage the adoption of globally-traded agricultural commodities, such as cassava and maize, which integrate smallholder farmers into regional and global value chains (GoL, 2015). Improved rural infrastructure and enhanced physical connectivity between Lao PDR and the surrounding economies of Thailand, Vietnam, and China have also facilitated smallholder farmers' integration into these markets. While this integration enhances market access and potentially contributes to increased household incomes, it also exposes farmers to global commodity price cycles and price volatility (Cashin et al., 2002; Nicod et al., 2020). This is particularly concerning in Lao PDR's developing and agrarian context, where rural households have

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limited experience and understanding of global market dynamics influencing price and resources to cope with such price risks (Epprecht et al., 2008).

Cassava provides a unique commodity case study to examine the price dynamics of agricultural commodities and their implications for smallholder farmers. Cultivation of cassava as a commodity crop has grown significantly in Lao PDR as well as throughout Southeast Asia in recent decades, driven both by regional demand and amenable cultivation characteristics. High demand is underpinned by cassava's numerous industrial uses once processed into native or modified starch, or dried cassava chips used in livestock feed and more recently ethanol production. Although the initial rapid expansion of the Southeast Asian cassava market can be traced to the 1960s to meet demand by the European Union, the market is now largely driven by demand from neighboring China (Kaplinsky et al., 2011). Further, cassava can be cultivated on poor land, is relatively drought-resistant, and requires low initial investment and few inputs, making it an attractive cash crop for resource-poor households (Delaquis et al., 2018).

While large bodies of literature have examined (1) price volatility in agricultural commodity markets (Jacks et al., 2010; Rapsomanikis & Sarris, 2006), (2) the role of market structure in price transmission (Beckert, 2011; Staritz et al., 2022), and (3) farmer coping mechanisms in response to price volatility (Nicod et al., 2020; Ruben & Masset, 2003a), few have examined these topics in tandem. In particular, the role of policy shocks on agricultural commodity price volatility and transmission across scales and borders remains poorly understood. Where the role of policy shocks has been considered, the analysis omits the institutional structures that transmit shocks across scales and remains narrowly focused on the transmission from domestic to global (Brander et al., 2023). This leads to truncated perspectives and a narrow understanding of possible solutions regarding the modes of agricultural production that would be most inclusive and viable for smallholder participation and benefit (Cramb et al., 2017).

Given the rapidly increased market integration in Southeast Asia as well as many parts of the world, it is essential to understand the cross-scalar and cross-border effects of policy shocks and price volatility and transmission. To address this disconnection in the literature, we investigate the case of price volatility and transmission in cassava markets in Lao PDR, with a particular focus on demand and policy changes in neighboring China. This case is illustrative of the high degree of market integration and globalization that characterizes the production and trade of numerous industrial agricultural commodities.

We adopt a cross-scalar and mixed-methods approach to examine the role of institutional structures and global-regional-domestic contexts in local price formation, price transmission, and consequences for smallholder farmers. Focusing on events over the past two decades, we evaluate research questions at three scales: first, we ask how and why price volatility of Southeast Asian regional cassava prices has changed in the context of increased market integration driven by Chinese demand, hypothesizing an interrelationship between maize and cassava markets due to their substitutability. We do this by assessing the influence of policy shocks caused by the Chinese government's temporary purchase and storage policy (TPSP) for maize and its cancellation on the Chinese maize market and subsequently on the Lao cassava market. Second, we describe how the local market structures of two cassava-producing study sites in Lao PDR shaped price transmission at the farm gate and how cassava farmers experience these price fluctuations. Finally, we explore the mechanisms adopted by farmers in these two sites to cope with these fluctuations. This allows us to link global, regional, domestic, and local processes and structures. Our findings highlight the importance of regional and local conditions and the influence of institutional factors on price formation and transmission at the local level.

The remainder of this paper is structured as follows. The second section provides a summary of the relevant literature our analysis draws on. The third section provides the case study context. The fourth section elaborates on the cross-scalar approach, methods, and data. The fifth section presents

the results of the study, followed by a discussion and policy implications in the sixth section. Concluding remarks are presented in the seventh section.

2. Literature review

Price volatility is a measure of the possible variation of a price variable, which have been further distinguished into trends, cycles, and shorter-term events. Trends include long-term factors, such as income growth and demographic change, while cycles are associated with medium-term macroeconomic factors. Short-term volatility are those in excess of trends and cycles, and are associated with sudden events such as weather-related shocks or policy changes (Eugenio, 2016; Piot-Lepetit & M'Barek, 2011). Transmission of prices and their fluctuations depends on the structure of markets. For agricultural commodities, attributes influencing the speed of transmission include the number of buyers and sellers, the homogeneity of the product, the number of close substitutes, the product's storability, transparency of price formation, ease of transfer between buyers and sellers, and restrictions on market processes (e.g. policy) (Schnepf, 2006). Agricultural products are subject to seasonal variations in price, and crops used by industrial processing sectors, such as cassava, feature price inelasticity of demand, where even small changes in supply can result in large shifts in price (Piot-Lepetit & M'Barek, 2011). In the case of cassava, these shifts can be relatively short-term and depend on the ease of substitution with other starches such as maize.

A large body of literature on market integration assesses levels of price transmission between markets, grounded in the law of one price. These studies are primarily concerned with improving market efficiency toward Pareto optimality of competitive equilibrium. From this perspective, smooth and prompt price transmission is essential to developing economies, as it provides information for producers to respond to changes in demand and contributes to price stabilization by inducing trade between surplus and deficit areas (Ravallion, 1986; Varela et al., 2013). To that end, studies within this body are typically focused on assessing degrees of market integration, identifying determinants of integration and price transmission, and removing barriers to market integration. This includes the removal of distortionary price and trade policies, to align domestic prices with world prices (Baffes & Gardner, 2003; Chen & Saghalian, 2016).

This view on the efficiency of global integration is challenged by a growing literature on global value chains (GVCs). Building on Gereffi's work, Kaplinsky (2000) posits a causal relationship between globalization and rising inequality, arguing that the (non-market) governance structures of value chains play a significant role in determining the distribution of benefits from trade and GVC integration. By understanding integration into value chains as participation through institutions, value chain analysis reveals the differential control and power institutions hold in constructing barriers to entry and generating economic rents (Beckert, 2011). GVC analysis distinguishes between buyer- and producer-driven commodity chains, in which traders are pivotal in organizing decentralized production networks and reveals a shift in power from producers to retailers in agrifood chains (Gereffi, 1994; Lee et al., 2012). Gereffi and Humphrey (2005) further distinguish between different governance types that characterize the relationship between buyers and their suppliers, ranging from a low degree of explicit coordination and power asymmetry (market type) to a high degree of explicit coordination and power asymmetry (hierarchy type). GVC studies have demonstrated that institutions across levels of the value chain play a pivotal role in commodity price formation and transmission (Bargawi & Newman, 2017; Staritz et al., 2022).

An additional body of literature examines how increased exposure to international markets impacts the risk and uncertainty faced by producers, taking into account the high degree of vulnerability typically faced by smallholder farmers in developing countries. This includes assessments of whether increased international market exposure increases the instability of agricultural household incomes (Rapsomanikis & Sarris, 2006), agricultural household vulnerability and risk mitigation strategies (Dercon, 2002; Eakin et al., 2006; Hoogeveen et al., 2004; Nicod et al., 2020), and links to processes of social differentiation (Bargawi & Newman, 2017; Ruben & Masset, 2003b).

Table 1. Summary of risk mitigation strategies.

Ex Ante Risk Management Strategies	
Income diversification	<ul style="list-style-type: none"> ● Diversification of production ● Diversification of employment ● Migration by choice
Product differentiation	<ul style="list-style-type: none"> ● Differentiation in quality of product ● Certification of differentiation
Self-insurance	<ul style="list-style-type: none"> ● Savings ● Investment
Group insurance	<ul style="list-style-type: none"> ● Mutual assistance between family and community ● Formal insurance
Ex Post Risk Coping Strategies	
Income diversification	<ul style="list-style-type: none"> ● Sale of assets, land, or food crops ● Diversification of employment ● Migration by necessity
Diversification of production	<ul style="list-style-type: none"> ● Temporary stoppage of production for alternative ● Permanent stoppage of production for alternative ● Reduction of production for alternative
Marketing options	<ul style="list-style-type: none"> ● Early sale of product ● Delayed sale of product/storage ● Sale to alternative buyers

Source: Authors' compilation from various sources (Bargawi & Newman, 2017; Dercon, 2002; Rapsomanikis & Sarris, 2006; Ruben & Masset, 2003a; Vongvisouk & Dwyer, 2016).

Dercon (2002) classifies strategies to mitigate against the impacts of shocks, including those stemming from commodity price volatility, as risk-management and risk-coping strategies. Risk management or income smoothing strategies attempt to ex-ante reduce risk before a shock occurs. In contrast, risk-coping or consumption smoothing strategies ex-post address the consequences of a shock that has already occurred. Table 1 provides a non-exhaustive set of examples of ex-ante price risk management and ex-post risk-coping strategies.

These strategies are not equally available to or applied by all households. Rather, households face various constraints, determined by their locality, the materiality of the crops they grow, and household characteristics, coupled with individual decision-making, resulting in heterogeneous outcomes. Hebinck and van der Ploeg's (1997) 'styles of farming' framework provides a structuralist approach that accommodates both the structural influence of the market, as well as the agency of individual farming households. The styles of farming framework centers on the interactive and iterative production of structure and agency. The structural market entails, 'specific room for maneuver, which is actively created by the actors involved through processes of negotiation and redesigning' (Hebinck & van der Ploeg, 1997, p. 206). This room for maneuver allows for differential positioning, and thus complex and heterogeneous farmer responses.

3. Cassava production in Lao PDR

These debates are particularly salient for Lao PDR. The GoL's encouragement of agricultural commercialization, coupled with policies to consolidate rural populations and eradicate shifting cultivation (Evrard & Baird, 2017), has spurred wide adoption and expansion of export-oriented, agricultural commodity crops. From these dynamics, recent literature on Lao PDR has emerged to evaluate various forms of agricultural commercialization, from land concessions (Dwyer & Vongvisouk, 2019; Nanhthavong et al., 2022; Suhardiman et al., 2015) to smallholder conversion to commodity crops (Fox & Castella, 2013; Hepp et al., 2019). Notable attention has been placed on the phenomenon of boom crops, characterized as crops that expand rapidly, often in the form of monocultures, but are followed by a slow down or 'bust.' The production cycle of these crops has been associated with price dynamics and volatility as drivers of the initial boom and subsequent bust (Hall, 2011; Junquera

& Gret-Regamey, 2019; Ornetsmüller et al., 2019). Examples from Lao PDR have included rubber (Vongvisouk & Dwyer, 2016) and maize (Ornetsmüller et al., 2019).

The cultivation of cassava in Lao PDR has significantly increased in recent decades. Cassava, a starchy tuber, is managed as an annual crop and exhibits resilience in challenging settings, such as poor soil fertility, high temperatures, and drought conditions (Delaquis et al., 2018). These features make for an appealing option for farmers with few resources and farmers in Lao PDR rarely apply inputs such as fertilizer when cultivating cassava (Mahanty & Milne, 2016; Malik et al., 2020). There are two cassava product families in the region, including dried cassava and processed starch. Dried cassava is minimally processed into chips or pellets, often through sun drying, and are used in bioethanol industries or as animal feed. Further processed native or modified starch feed into numerous food, textile, and industrial uses (Kaplinsky et al., 2011).

Our study focuses on cassava cultivation in the two districts of Paklai and Kenthao in Xayaboury province in north-western Lao PDR. Kenthao district shares a long border with Thailand, containing a major international border gate to Loei province, Thailand. Paklai is located further from the border and is situated near the Nam Poui National Biodiversity Conservation Area. According to the 2015 Population Census (Lao Statistics Bureau 2022), the incidence of poverty in the two districts is relatively low at 16.0% and 15.4% based on the national poverty line. However, comparisons of the 2013 and 2019 Lao Expenditure and Consumption Survey indicate that the incidence of poverty in Xayaboury province increased during this period by 5.4%, contrary to the overall national trend (Lao Statistics Bureau & World Bank, 2020).

The majority of populations in both districts depend on agriculture as their main economic activity, with only 17.23% and 9.86% of the population engaged in non-farm sectors in Paklai and Kenthao respectively (Lao Statistics Bureau 2022). Cassava is a major source of income for households in Paklai and Kenthao, constituting between 73% and 40% of the total income between the poorest and wealthiest quartiles (Manivong et al., 2018). While maize dominated in both districts in the mid-2000s, the area and production of maize has recently declined, and cassava has increased. Figures 1 and Figure 2 depict the district harvested area and production of maize and cassava in Kenthao and Paklai. The area under cassava cultivation grew faster in Kenthao district than in Paklai and overtook the area under maize cultivation in 2017.

Despite their proximity, the cassava market structures differ notably between Kenthao and Paklai districts; see Manivong et al. (2018) for a detailed value chain analysis of cassava in the two districts.

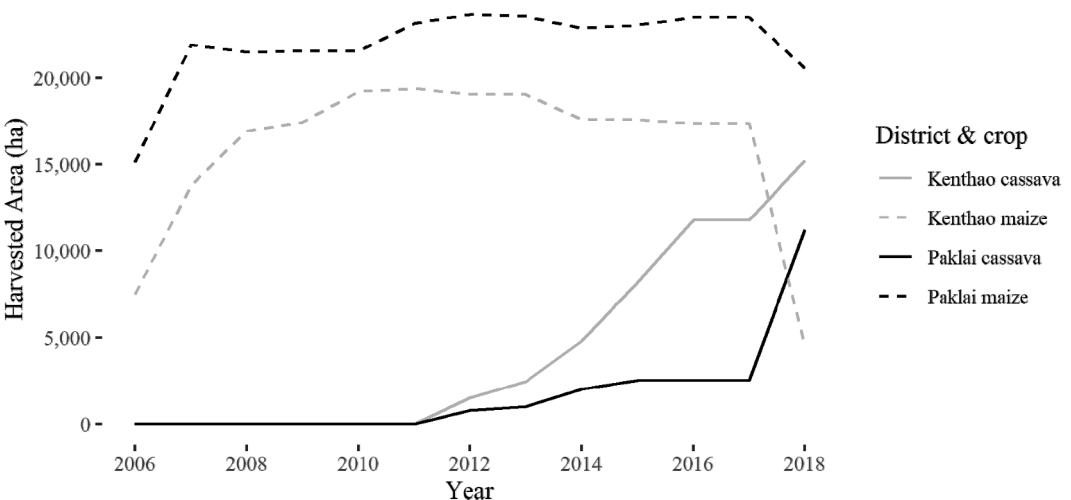


Figure 1. Harvested area of cassava and maize in Kenthao and Paklai districts. Source: District authorities to the Ministry of Agriculture and Forestry.

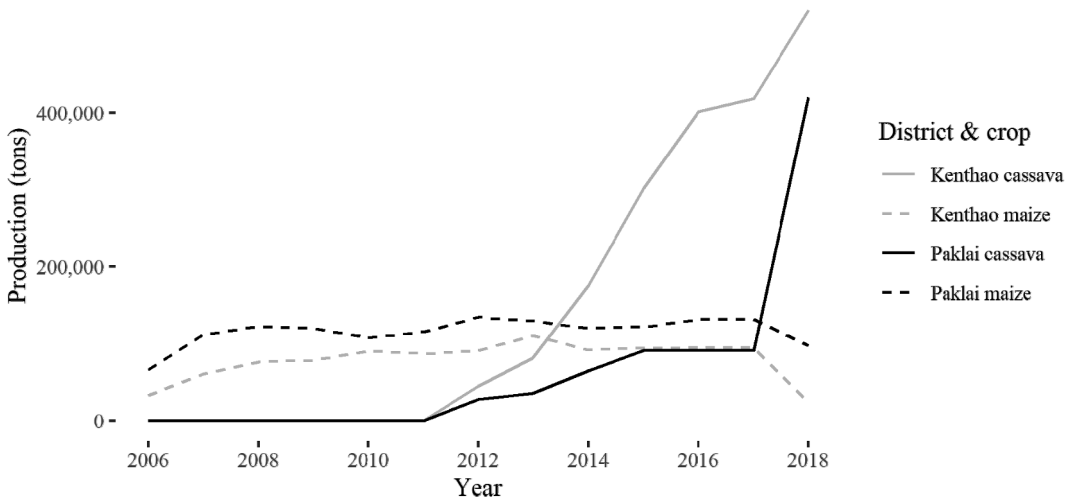


Figure 2. Production of cassava and maize in Kenthao and Paklai districts. Source: District authorities to the Ministry of Agriculture and Forestry.

Paklai district's cassava market is characterized by a monopsony structure, dominated by the Chinese-owned starch production factory, Lao Prosper Company. The company operates in an outgrower scheme with local farmers in the district, sourcing an additional 20% of their cassava from other areas. Starch produced by the factory is transported north to the Chinese border of Yunnan province and sold to Chinese buyers. At the time of establishment, the Lao Prosper Company entered a monopsony arrangement with the district that guaranteed farmers' harvests to the company. This was enforced through the imposition of fines against farmers found to be selling their cassava harvests elsewhere. Such arrangements have been relatively common in Lao PDR and elsewhere as a method to encourage foreign direct investment, ensuring viable supply to new companies. After several years of surplus production within the district and growing discontent among farmers, restrictions were relaxed, and farmers were permitted to sell the excess harvest to traders.

In contrast, Kenthao district's cassava market structure is characterized almost entirely by international trade with Thailand, facilitated by the international border gate and the strong presence of traders. To support this trade, a number of small- and large-scale chip drying processors developed in the district, selling fresh roots and dried chips to Thai companies across the border. One large processor also provides a small number of roots to the Lao Prosper Company in Paklai district. Farmers in villages close to Kenthao district town sell fresh roots to small-scale chip processors or produce dried chips themselves, which are collected by small processors. Farmers living further away from the district town sell fresh roots to traders in their village representing large processors or must transport their harvest to the district town. Only a small number of farmers sell roots directly to large processors.

The great majority of cassava produced in Lao PDR is destined to regional markets, as demonstrated by the two districts studied here which export cassava to neighboring China and Thailand. Local prices are hence susceptible to shocks in regional markets as well as global markets. Starting in 1997, the government of China introduced an agricultural support program to support grain production, including maize, and protect producers. The goal of this policy was to, 'continually [boost] subsidy payments and price floors to ensure that net returns to farmers [remained] steady from year to year' (Gale, 2013, p. 7). The program initially included a protective price policy and introduced a TPSP in 2008. State-owned reserves purchased maize supplies when the market reached the floor price, in some years exceeding 25% of total production. Maize prices and

productivity increased in the following years (Li & Lin, 2022). By 2016, this practice accumulated an estimated 220 to 250 million tons of maize reserves. That same year, the government of China announced the end of the TPSP and the release of the maize stockpile (Li & Lin, 2022; Pratt, 2016). While there have been subsequent studies examining the effects of the TPSP on domestic price dynamics (e.g. Dai et al., 2022; Zhang & Liu, 2020), its cross-border and cross-scalar effects have not yet been examined. We hypothesize that this policy shock translated into price volatility in the domestic cassava market in Lao PDR, and that the impact of this shock is variegated by local market structures.

4. Materials and methods

4.1 Cross-scalar and mixed-methods approach

We adopted a cross-scalar and mixed-methods approach to assess the impacts of global agricultural commodity markets on regional cassava price dynamics and link these to the experiences of cassava farmers in two districts in Lao PDR. 'Scales' refer to the 'spatial, temporal, quantitative, or analytical dimensions used to measure and study any phenomenon' (Gibson et al., 2000, p. 218), where 'cross-scale' indicates interactions across different scales. Ignorance of cross-scalar interactions limits broader system understanding and can lead to policies or solutions at inappropriate scales (Cash et al., 2006). This neglect of cross-scalar interactions is reflected in the dissociation between the market integration literature and the literature focused on the impacts of commodity price volatility on producers.

In our present study, we examined three scales and their interactions: 1) global maize and regional cassava prices; 2) regional cassava prices and local cassava market structures in two cassava-producing smallholder communities in Lao PDR; and 3) local cassava prices and farmers' agency and risk mitigation strategies in these smallholder communities. At each scale, we addressed market attributes influencing price formation and transmission. We apply mixed-methods associated with each scale, utilizing quantitative methods for the first scale, a mix of quantitative and qualitative methods for the second scale, and qualitative methods for the third scale. This study was conducted in 2017, with local support from the International Centre for Tropical Agriculture (CIAT) and the National Agriculture and Forestry Research Institute (NAFRI) in Lao PDR. Fieldwork was undertaken as part of the 'Developing Cassava Production and Marketing Systems to Enhance Smallholder Livelihoods in Cambodia and Lao PDR' project, building and expanding on previous analysis conducted within the project.

4.2 Time series analysis of price data

Due to the substitutability between cassava and maize in a variety of uses, particularly for the production of starch (Howeler, 2006), the two commodity markets were hypothesized to be inter-related and influence each other's price fluctuations. We assessed this hypothesis by examining the correlation and cointegration between monthly global maize prices and regional cassava prices between 1998 and 2018. Given the driving influence of Chinese demand on the cassava market in Southeast Asia, we paid particular attention to the Chinese maize TPSP introduced in 2008 and associated price fluctuations. The study was divided into two sub-samples: a pre-TPSP period from 1 January 1998 to 1 February 2008, and a period during and after the TPSP from 1 March 2008 to 1 April 2018. Although the TPSP was introduced in October 2008 (Dai et al., 2022), the sample was evenly split so that each period contained 122 monthly observations.

For the price correlation and cointegration analysis, we utilized three monthly price time series. (1) The regional cassava price was represented by the Thai monthly dried cassava chip price data provided by the Thai Tapioca Development Institute (TTDI). Thai prices provided an appropriate regional representation due to its highly developed cassava industry and reliable data, compensating for the lack of reliable price data from Lao PDR. (2) Due to the

lack of a continuous time series for Chinese maize prices, a continuous series was constructed from two different data sources: Chinese maize prices from January 1998 to December 2012 were drawn from spot prices reported in the China Agricultural Yearbooks (Ministry of Agriculture of the People's Republic of China, 2018), while January 2013 to April 2018 are drawn from the Dalian Commodity Exchange (DCE) futures prices (AHDB, 2018). (3) US maize prices were taken from the Chicago Board of Trade (CBOT) (World Bank, 2018). To account for unit roots in the correlation analysis, the first difference of each time series was taken, and stationarity was confirmed for the de-trended time series through an Augmented Dickey-Fuller test.

Three measurements were used to examine price volatility, price relations, and the effects of the Chinese maize TPSP. First, the volatility of the regional cassava prices was assessed by comparing the price variance in the two periods. Second, the presence of a relationship between regional cassava and US and Chinese maize prices was assessed through the estimation of Pearson's pairwise correlation coefficient, the Engle and Granger (1987) cointegration test, and the estimation of an error correction model (ECM) over the two sub-samples. Cointegration analysis enabled us to evaluate whether a long-run relationship between regional and global prices exists. If such relationship exists, it can be represented in form of an ECM. ECMs can quantify both short-run and long-run effects and the responsiveness of the dependent variable (a price series) to the variation in the independent variable (another price series). This responsiveness is captured in the speed of adjustment coefficient, which is significant if a long-run relationship between the two price series exists. Finally, rolling and recursive correlations were performed to assess the change in the strength of the correlations over time.

4.3 Focus group discussion and multi-stakeholder consultations

We conducted focus group discussions to investigate smallholder farmers' experience of volatility in cassava markets and their corresponding coping mechanisms. The first focus group discussion was held in Nam Line village, Paklai district, consisting of eight participants. The second was held in Haddeng village, Kenthao district, and consisted of 10 participants. The discussions were coordinated by NAFRI through respective village chiefs. Villagers were requested to participate in the focus group discussions through village-wide announcements. Data specific to individual households were not collected beyond information revealed in the focus group discussions, limiting our ability to assess for biases and generalizability of responses. Nonetheless, the focus group discussions provided valuable insight into the dynamics of the two study sites.

To explore the price dynamics and transmission experienced by local communities, focus groups in each site were first asked to jointly produce a timeline of annual cassava prices from 2013 to 2018 based on their recollection. Once the price dynamics were established, focus group participants were asked to describe how they reacted to changes in prices over this time period, including increases as well as decreases in price. To organize the findings from the focus group discussion, we drew on Dercon's (2002) survey of shock and risk coping mechanisms. Specifically, we adopted the distinction between risk management, or ex-ante income smoothing, and risk-coping, or ex-post consumption smoothing, strategies summarized in Table 1. Ethical clearance was approved by SOAS, University of London (as the study was conducted as part of a master's thesis) prior to the data collection and consent was sought from all discussion participants. Finally, insights from these discussions were complemented by observations from multi-stakeholder consultations between farmers, government officials, and industry representatives held in each district. These consultations were conducted by NAFRI and CIAT researchers in each district, in which information was presented on market developments, results of household surveys, value chain assessments, and results from agronomic trials conducted with farmers as part of the wider ACIAR funded research project. These observations provided historical and contextual information regarding the cassava market formation in each district.

5. Results

5.1 Global and regional price transmission: price analysis

Chinese maize prices are seen to steadily increase as well as diverge from US maize prices following the introduction of the TPSP in 2008, depicted in Figure 3. The Chinese maize price began declining just before the official announcement of the TPSP removal in 2016. Three-month rolling coefficients of variation of prices are plotted in Figure 4. While Chinese maize prices stabilized, Thai cassava prices increase in volatility. The variation in Chinese maize prices increases at the end of the series when the TPSP is removed in 2016. In the latter half of the period, US maize prices show more persistent volatility than both the Chinese maize and Thai cassava prices. As variation was calculated based in USD prices, this does not account for price volatility due to exchange rate volatility. A plot of Chinese maize prices in USD and RMB in the Appendix shows that dynamics in the two-price series are close. For robustness, RMB denominated maize prices are considered in addition to USD denominated ones throughout our price analysis.

The price ranges were calculated and compared between periods before and during the TPSP. The price range for US maize, Chinese maize, and Thai cassava are presented in Table 2. Volatility increased across all three markets in the second period, with volatility in Chinese maize increasing the most. The range of Thai cassava prices increased by 30.6%, US maize by 28.29%, and Chinese maize by 52.56% (71.80% in domestic currency) between periods.

Further, Pearson's pairwise correlations of de-trended price changes were calculated for each relationship pre-price support and post-implementation in Table 3. While the first period shows no statistical relationship between any of the markets, significant relationships are observed in the second period between Thai cassava and US maize prices and weakly significant between Thai cassava and Chinese maize prices. It is worth noting that correlation analysis captures the short-run and contemporaneous relationship between these markets due to the de-trending of the price series before analysis.

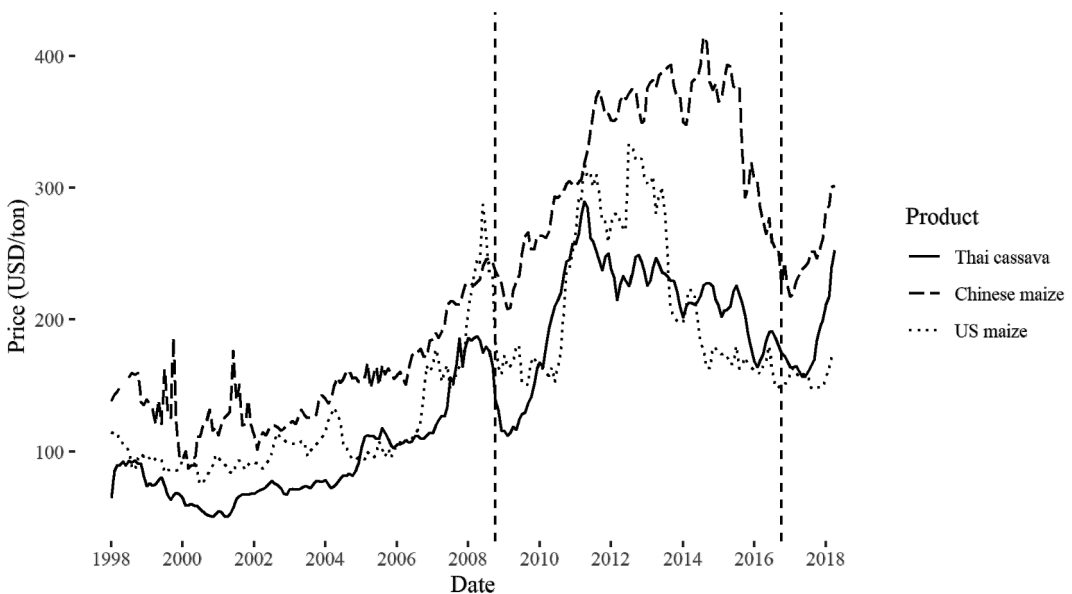


Figure 3. Monthly US maize, Thai cassava, and Chinese maize prices between 1998–2018. Vertical lines indicate the introduction and removal of the TPSP; Source: AHDB (2018); Ministry of Agriculture of the People's Republic of China (2018); TTDI (2018); World Bank (2018).

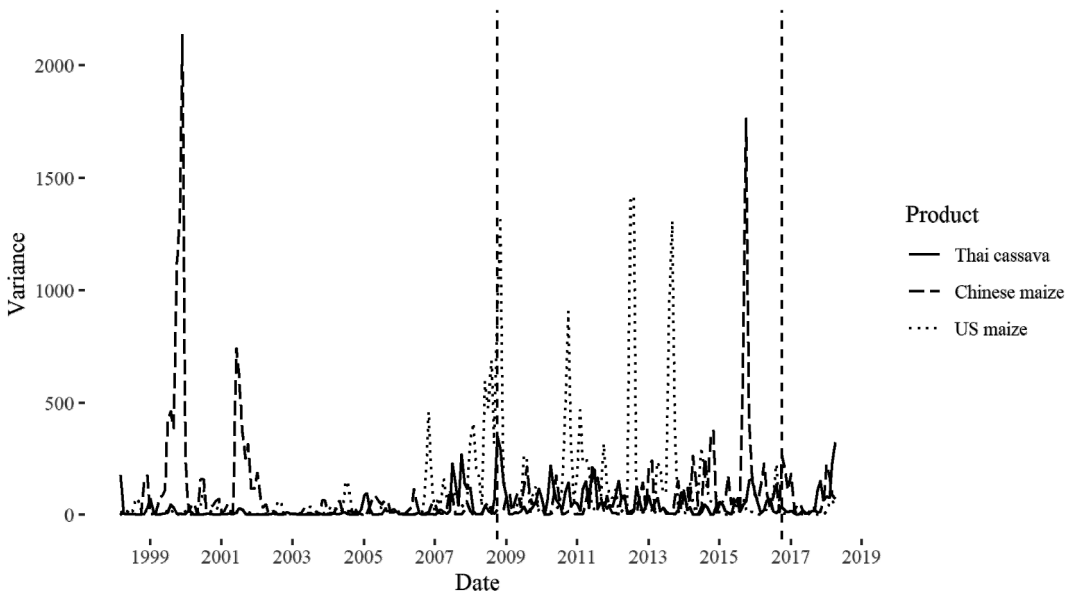


Figure 4. Three-month rolling coefficient of variation of US maize, Chinese maize, and Thai cassava prices between 1999–2018 (in USD per ton). Vertical lines indicate the introduction and removal of the TPSP. Source: AHDB (2018); Ministry of Agriculture of the People’s Republic of China (2018); TTDI (2018); World Bank (2018). Authors’ calculation.

Table 2. Price volatility in US maize, Chinese maize, and Thai cassava markets (USD).

	Pre-TPSP, 1998–2008			TPSP and after, 2008–2018			Range differential	Percent change (domestic currency)
	Min	Max	Variance	Min	Max	Variance		
US maize	75.27	220.07	736	147.29	333.05	3382	40.96	28.29%
Chinese maize	86.96	221.35	986	209.62	414.64	3650	70.63	52.56% (71.80%)
Thai cassava	50.27	186.06	910	112.06	289.41	1664	41.56	30.60%

Source: AHDB (2018); Ministry of Agriculture of the People’s Republic of China (2018); TTDI (2018); World Bank (2018). Authors’ calculation.

Table 3. Correlation and cointegration analysis between US maize, Chinese maize, and Thai cassava markets.

	Correlation analysis		Cointegration analysis		
	Pre-TPSP, 1998–2008	TPSP & after, 2008–2018	Full sample 1998–2018	Pre-TPSP, 1998–2008	TPSP & after, 2008–2018
US maize (USD) and Chinese maize (USD)	-0.10 <i>0.2749</i>	0.02 <i>0.7848</i>	-3.495**	-2.969*	-2.322
US maize (USD) and Chinese maize (RMB)	-0.12 <i>0.2027</i>	0.01 <i>0.9367</i>	-3.941**	-2.613	-2.421
Thai cassava (THB) and US maize (USD)	-0.04 <i>0.6568</i>	0.19* <i>0.0386</i>	-2.824	-2.488	-1.685
Thai cassava (THB) and Chinese maize (USD)	0.03 <i>0.7223</i>	0.16 <i>0.0710</i>	-3.634**	-3.169*	-2.444
Thai cassava (THB) and Chinese maize (RMB)	0.02 <i>0.7978</i>	0.13 <i>0.1400</i>	-4.160**	-2.893*	-2.525

Note: *significant at 5% and **significance at 1% level; p-values in italic. The null hypothesis of the cointegration analysis is no cointegration; MacKinnon (1991) critical values are used and the lag length in the auxiliary regression is decided by AIC. Source: Authors’ calculations.



Figure 5. Three-year rolling window correlation between US maize and Thai cassava, and Chinese maize and Thai cassava prices. Note: vertical lines indicate the introduction and removal of the TPSP; horizontal dotted lines represent statistical significance at p -value < 0.05 calculated using the average standard error, which was found to be relatively stable. Source: AHDB (2018); Ministry of Agriculture of the People's Republic of China (2018); TTDI (2018); World Bank (2018). Authors' calculation.

Rolling and recursive window correlation analyses were performed to establish the stability of this relationship over the sample period. A three-year (36 months) rolling window correlation of the US maize and Thai cassava price relationship and the Chinese maize and Thai cassava price is pictured in Figure 5 below. One-year (12 months) recursive windows of the same two relationships are depicted in

Figure 6 and Figure 7. Most notable from these relationships is the period during which the TPSP was in place, in which Thai cassava becomes more closely related to US maize than to Chinese maize, indicating that the introduction of the TPSP increased the contemporaneous correlation with the US market. In the recursive window, the starting point of the calculation remains fixed in January 1998, but the window widens over time. The recursive relationships show that while the Thai cassava price relationship to Chinese maize does increase somewhat after the TSPS, the relationship to US maize prices remains dominant.

The contemporaneous short-run analysis is complemented by the cointegration analysis which reveals a significant long-run relationship between Thai cassava and Chinese maize prices and between Chinese and US maize prices, see Table 3. This relationship weakens in the second half of the sample period, which captures the TSPS and post-TSPS period. The results of the ECM are summarised in Table 4. The long run relationship between Thai cassava and Chinese maize is confirmed through both sub-sample periods. However, the size of the long run coefficient shrinks, which indicates a reduction in the long run elasticity of the Thai cassava price to the Chinese maize price post-TSPS introduction. No long run relationship is found between the Thai cassava and US maize price. However, the short run relationship is highly significant, indicating short term price shocks are transmitted from the US maize market to the Thai cassava market.

5.2 Local structures and price transmission: farmer responses

Transmission of price fluctuations from the global commodity market to the farm gate scale were confirmed by both focus groups in Kenthao and Paklai. When asked to collectively construct a timeline of cassava prices over the last five years, a sharp period of price decline was identified between 2015–16, coinciding with the removal of China's TPSP. Timelines constructed by the farmer groups are depicted in

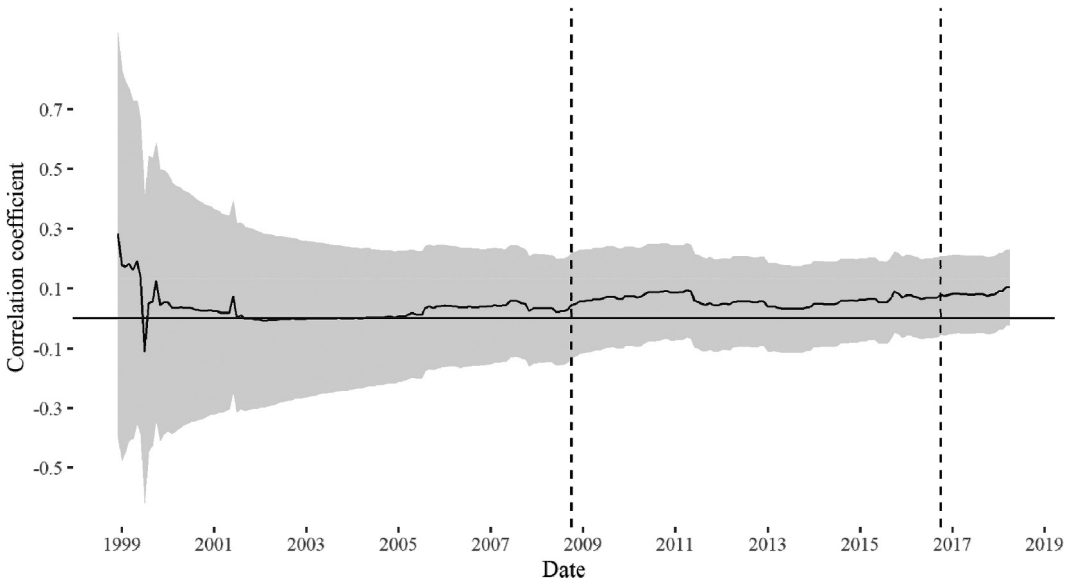


Figure 6. One-year recursive window correlation between Chinese maize and Thai cassava. Note: vertical lines indicate the introduction and removal of the TPSP; gray area indicates 95% confidence interval. Source: (AHDB, 2018; Ministry of Agriculture of the People’s Republic of China, 2018; TTDI, 2018). Authors’ calculation.

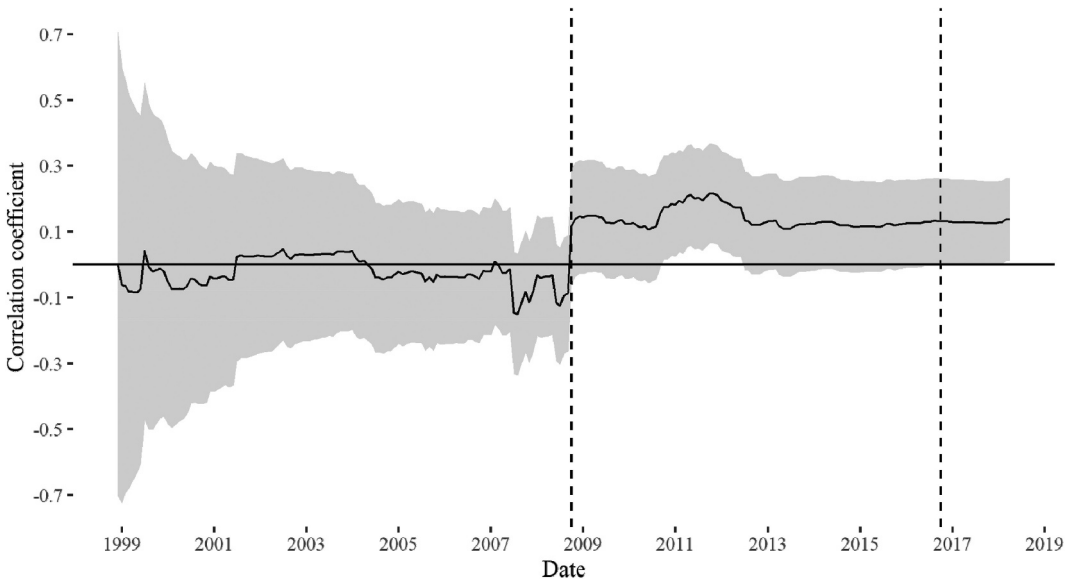


Figure 7. One-year recursive window correlation between US maize and Thai cassava. Note: vertical lines indicate the introduction and removal of the TPSP; grey area indicates 95% confidence interval. Source: (TTDI, 2018; World Bank, 2018). Authors’ calculation.

Figure 8. Prices in Kenthao are provided by the farmers in Thai baht, indicating the influence of cross-border trade. For ease of comparison, price points were converted to Lao kip using historical, annual exchange rates (OANDA, 2018). At the lowest point, prices in Paklai reached 380 kip per kilogram, whereas Kenthao district saw prices as low as 220 kip per kilogram in 2016. Prices recovered in 2017, reaching as high as 580 kip per kilogram in Paklai in 2018. For comparison, annual harvest month (February and

Table 4. Error Correction Model with Thai cassava as the dependent variable.

	Full Sample, 1998–2018	Pre-TPSP, 1998–2008	TPSP & after, 2008–2018
Chinese maize (RMB)			
Short run	0.0558	0.0590	0.1156
	2.2580 [0.1329]	1.8306 [0.1761]	1.5743 [0.2096]
Long run	1.5588**	2.3759**	0.8974*
	94.971 [0.0000]	12.551 [0.0004]	5.6354 [0.0176]
Speed of adjustment	-0.0510**	-0.0520*	-0.0542*
	3.31 [0.0011]	2.26 [0.0260]	2.22 [0.0285]
Chinese maize (USD)			
Short run	0.0389	-0.0094	0.1408
	1.1187 [0.2902]	0.0423 [0.8371]	2.3499 [0.1253]
Long run	1.1178**	2.0380**	0.7160*
	66.164 [0.0000]	14.798 [0.0001]	5.4203 [0.0199]
Speed of adjustment	-0.0436*	-0.0565*	-0.0533*
	2.55 [0.0113]	2.22 [0.0288]	2.23 [0.0275]
US maize (USD)			
Short run	0.1194**	-0.2253**	0.1051*
	7.4972 [0.0062]	8.9084 [0.0028]	4.1254 [0.0422]
Long run	0.5644	2.9721*	0.0763
	0.1764 [0.6745]	5.1588 [0.0231]	0.012542 [0.9108]
Speed of adjustment	-0.0069	-0.0319	-0.0261
	0.581 [0.5621]	1.66 [0.1003]	1.30 [0.1959]

Notes: *Significant at 5% and **significant at 1% level; p-values in brackets. Up to 3 lags are considered; lag length is decided by AIC. Short run is the short run coefficient (sum over the contemporaneous and lagged values if significant), long run is the long run coefficient, speed of adjustment is the speed of adjustment coefficient. Wald test for general restrictions is used to evaluate the significance of the derived short run and long run coefficients.

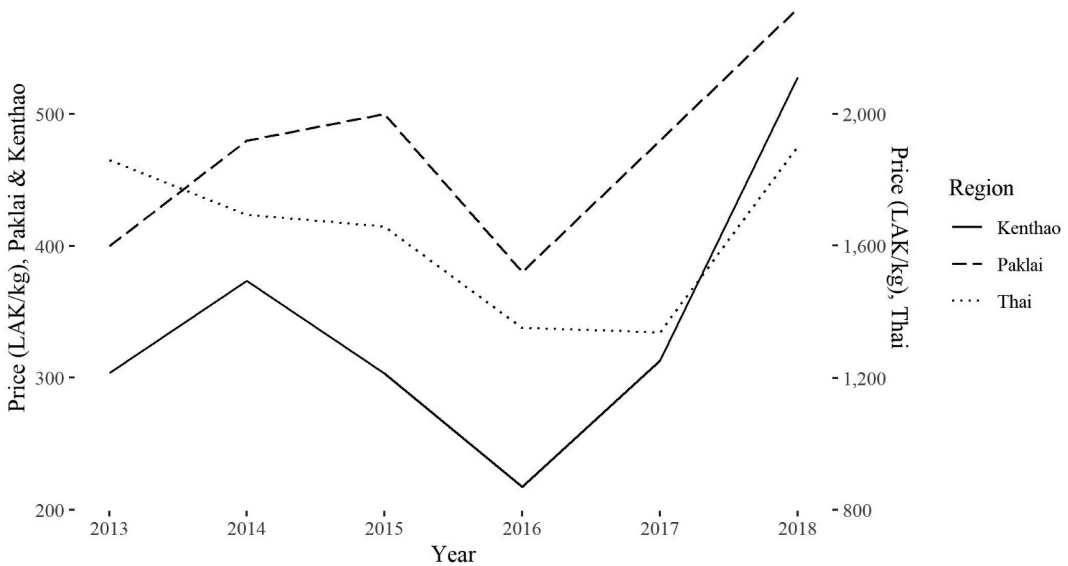


Figure 8. Cassava price timeline constructed by focus groups in Kenthao and Paklai districts in LAK/kg (LHS) and Thai cassava price (harvest month averages from monthly series) in THB/kg (RHS). Source: Focus group discussions in Kenthao and Paklai; TTDI (2018).

March) averages for Thai dried chips were converted to LAK/kg and included in the Figure A1. While Thai prices reflected similar trends as the Paklai and Kenthao farmgate prices, overall, the series was higher and differed in precise year-to-year changes. This could partially be due to the price differences between dried chips and fresh roots.

In both districts, focus group participants identified a market price at which continuing with cassava would be unsustainable for their households. In Paklai district, this was identified as 300 kip per kilogram; in 2016, the price hovered at 380 kip. In Kenthao, the shutdown price was named at 250 kip per kilogram. The market price was below this in 2016, falling to 220 kip. Although farmers expressed concern regarding the price decline, those that continued with cassava said they had been optimistic that prices would recover. One participant compared the process to gambling. Although farmers identified a shutdown price, participants said that they did not seek additional price information when making planting decisions, rather relying on information from previous years to guide their decisions.

In addition to the significant price decline between 2015 and 2016, focus group participants in both Paklai and Kenthao districts experienced intra-season price fluctuations and other grievances that were strongly defined by their respective market structures. Although the strict monopsony arrangement in Paklai had been relaxed in recent years allowing the option to engage in the dry-chip value chain, farmers were reluctant to absorb the additional transportation costs to sell to other traders. They continued to sell primarily to the Lao Prosper company, voicing several grievances related to the company's price setting and payment system. For instance, the company would post a buying price in the village, but farmers would find a reduced price upon delivering their product to the farm gate. Daily fluctuations ranged from 10 to 50 kip per kilogram.

When asked if they applied any maneuvering tactics to secure a better price for their harvest, the participants explained that they were not able to exert upward pressure on prices and were fully price-takers due to time constraints. Farmers had only a narrow window to deliver their harvests; the factory operates for three to four months each season, after which the only option remaining for farmers is to sell to traders from more distant processing factories at a discounted rate. Farmers had to accommodate for the factory processing schedule in planning their harvest, also accounting for the needs of their paddy fields and the weather. Harvesting cassava is labor intensive, requiring the labor of two to harvest between 1 and 1.5 tons per day. Farmers preferred to self-deliver the harvest to the factory the same day to avoid weight loss through moisture evaporation. These factors were compounded by most farmers' cash income needs by harvest season. As a result, farmers rush to sell their harvests as quickly as possible and lack the ability to withhold supply or exert pressure on the price.

Farmers in Paklai had no choice but to accept the price and conditions given when they arrived at the factory gate. They were in a captive relationship with Lao Prosper company with a high degree of power asymmetry and little room to maneuver (Gereffi & Humphrey, 2005). Focus group participants complained of long queues, some having slept overnight at the factory gate waiting to sell their cassava roots, while others were turned away entirely. Further, the factory often ran short of cash reserves, forcing farmers to return several days after delivery to collect their payment or go through long, administrative processes at banks. Farmers recognized that the price fluctuations at the factory gate were a function of local supply and demand. One focus group participant observed that the prices at the factory would decline when multiple families delivered their harvests and would rise when few delivered. Participants noted that there was no direct communication between the company and the community regarding prices beyond the posted prices in the villages, and although community members discussed the prices, households felt compelled to be self-reliant.

Farmers' experience of localized price fluctuations differed significantly in Kenthao district. While farmers in Paklai had to accept the factory price, focus group participants in Kenthao identified traders as their primary source of information, changing the degree of interaction drastically. Although farmers maintained that they were not able to negotiate prices directly with traders, they reported making daily phone calls to traders during the harvest period to track price information. Prices would fluctuate between 10 and 30 kip per day. Farmers thus had the information and opportunity to delay harvesting if they found the price unsuitable on that day. Further, there were a variety of traders operating in the district, who were local community members and known to the farmers. The relationship between farmers and buyers resembled a market type with low degree of power asymmetry in the typology of GVC governance (Gereffi & Humphrey, 2005).

Traders representing the dry processors exporting to Thailand offered the best prices, while smaller traders representing local processors buy at a lower price of 20 to 80 kip per kilogram but offered the advantage of being closer to the farmers. Despite the price differential, farmers preferred the closer traders, since their tractors could not transport large quantities at a time. Notably, there are numerous processing factories in Kenthao district that are known to operate for two weeks longer than the factory in Paklai, which closed once a minimum amount of feedstock can no longer be achieved. Additionally, farmers in Kenthao reported exercising a form of group assistance that, while not specifically applied for mitigating price fluctuations, proved beneficial during the cassava price decline. Households cultivating cassava engaged in labor exchanges to augment their labor supply, reducing the burden of the labor-intensive harvesting and constraints on transportation. Participating households noted the improved returns of this strategy, as well as a greater sense of enjoyability in their work.

5.3 Local structures and risk mitigation: farmer responses

5.3.1 Initial price increase and conversion

Although both Kenthao and Paklai were previously maize-producing areas, farmers in both districts reported being aware of the higher returns offered by cassava. Cassava prices in Lao PDR had been increasing since the early-2000s, surpassing that of maize by the mid-2000s. Compared to maize, cassava requires less weeding and grows well even in poor soils. Returns are also typically much higher for cassava than for maize, by a margin of between seven and eight million kip per hectare.

Focus group participants in Paklai stated that they had learned of the benefits of growing cassava during travels to Thailand, where they had observed others converting. One participant even remarked that relatives in Vientiane had teased her for not converting and taking advantage of the high prices. Yet, despite the rapid price increase, converting to cassava was not a viable option in Paklai without a market linkage for farmers to sell their products. Thus, farmers welcomed the opening of the Lao Prosper Company starch factory in 2008. Upon their arrival, Lao Prosper offered free cassava planting material to encourage local conversion to cassava and guaranteed a harvest price of 500 kip per kilogram. With the provided planting material and low or no additional inputs required, the investment to convert to cassava was low. At the time the focus group discussions were conducted, most participants in Paklai had been growing cassava for three to four years. Participants noted that most of the village had converted either partially or entirely to growing cassava after the establishment of the Lao Prosper factory.

In Kenthao district, focus group participants recalled that seven or eight households had adopted cassava when Lao Prosper offered free planting material, but that the factory traders did not come to purchase the harvest. Only after receiving a guarantee from a local trader that there would be a buyer at harvest time, 50 households converted to cassava the following season. By 2013, participants estimated that 80% of the households had converted to cassava.

5.3.2 Mitigation of the price collapse

While prices were high, participants reported investing additional income to build or renovate houses, acquire motorbikes and tractors, livestock, and gold, and expand rice fields. During the 2015–16 period, participants said that they had never experienced such a sharp decline in commodity prices. In Paklai, most participants in the discussion continued growing cassava throughout the period of decline, although they estimated that approximately half of the village diversified their production by growing less cassava. Many returned to growing maize or a combination of maize and cassava. One member of the focus group that returned to maize, who identified herself as a local trader and money-lender, attributed the reconversion to the price decline and subsequent return to cassava in 2018 to the price recovery. When asked if community members discussed and sought advice on their risk mitigation strategies with neighbors, participants in both Paklai and Kenthao stated that there was little open

discussion between households. Yet, when asked where ideas originated for strategies adopted by households, most participants noted observing and imitating their neighbors.

Conversely, in Kenthao district there was no reported reconversion to maize during the cassava price decline. Instead, those that chose to diversify their production expanded to forages, for which there was a local market for seeds. Maize was noted to be particularly undesirable due to the poor soil conditions in the area, low prices, and storage susceptibility to rats, indicating the biophysical limits on available options. The primary coping mechanism for the price decline in Kenthao was to store cassava roots by delaying harvest until the following season when prices recovered in 2017. This was identified as a strategy for those with larger areas or sufficient paddy rice production. Delaying harvest preserves the roots in the ground and prevents weight loss but entails forgoing income for the season. Possibly, households harvested amounts sufficient to meet their cash needs while storing the remainder. Further, Kenthao's proximity to the Thai border provided alternative income sources, particularly through migration. An officer of the District Agriculture and Forestry Office noted that members of numerous households migrated the short distance across the border for contract work on farms or construction sites for short durations between nine days up to three months.

6. Discussion

Exploring the three scales of (1) global commodity markets, (2) local market structure, and (3) farming households highlight the importance of institutions and interactions between these scales in price formation and transmission, as well as shaping the landscape for farmers' maneuvering. We identify three notable observations emerging from these interactions with policy relevance.

First, our analysis supports the hypothesis that the maize and cassava markets are interrelated in two ways: the comparison of the variance of prices in the period pre-TPSP and during and after the TPSP confirms an increase in volatility across markets; and the significant cointegration relationship between the Chinese maize and Thai cassava prices supports the hypothesis that Chinese maize prices influence the cassava market in the rest of the region. Because agricultural commodity markets are globally and regionally interlinked and macroeconomic shocks are transmitted between commodity markets as well as from global to local scales, important insights can be gained by considering macro- and microeconomic dynamics together. This is particularly important for Lao PDR. As the country's economy continues to integrate into regional and global markets, exposure to price volatility and the resulting vulnerability of smallholder farmers to such volatility is likely to rise.

Second, local market structures emerged as significant components in linking cross-scalar interactions and shaping the heterogenous room for maneuver available to farmers, highlighting the role of institutions in price formation and transmission. Despite the global and regional demand driving domestic cassava prices upwards, initial conversion to cassava had to be facilitated by the establishment of local market structures at the local scale supported by infrastructure improvements. This took a formal structure in Paklai with the establishment of the Lao Prosper starch factory, whereas in Kenthao, these linkages were informal and depended on the tenuous relationships and trust between farmers and traders. Further, the landscape of responses to long- and short-run price fluctuations was largely shaped by the local market structure, which provided or inhibited the exercise of various strategies. The monopsony arrangement in Paklai contributed to limiting strategies to the diversification of production, as farmers returned to maize or a combination of maize and cassava cultivation. With limited communication and interaction with the processing factory, farmers did not have room for price negotiation, resulting in them being price-takers. These daily fluctuations could have been influenced by the fixed processing capacity of the starch factory. Without a coordinated harvest schedule, farmers supplying roots to the factory competed against each other and ultimately drove down prices. The market structure in Kenthao, on the other hand, supported a greater variety of strategies, facilitated by greater interaction between scales. Farmers in Kenthao exercised marketing options of delayed harvest and sale, facilitated by income diversifying strategies through migration. The presence of multiple traders and buyers and their willingness to interact with farmers provided the

opportunity to adjust harvesting schedules. Other factors, such as biophysical limitations and the presence of development activities also affect room for maneuver (Cramb et al., 2017) but were not explicitly examined here. These findings support previous conclusions in the literature that local-level institutions play an important role in price formation and demonstrate the need for context-specific interventions that account for the local market structure.

Third, our study also found that in both Paklai and Kenthao, most risk mitigation strategies applied by farmers were ex-post responses, rather than ex-ante preparation for shocks. This is in line with findings by others not only in farmers' risk mitigation but also in official government strategies as well. For instance, Vongvisouk and Dwyer (2016) surveyed local government responses to declines in the Lao rubber industry, finding that strategies were also in response rather than in preparation for shocks. Interventions included attempts to renegotiate prices by waiving taxes and negative regulations on farmers to prevent conversion to other crops. Ex-post strategies are commonly observed in developing economies (Dercon, 2002). Further, there was also indication of other factors that shaped the strategies available to farmers. This included the socioeconomic status of households, as illustrated by the example of the trader and money-lender's ability to switch between crops, biophysical limitations to cultivatable crops, as well as income diversity and migration, illustrated by migration of farmers to wage labor opportunities in Thailand. The concentration on ex-post strategies presents an opportunity for communities and state agencies in developing countries to adopt ex-ante interventions in preparation for shocks. This includes the development of decision-making tools to improve the understanding of the market (and production) risk of farming decisions, improving access and understanding to financial mechanism to manage risk (particularly behavior around savings during periods of high prices), enhanced on-farm diversification, and education and training that enables livelihood diversification driven by opportunity rather than in response to shocks.

These three findings highlight the relevance of the cross-scalar approach. Studies focused on agricultural commodity markets and price transmission neglect the full impacts of price volatility on local livelihoods. Studies focused at the local scale on impacts on the ground may have a truncated view of price formation and over-emphasize the power of upstream actors to dictate prices and their ability to absorb price fluctuations themselves with thin processing margins. Studies focused on the domestic and global scales neglect the importance of local institutional structures and their role in shaping volatility transmission as well as risk mitigating strategies available to farmers.

7. Conclusion

We apply a cross-scalar and mixed-methods approach to evaluate the dynamics and causes of price volatility in cassava markets in Southeast Asia, and the responses to these price dynamics locally in two cassava-producing districts in Lao PDR. In analyzing agricultural commodity prices, we found that the degree of volatility exhibited by the cassava market increased following the implementation of China's temporary purchase and storage policy for maize in 2008. Chinese maize policy changes had a large effect on global maize supply and thus were hypothesized to have affected cassava prices, which is a close substitute for livestock feed and industrial applications. Significant short-run correlation and long-run co-integration relationships between Chinese maize and Thai cassava prices support this hypothesis.

Further, focus group discussions highlighted the significant role of intermediate market structures at the local scale in transmitting global commodity market dynamics as well as determining farmers' room for maneuver. While the study revealed that macroeconomic shocks were transmitted to the farm gate, captured in a sudden period of price decline in 2015–16, the evaluation of farmer risk management and coping strategies showed heterogeneous responses to the same shock. This heterogeneity was observed to be a function of varying intermediate market structures between the two districts, highlighting the role of local-level institutions in price formation. Strategies observed included diversification of production into other crops, income diversification through migration, marketing options through storage, delayed sale, and alternative buyers, and group insurance strategies. Significantly, the monopsony market arrangement provided restricted space for farmer

interaction, constraining the availability of coping strategies. In contrast, the market structure characterized by cross-border trade enabled farmer interactions and permitted a wider range of strategies.

Finally, our cross-scalar approach bridges the previous gap in the literature between studies focused on global agricultural commodity markets and price transmission, and local-level studies assessing value chains and livelihoods. Our results highlight the linkages between global, regional, and local agricultural commodity markets, the resulting vulnerability for smallholder farmers, and the role of institutions in price formation across scales.

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Appendix



Figure A1. Chinese maize prices in USD and RMB between 1998 and 2018. Source: AHDB (2018); Ministry of Agriculture of the People's Republic of China (2018).