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Agricultural value chains in a fragile state

The case of rice in Myanmar

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ABSTRACT

Nearly one-quarter of the global population lives in fragile states. Yet, despite the enormous importance of these areas for reducing global poverty and food insecurity, there is relatively little research examining how agricultural value chains, crucial for assuring food security, respond and adapt to such contexts. This paper analyzes Myanmar's rice value chain–its most important staple crop and largest value chain–during the economic collapse and political instability caused by a military coup in early 2021. It relies on unique data collected with a large sample of rice retailers and millers before and after the coup. Despite many challenges in the rice value chain after the coup, such as banking and transport, rice processing and trade continued, assuring availability of rice in most retail markets and illustrating the resilience of the value chain to a major shock. While processing margins were mostly stable, an increased distribution margin (between rice millers and retailers) led to 11 percent higher average retail prices after the coup, implying welfare costs of almost USD 500 million. Using a market-pair regression method, we find that localized violence near sellers and buyers, distances traveled, and distance of vendors from international borders are associated with significantly increased rice price dispersion between rice retailers and mills. Despite the amalgam of problems to address in such settings, prioritizing the easing of transport restrictions, stabilizing fuel prices, and facilitating safe spatial arbitrage of food products would likely help prevent further food price inflation, assure higher farm prices, and improve welfare.

1. INTRODUCTION

An estimated 1.8 billion people–almost one quarter of the world's population–lived in fragile states in 2020.[1] This share is expected to grow to 26 percent in 2030 and 31 percent in 2050 (OECD 2020). Moreover, three-quarters of the extreme poor in the world reside in fragile states (OECD 2020). Yet, despite the enormous importance of these areas for reducing global poverty and food insecurity, there is relatively little research on livelihoods and trade because safe and reliable data collection is often a challenge. Access to food, food prices, and the functioning of food value chains are critical when states fail but, insights into the functioning of agricultural markets and food value chains are rare within such conflict-affected areas.[2]

In this paper, we examine agricultural value chains in Myanmar during a period of major political instability. Myanmar's military seized control of the country in a coup on February 1, 2021, setting the country down a path of widespread violence and major economic collapse. In protest of the coup, Myanmar's people organized a Civil Disobedience Movement (CDM) and worker strikes, which led to disruptions in service delivery of both public institutions and private businesses. Banks closed to in-person services and faced severe liquidity shortages, limiting businesses' ability to pay employees and suppliers, and for residents to access their money. Access to formal and informal credit mostly dried up. Internet access and communication was restricted. Violence and insecurity rose sharply after the coup. Cumulatively, these disruptions had major economic consequences as GDP declined by 18 percent and poverty rates increased to between 40 and 50 percent of Myanmar's population (Boughton et al. 2021, World Bank 2021, UNDP 2021).

We study the rice value chain for two reasons. First, rice is the main staple in Myanmar, accounting for 51 and 62 percent of urban and rural calories consumed, respectively, making it crucial for food security in the country.[3] It is also the predominant crop for a large number of farmers and an important export. Second, approximately 70 percent of rice that is consumed is purchased. Value chains are therefore essential in assuring sales of paddy from farmers, milling of paddy to rice, and distribution of rice to consumers. Rice is typically traded over large distances in the country, implying that coup-related disruptions in the functioning of the value chain coup will be widely felt. To study the rice value chain, we use unique primary data collected by phone before and after the coup at the midstream (rice millers) and downstream (retail food vendors) and combine these data with a number of secondary datasets.

We look at three research topics. First, we assess the extent of the disruptions to the rice value chain following the military coup by investigating disruptions midstream and downstream, and rice availability in retail markets. Second, we analyze the size of processing and distribution margins within the value chain and assess how they have been affected by the coup. Third, we look at spatial price dispersion from the mills to food vendors comparing rice prices before and after the coup using a market-pair regression methodology of miller-vendor pairs with miller and vendor fixed effects. We test what explanatory variables of price dispersion used in international literature matter in this context and to what extent these factors have been affected by the instability. We examine travel

[1] The OECD characterizes fragility as "the combination of exposure to risk and insufficient coping capacity of the state, systems and/or communities to manage, absorb or mitigate those risks." (OECD, 2020, p. i). In its assessment, fragility is measured across the economic, environmental, political, security, and societal dimensions by 8-12 indicators per dimension (OECD 2020).

[2] There are a number of studies that have looked at the relationship between food prices and violent conflict. Researchers have analyzed rising food prices as the cause of violence and unrest, often finding significant linkages (Bellemare 2015, Dube and Vargas 2013, Hendrix and Haggard 2015) and feedback loops between violence and increasing food prices (Raleigh et al. 2015). Others have assessed the influence of climate and weather as a major cause of food scarcity and food price changes, and consequently violence (Maystadt and Ecker 2014, Mach et al. 2019, Burke et al. 2015) while Koren (2018) shows that food abundance might actually be driving conflict as groups vie for control of food resources. Khan and Saqib (2011) show that political instability is related to inflation more broadly. Few assessments have been done on food price variation due to such disruptions within countries. An exception is Hastings et al. (2021) who looked at food price transmission between cereal markets in war-torn Somalia. There has seemingly been no study done on changes in margins and price dispersion within value chains within conflicted-affected areas.

[3] Estimated in 2015 (based on Myanmar Poverty, Livelihood, and Consumption Survey).

costs (Minten and Kyle 1999, Minten et al. 2016), border crossings (as a proxy for export market access) (Aker et al. 2014), and differences of ethnic group composition between markets (Aker et al. 2014, Robinson 2016). We also assess the direct effects of measures of violent events in sending and receiving markets on price dispersion.

Our data reveal significant business disturbances for food vendors and rice millers after the coup linked to banking and transport. Yet, despite these challenges, local trade and milling continued, though at lower activity levels than normal, assuring availability of rice in most retail markets in the country. Upstream, farm prices and milling margins were found to be mostly stable after the coup. However, we see increases in retail rice prices by 11 percent on average. Simulation results of these increased distribution margins indicate sizable welfare costs for rice consumers and producers, estimated at almost 0.5 billion USD at the national level (equivalent to about 3 percent of agricultural GDP in 2020). Regressions reveal that spatial price dispersion increased after the coup with the distance between mills and vendors widening the price differences. Violence near mills or vendors, which increased dramatically during the coup, also increased price dispersion. However, in contrast with previous findings (Aker et al. 2014, Robinson 2016), we find that differences in ethnic composition of sending and receiving townships/markets did not affect dispersion. Price dispersion further decreased with proximity of food vendors to land borders, possibly due to the price reducing effects of competition from exports in those markets. However, the border effect was weakened severely during periods of border closures. The results indicate that the most severe effect of the coup on retail prices were found in the areas furthest away from export opportunities and major production zones that were affected by violence.

When the state fails to assume its normal role and private sector activities are curtailed, it is crucial that agricultural value chains continue to function well to ensure food security and to prevent increases in food retail prices to avoid further suffering of vulnerable households. Our findings indicate that easing transport restrictions, stabilizing fuel prices, and facilitating safe spatial arbitrage of food products would reduce the welfare costs of market disruptions by preventing food price inflation while assuring remunerative prices for farmers. To the extent possible, maintaining safe border trade of agricultural commodities may help stabilize prices in the domestic market. Finally, as mobile phone use is often widespread, even in a failed state, close monitoring of a number of important aspects in such environments can take place and should therefore be encouraged.

The paper proceeds as follows. In the next section, we provide important background information on the political conflict and the rice value chain in Myanmar. The econometric specification used to empirically test price changes during the crisis is discussed in Section 3 along with our data and survey methods. Section 4 illustrates the disruptions noted in the value chain. Section 5 presents graphical analyses of price and margin changes, revealing retail price increases following the coup, as well as price regressions results. Section 6 discusses the implications of our results and section 7 concludes by summarizing the key results and by discussing main policy implications.

2. BACKGROUND

2.1 The political crisis

The military coup on February 1, 2021 generated broad strikes and a generalized CDM, which hampered the functioning of most public as well as private sector activities limiting economic activity. While the economic impacts have been ubiquitous, there were four areas with exceptional disturbances.

First, local and international trade has been affected in important ways. Rising fuel costs and concurrent transportation restrictions and curfews, enforced at multiple administrative levels, have

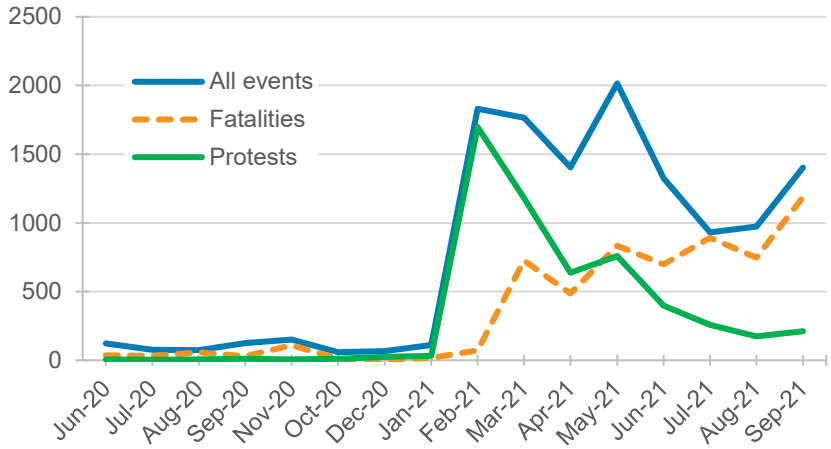
increased domestic transport costs. There have also been significant declines in imports and exports since the coup. Immediately after the coup, port and custom procedures were disrupted and a large number of truck drivers went on strike. Consequently, local and international transportation costs increased significantly.[4]

Second, in the immediate aftermath of the coup, the CDM caused most bank branches to close for several months. Afterwards, access to banking services remained limited and currency has been in short supply. Trust in formal banking has diminished, limits were imposed to withdrawals, and long queues formed at bank branches and ATMs. Access to formal and informal credit was also increasingly problematic (Boughton et al. 2021). The local currency, Myanmar Kyat (MMK) rapidly depreciated and seven months after the coup, the reference rate of the Central Bank stood at almost 2,000 MMK/US$ compared to 1330 MMK/USD on February 1, 2021.

Third, internet access was restricted in the months immediately after the coup. There were nightly blockages of fixed-line broadband connections, mobile data and wireless broadband networks were cut, and access to social media was blocked. While the military relaxed some of these strict controls over time, only a limited number of online services are allowed and there are frequent reports of areas being cut off from the internet. Myanmar's 14-point score decline in a *Freedom on the Net* score in 2021 was the largest registered drop since the organization started measuring this score (Freedom House 2021).

Finally, and critically, violence and insecurity rose sharply after the coup. Monthly violent events catalogued by Armed Conflict Location and Event Data (ACLED) shows a clear and pronounced increase in the total number of violent events and fatalities in Myanmar immediately following the coup (Figure 1). At first, protests accounted for the majority of events, but the military regime began cracking down on protesters in March 2021. As a result, the number of protests declined, but more harmful and violent events became more common as the military continued their ruthless crackdown and Myanmar's civilians and ethnic armed organizations responded. Monthly fatalities have increased steadily since March, spiking in September 2021.

Figure 1: Evolution of violent events, fatalities, and protests, monthly totals June 2020-September 2021



Source: ACLED 2021 (Raleigh et al. 2010).

[4] However, some of these impacts were linked to international changes unrelated to the coup as the global shortage of containers led to less local demand. More stringent COVID-19 restrictions by Myanmar's neighbors also made international trade with Myanmar more difficult. Specifically, border trade with China was significantly reduced during the first wave in 2020 (Frontier 2020). Restrictions lessened starting in July 2020 and exports of agricultural and other commodities resumed, though normal trade proved to be short-lived as China again imposed severe restrictions during the coup and a third wave of COVID-19 beginning in July 2021 and extending for several months afterwards (Frontier 2021).

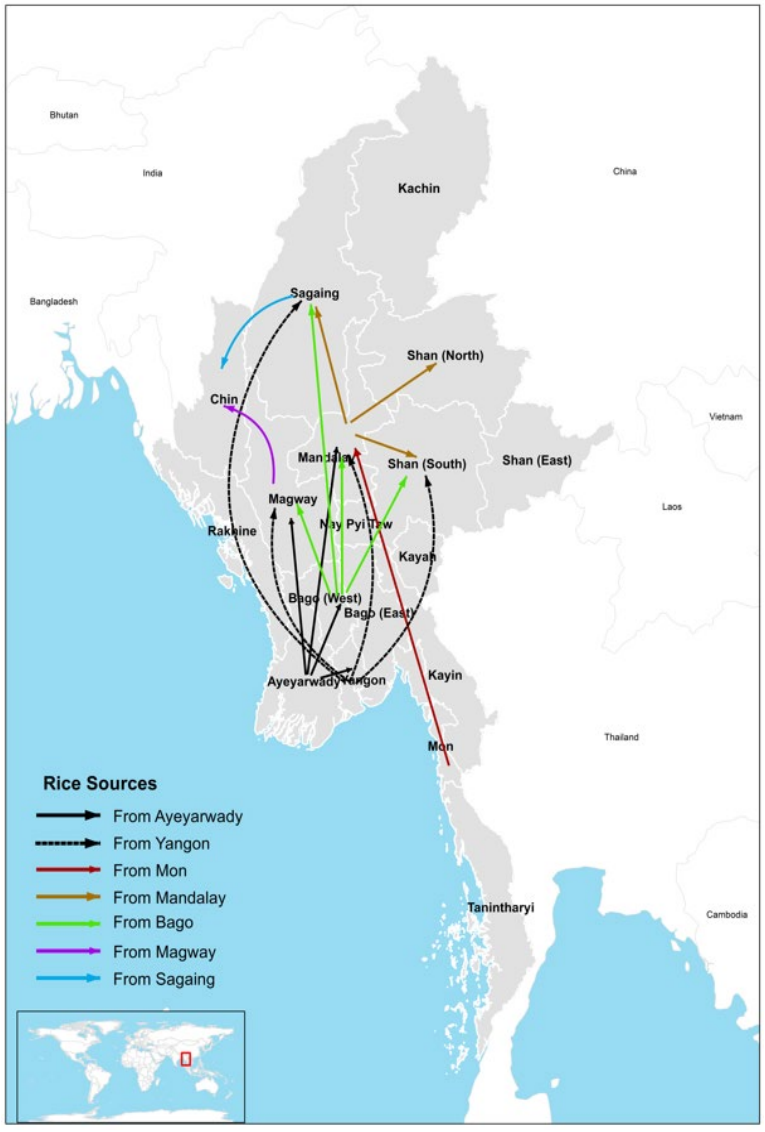
The overall impact of these disruptions was a widespread drop in economic activity. The World Bank (2021) estimated that the economy contracted in 2021 by 18 percent, while others highlighted large increases in poverty (Boughton et al. 2021, UNDP 2021).

2.2 Rice in Myanmar

Rice is the most important staple in Myanmar with an average per capita consumption of 170 kgs per year (USDA 2021a), one of the highest in the world. Rice is also an important export product. Official export data place rice second to pulses but some sources (e.g., Dorosh et al. 2019; USDA 2021a) indicate that Myanmar's rice exports might be as important as pulse exports in terms of export value, reaching USD 900 million in 2019/2020 (U Ye Min Aung 2020). In 2020, an estimated 2.3 million tons of rice were exported through formal and informal channels (USDA 2021b). Most of the rice is exported to China though more recently we see increasing diversification of export locations, including Europe and Africa (Diao et al. 2020, USDA 2021b).

Paddy rice is also a hugely important crop for the livelihoods of Myanmar's farmers. Data from the 2017 national Myanmar Livelihood and Consumption Survey (MLCS) showed that 60 percent of the farm households nationwide grew paddy during the monsoon season (the major agricultural season). However, some areas are better suited for commercial rice production and the major rice production areas are mostly situated in the southwest of the country. The regions of Bago, Yangon, and Ayeyarwady collectively account for 45 percent of the monsoon rice produced in Myanmar (Goeb et al. 2021). Rice mills are an essential node in the value chain's midstream as raw paddy is processed into head rice (the consumer product) prior to sale to consumers or export. Major rice mills are located near the main paddy production regions, with large concentrations in Bago, Yangon, and Ayeyarwady.

Figure 2: Rice flows in Myanmar



Source: Authors, based on Vivero and Oo (2019)

After milling, rice is distributed throughout the country (Figure 2). Analysis of the national 2015 MPLCS shows that 72 percent of household rice consumption is obtained from the market indicating the importance of the value chain. A significant part of rice production is transported from the Southwest by land to Yangon or secondary cities in the South. Part of the rice is shipped by land or

boat to the north to Mandalay and secondary cities or for export to China, most often through the border town Muse (Proximity Design 2016). Rice is also shipped by boat from the port in Yangon to other countries. The year before the coup, it was estimated that almost 50 percent of exported rice –in value terms–was destined for China (USDA 2021b). However, exports have been significantly disrupted since the coup. In July 2021, exports were only 76 percent of the level the year before (USDA 2021b). The closure of border gates to China, linked to COVID-19 measures taken by the Chinese government also contributed to the reduction of exports.

3. DATA AND METHODOLOGY

3.1 Data

Our analysis uses a panel survey of rice mill owners and managers interviewed by phone in June and September 2021.[5] The sample comes from three main rice producing regions–Ayeyarwady, Bago, and Yangon. After selecting two townships from each region, medium- and large-scale rice mills were randomly selected for survey participation with 334 millers completing interviews in June and 239 millers in the September round (Table 1).[6]

The miller surveys had two main objectives. The first was to understand how rice millers have been impacted by the political crisis. To that end, the questionnaires covered disruptions to business activities, e.g., transportation restrictions affecting paddy purchases or rice sales, and business responses to those disruptions. The second objective was to understand price changes at mills for purchased paddy and sales of milled rice. We asked millers to report current prices at the time of the interview (June and September 2021) as well as recall prices from one year prior (June and September 2020) for the rice variety with the highest throughput in the 30 days prior to interview.

Myanmar rice prices vary according to quality and variety (Goeb et al., 2021). To lessen this unwanted variation, we focus on data for Emata rice varieties, the most common variety group both in our data and in national production/consumption, and restrict our sample for analysis to those mills buying Emata paddy or selling Emata rice. As a result of that sample restriction, for each product and each survey, the number of price observations is less than the full sample of mills (Table 1). Overall, our miller data include 691 observations for paddy and 905 observations for rice.

Table 1. Number of interviews and Emata rice price observations, by survey round

	Millers			Food vendor	
	N interviews	N price observations		N interviews	N price observations
		Paddy	Rice		Rice
September 2021	239	114	202	191	153
June/July 2021	344	242	264	197	153
September 2020		105	188	216	166
June/July 2020		230	251	175	124

Note: Price data in 2020 for rice millers are from recall data collected in 2021 surveys.
Source: Miller survey–June and Sept 2021 rounds; Vendor survey–June and Sept 2020, June and Sept 2021 rounds.

The second source of primary data is a panel of four rounds of phone surveys with food vendors interviewed in June/July 2020, September 2020, June/July 2021, and September 2021 (Table 1). The food vendor sample was constructed by identifying respondents that are well-informed on food markets, that deal regularly with food traders (such as suppliers and wholesalers) and are highly numerate and knowledgeable about food prices. Although the sample is not representative, there is

[5] The rice millers survey is a continuation of a panel conducted during the COVID-19 pandemic.

[6] The sample was first used for an in-person study conducted by the International Growth Centre (IGC) in collaboration with the Ministry of Commerce (MOC) in 2019.

good national coverage with respondents in each agro-ecological zone and each state/region. We again focus on the main Emata rice variety group for our price data. The total number of rice price observations at the vendor level is 596. The vendors in our sample are mostly female (58 percent) and rural (84 percent; Table 2). In contrast, the interviewed millers are predominantly male (88 percent) and urban (83 percent).

To assess spatial variation in prices we construct three distance metrics between millers and vendors using transport infrastructure (i.e., road network) data from 2019.[7] First, we calculate the distance between each mill-vendor pair along the road network using the centroid of the mill and vendor townships (in lieu of their exact coordinates). Second, we calculate the distance between each mill-vendor pair through Yangon (i.e., the distance from the mill to Yangon plus the distance from the vendor to Yangon). While this is a less direct route, it is a common trade path (Figure 2) as Yangon is the largest city and home to the country's largest rice wholesale markets. Third, we estimate transport times between each mill-vendor pair along the road network. Travel times are estimated using transport infrastructure and landscape features (land use, rivers, lakes, and slope obtained from the Myanmar Information Management Unit). We assigned a travel speed to each of the road types (major, secondary, tertiary, tracks/other) in the geographic information system (GIS) data, ranging from 75 to 10 kilometers per hour. Then we combined the GIS layers into a friction (or impedance) grid converted into one-kilometer grid cell raster layers. Slope is also considered to model uphill and downhill movement.[8] The travel time raster grid is generated by calculating the travel time between miller and vendor townships. Given the broad assumptions and the quality of data used, the model provides estimated travel times between mill-vendor pairs. On average, the distance between mill-vendor pairs is 490 km via the main road network, with an average estimated travel time of 9.2 hours (Table 2). Diverting the transit path through Yangon increases the average distance between mill-vendor pairs to 640 km.

We also construct a metric of violence using publicly available data from the Armed Conflict Location & Event Data project (Raleigh et al. 2010). To assess how violence may impact prices, we use a simple count of the number of violent events in the miller or vendor township in the month of and the month immediately preceding each interview round. Thus, the violence data vary across each mill and vendor and over time. The national increase in violent events shown in Figure 1 are apparent near millers and vendors relative to 2020 (Table 2).

Lastly, we use township profiles from the General Administration Department (GAD 2019) to identify the ethnic group with the largest share of the population. Approximately 96 percent of millers and 71 percent of vendors are in townships where Bamar is the main ethnic group and 71 percent of mill-vendor pairs are in townships with the same main ethnicity.

[7] Downloaded from https://geonode.themimu.info/layers/geonode%3Ammr_rdsl_250k_mimu.

[8] All input layers are combined into a friction grid using a Python (arcpy) script that runs a "Mosaic to New Raster" function in ArcGIS 10.7.

Table 2. Description of survey sample

	Definition	Mean	Std Dev	N
Millers				
Age	Miller age	49.54	11.82	294
Gender=female	Miller gender is female (i)	0.12	0.32	297
Urban	Mill located within 5 km of nearest urban center (i)	0.83	0.37	297
High school	Miller completed high school (i)	0.57	0.50	294
Experienced	Miller with above median (15) years of experience (i)	0.44	0.50	297
Ethnicity=Bamar	Miller township main ethnicity is Bamar (i)	0.96	0.19	317
Violence				
September 2021	Number of ACLED events at township level in Sept and Aug 2021	2.29	3.18	195
June/July 2021	Number of ACLED events at township level in June and July 2021	3.05	3.61	252
September 2020	Number of ACLED events at township level in Sept and Aug 2020	0.09	0.29	183
June/July 2020	Number of ACLED events at township level in June and July 2020	0.00	0.00	239
Vendors				
Distance to border	Distance to nearest land border ('000 km)	0.39	0.18	220
Age	Vendor age	42.37	10.30	220
Gender=female	Vendor gender is female (i)	0.58	0.49	220
Urban	Vendor location in an urban area (i)	0.16	0.37	220
General store	Vendor is a general store (i)	0.93	0.26	220
Ethnicity=Bamar	Vendor township main ethnicity is Bamar (i)	0.71	0.45	220
Violence				
September 2021	Number of ACLED events at township level in Sept and Aug 2021	6.49	11.82	152
June/July 2021	Number of ACLED events at township level in June and July 2021	6.90	14.46	151
September 2020	Number of ACLED events at township level in Sept and Aug 2020	0.20	0.85	163
June/July 2020	Number of ACLED events at township level in June and July 2020	0.20	1.06	122
Mill-vendor pairs				
Distance	Distance between each mill-vendor pair at township level along the road network ('000 km)	0.49	0.26	63,877
Distance through Yangon	Distance between each mill-vendor pair through Yangon at township level along the road network ('000 km)	0.64	0.29	63,877
Travel time	Travel time between each mill-vendor pair at township level along the road network (hours)	9.22	4.43	63,250
Same ethnicity	Miller and vendor townships have the same main ethnic group (i)	0.71	0.46	63,877

Note: Samples vary by variable level and data availability. '(i)' denotes indicator variable with 0=no and 1=yes.
Source: Mill survey, Vendor survey, ACLED.

3.2 Methods

Our research seeks to understand how the disruptions caused by the military coup have altered price formation for rice in Myanmar. First, we test the extent to which different margins in the rice value chain are affected by the coup. We estimate using the following model:

$$(1)\ P_{jt} = \delta_t + \alpha_1 MilledRice_j + \alpha_2 Retail_j + \left[\delta_t * MilledRice_j\right]' \boldsymbol{\rho_1} + \left[\delta_t * Retail_j\right]' \boldsymbol{\rho_2} + \alpha_3 PctBroken_{jt} + \omega_j + \epsilon_{jt}$$

where P_{jt} is the rice price per kg at level j (paddy, milled rice, and retail rice) and time t; δ_t are indicator variables for each of four time periods, two before the coup (June and September 2020) and two after the coup (June and September 2021); $MilledRice_j$ and $Retail_j$ are indicator variables for price levels of milled rice and retail, respectively (paddy prices are the base level); $PctBroken_{mt}$

is the percentage of broken rice kernels in milled rice; ω_j are fixed effects for vendors (retail price) and millers (paddy and milled rice prices); and ϵ_{jt} is an iid error term.

There are several estimators of interest. δ_t will capture the change over time in prices that millers paid for paddy. α_1 will show the June 2020 average price that millers receive for their milled rice minus what they paid for paddy (paddy-to-rice margin). Similarly, α_2 will show the differences between retail rice prices and paddy prices in June 2020. The coefficient vector $\boldsymbol{\rho_1}$ will show changes in the milling margins over time, while $\boldsymbol{\rho_2}$ represents changes in retail margins over time. Positive (negative) values of these coefficients imply that the change in prices was greater (less) than the change in paddy prices. Lastly, α_3 will show the relationship between the percentage of broken rice and milled rice prices.

Second, we are interested in the impacts of (i) mid-stream transportation disruptions and cost increases, (ii) proximity to export markets, and (iii) local violence on spatial arbitrage between mills and vendors. To address this, we use a market-pair approach that compares rice prices at mills to prices at retail outlets before and after the coup using the following regression model:

$$(2)\ \left|ln\left(\frac{P_{vt}}{P_{mt}}\right)\right| = \delta_t + [\delta_t * D_{vm}]'\boldsymbol{\gamma_1} + [\delta_t * Dborder_v]'\boldsymbol{\gamma_2} + \beta_1 V_{mt} + \beta_2 V_{vt} + \beta_3 E_{vm} + \beta_4 PctBroken_{mt} + \theta_v + \mu_m + \varepsilon_{vmt}\ ,$$

where $P_{vt}$and P_{mt} are rice prices per kg at time t for vendors and millers, respectively. As is common in the price dispersion literature, we take the absolute value of the natural log ratio of prices. Coefficients are then interpreted as percentage changes in the magnitude of the price ratio. D_{vm} is the over-road distance between each mill-vendor pair in 1,000 km; $Dborder_v$ is the distance from each vendor to the nearest over-land border crossing; V_{mt} and V_{vt} are the total number of violent events cataloged by ACLED at the township level during the month of interview and the preceding month for millers and vendors, respectively; $E_{vm}$is an indicator variable equal to one if the vendor and mill townships have the same majority ethnicity group; θ_v and μ_m are vendor and miller fixed effects, respectively; and ε_{vmt} is an iid error term.

The miller and vendor fixed effects control for all time invariant characteristics (observable and unobservable) at the miller and vendor levels including mill size and capacity, vendor market size, geographic location, and urban status.[9] We cannot track rice departures from a specific mill nor do we know from where rice sold by vendors originated. D_{vm} thus does not reflect actual rice flows but serves as a proxy for spatial arbitrage between mills and vendors. The coefficient vector $\boldsymbol{\gamma_1}$ will then show estimates of differences in spatial arbitrage influences on consumer rice price formation over time (i.e., before and after the coup), specifically how the relationships between distance (between mills and vendors) and the log price ratio have changed. If price dispersion has increased during the coup, the two post-coup coefficients in $\boldsymbol{\gamma_1}$ will be positive. To ensure that our results are not dependent on our choice of distance metric we also use two additional metrics: (i) the distance between mill-vendor pairs through Yangon, the major rice wholesale center for Myanmar, and (ii) estimated travel times between mill-vendor pairs.

To reduce variations in prices caused by rice characteristics we limit price comparisons in both regressions to Emata varieties which account for the vast majority of Myanmar's rice exports (USDA, 2021b), much of which flows overland to neighboring countries. When borders are open, they can help stabilize prices in the domestic market (Goeb et al. 2021) and $Dborder_v$ is included in the regression as a test of these potential stabilizing effects on prices. $\boldsymbol{\gamma_2}$ provides estimates of how the relationships between the log price ratio and distance to border crossings (and therefore cross-

[9] As a robustness check we also estimate (1) with market-pair fixed effects that control for all time invariant factors of each market pair à la Aker and Fafchamps (2010).

border trade centers) have changed. $\boldsymbol{\gamma_1}$ and $\boldsymbol{\gamma_2}$ are interpreted as the percentage change in the magnitude of the price ratio from an additional 1,000 km of distance between mill-vendor pairs and land borders, respectively, for each time period relative to June 2020. If trade was disrupted due to border closures during June 2020 and September 2021, there would be differences in the $\boldsymbol{\gamma_2}$ coefficients in the September 2020 and June 2021 time periods.

Localized violence may have a direct effect on marketing and prices distinct from general trade and business disruptions. At the mill level, this could be reflected in lower prices for rice from reduced demand and at the vendor level there could be price increases from a lower supply of rice. In these cases, price dispersion would increase and β_1 and β_2 would be positive. Previous literature has documented increased price dispersion across different ethnic groups (Aker et al. 2014). If that is evident within Myanmar, β_3 would be negative. Lastly, the percentage of broken rice is an important determinant of prices at the mill level, and larger shares of broken rice within the milled head rice likely reduce prices and increase price dispersion, which would show in a positive value for β_4.

4. DISRUPTIONS TO THE VALUE CHAIN

There were significant disruptions to Myanmar's rice milling sector during the summer paddy season of 2021 (Table 3). Almost 90 percent of millers reported that the banking sector was the most impactful disruption to business. More than 80 percent of respondents reported challenges in making and receiving payments in June. Payment issues lessened somewhat in the September survey though still more than half experienced difficulties and, again, 74 percent of millers cited banking as the largest challenge. Millers responded to the banking crisis by shifting towards cash transactions in both June and September when more than 90 percent of all paddy purchases and more than 75 percent of all rice sales were in cash. Compounding the cash challenges, millers reported 13 percent less working capital available to buy paddy in June 2021 than in June 2020. Millers also began using a modified 'hundi' payment system to sell rice, whereby a sale is negotiated, and payment is transferred from a trusted third party with cash available. In June 2021, 10 percent of all rice sales were conducted via the hundi system, compared to just 1 percent of sales prior to the coup.

Table 3. Mill disruptions in banking and transport, June and September 2021

	June 2021	Sept 2021
Banking and payments		
Challenges receiving payment for rice (%)	82	52
Challenges paying for paddy (%)	86	63
Cash share of transactions (%)		
Buying paddy	94	93
Selling rice	76	81
% Change in weekly working capital compared to 2020	-13	-17
% Reporting banking/cash as main business disruption	90	74
Credit lent out to farmers		
Increased demand from farmers (%)	26	34
Challenges recovering payment (%)	33	35
Credit taken in by mills		
Challenges acquiring new credit (%)	23	22
Challenges repaying credit taken in (%)	39	32
Transportation disruptions		
Restrictions/curfews (%)	70	58
Increased costs in last 30 days (%)	64	63
N	266	183

Note: Reference period for all questions is 30 days prior to interview.
Source: Miller survey–June and September 2021 rounds.

Millers also reported credit disruptions in both June and September 2021. With limited formal farm credit available in Myanmar, millers extend credit to farmers for inputs, either as cash or in-kind. More than one quarter of millers reported increased demand for credit in June and more than one third reported increased demand in September. About one third of millers reported challenges collecting repayments from farmers in each round. Millers also had difficulties with credit taken in. More than one fifth of millers had challenges acquiring new credit in June and September, while 39 percent had difficulties repaying their credit in June and 32 percent had difficulty in September. The credit challenges have been persistent throughout Myanmar's agri-food system (Boughton et al. 2021), and together with the banking and cash challenges, present a threat to the financial viability of milling.

Transportation restrictions and curfews were also widespread in both survey rounds, reported by 70 percent of millers in June and 58 percent in September. Nearly two-thirds of interviewed millers reported rising transportation costs in each survey. Together with the banking and cash disruptions that hinder buying and selling, these transportation disruptions create friction in Myanmar's rice trade and may lead to higher costs in the value chain's midstream, and, ultimately, to higher prices for consumers.

Importantly, mills were largely able to operate in the study period, albeit at a somewhat lower capacity. In June 2021, 80 percent of interviewed millers were operating, though in September 2021, seasonally the lowest month for rice milling activity, that share fell to 62 percent. Among active mills, monthly throughput in 2021 was 25-36 percent lower on average than in 2020. Yet, the national flow of rice was not choked off completely by mill inactivity during the coup and millers were still able to produce large quantities of Emata rice.

Food vendors also experienced significant disruptions in June and September 2021 (Table 4). We asked vendors if they had experienced any disruptions and about perceived changes in the availability of different food products, including rice, compared to similar periods in previous years. About 28 percent of vendors reported difficulties sourcing products from outside the village and 19 percent experience problems sourcing from local farmers in September. Both of these figures show large increases from June (Table 4). Rice availability was not affected as much with only 2 percent of vendors experiencing a decline in availability in June 2021 and 6 percent in September 2021.

Table 4. Vendor disruptions in food supply and transport, June and September 2021

	June 2021 (%)	Sept 2021 (%)
Food supply		
Local farmer supply difficulties	3	19
Outside village supply difficulties	7	28
Lower availability of some food products	2	11
Lower availability of rice	2	6
Higher prices of some food products	78	79
Transportation disruptions		
Transportation difficulties	3	24
Less transportation available	0	21
Violence in or near village since Feb 1	-	18
N	182	175

Note: Reference period is 30 days prior to interview except for 'Violence in or near village since Feb 1'.
Source: Vendor survey–June and September 2021 rounds.

Nearly a quarter of vendors had transportation difficulties in September and a similar share reported a decline in transport availability. We asked food vendors about fuel and transportation costs for people traveling from their locality to Yangon to understand changes after the coup in the September 2021 survey with recall to prices three months and nine months earlier. We see

substantial increases across the board in the costs of both. Average transport costs to Yangon were 72 percent higher in September 2021 compared to January 2021 (prior to the coup). Lastly, 18 percent of vendors reported violence in or near their village since February 1, 2021.

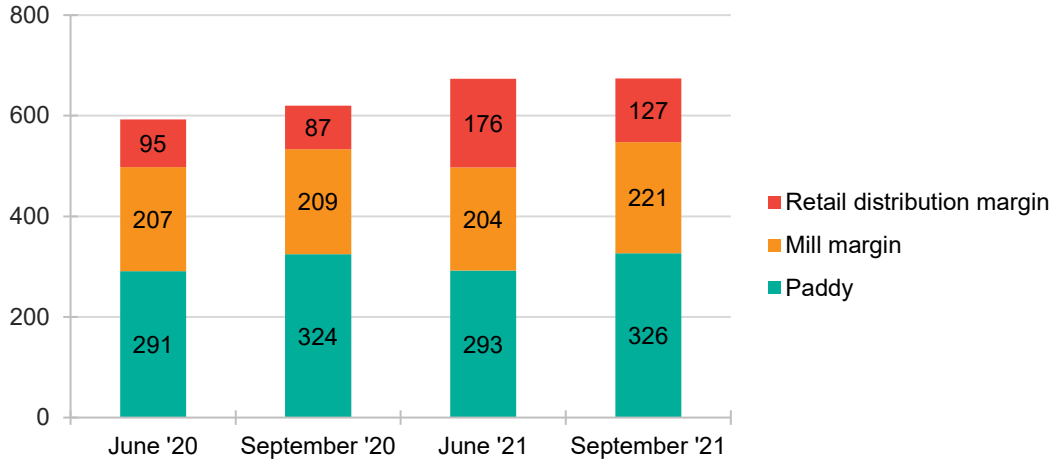
Overall, it is clear that both food vendors and rice millers have not been immune to the widespread impacts of the coup on economic activity in Myanmar (World Bank 2021). Although food availability has not dramatically declined, overall availability of food products may not capture important impacts on food prices. Indeed, slightly less than 80 percent of vendors in both rounds reported higher prices for some food items. It is especially important to understand price changes for paddy and rice as these prices are important for rice producers given their large number in the country and for consumers given the high share of rice in the food consumption basket.

5. RICE PRICE FORMATION IN THE VALUE CHAIN

5.1 Descriptive analysis

Before analyzing regression results, it is informative to explore price changes over time at different points of the rice value chain to see if there have been noticeable changes after the coup (Figure 3). There is a relatively large gap between milled rice prices and paddy prices in each time period, though we note that these price per kg comparisons do not account for the milling conversion of paddy to rice. On average, 100kg of paddy produces roughly 68kg of milled rice. Thus, the actual mill profits are much smaller than the price distributions suggest. The milling margins, defined as the difference between milled rice and paddy prices, do not appear to change much after the coup, consistent with early observations of small changes during the COVID-19 crisis (Goeb et al. 2021). In contrast, the retail distribution margins, defined as the difference between retail and milled-rice prices, are smaller, but noticeably larger after the coup.

Figure 3. Average rice prices in the value chain over time (MMK/kg)



Source: Miller survey–June and Sept 2021 rounds; Vendor survey–June and September 2020, June and September 2021 rounds.

In the rice value chain, the price distributions are narrowest for paddy and widen farther downstream with retail prices having the widest distributions.[10],[11] This effect is at least partly driven by geographical price dispersion as the paddy and milled rice prices are at mills located in the main

[10] Appendix 1 shows kernel density estimations of rice prices at each level of the value chain over time.

[11] Rice price increases can also be highly localized as the military has sometimes prevented additional rice from getting to certain areas drives up rice prices there (e.g. https://www.irrawaddy.com/news/burma/displaced-kayah-civilians-going-hungry-as-myanmar-junta-blocks-supplies.html).

rice growing regions. In contrast, the food vendors are geographically dispersed across the country, with many being far from the main rice growing regions.

5.2 Regression analysis

5.2.1 Margins in the value chain

Analysis of margins through regression analysis confirms these observations (Table 5). Paddy prices increased between June and September in both years, following a normal seasonal trend as supply lowers in September. Yet, the year-on-year changes in each month are remarkably small and insignificant, showing less than 3 MMK/kg increase in 2021 relative to 2020. Similarly, milling margins are mostly stable over time, with small decreases between June 2020 and June 2021. The small increases between September 2020 and September 2021 are significantly different in the fixed effects estimation but represents a less than 5 percent rise relative to one year prior (Table 5, column 2). In contrast to paddy prices and milling margins, average Emata rice retail prices are much higher in 2021 than the same months in 2020, as reflected in the significantly higher retail coefficients in June and September 2021. Retail distribution margins increased by more than 80 and 40 MMK/kg year-on-year in June and September 2021, respectively.

Table 5. OLS estimates of changes in paddy prices and milling and retail distribution margins over time

Dep var=Price (MMK per kg)	(1)	(2)
Constant (June '20, paddy)	291.235***	376.298***
	(1.884)	(2.996)
Sept '20 (paddy)	33.649***	31.642***
	(4.042)	(4.003)
June '21 (paddy)	1.771	1.849
	(2.863)	(1.823)
Sept '21 (paddy)	36.824***	34.017***
	(3.309)	(3.479)
Milled rice (June '20)	228.344***	217.328***
	(4.894)	(4.345)
Milled X Sept '20	-1.089	-1.055
	(6.358)	(4.966)
Milled X June '21	-3.034	-2.72
	(5.385)	(2.057)
Milled X Sept '21	8.728	9.826**
	(5.794)	(4.550)
Retail (June '20)	301.523***	
	(11.805)	
Retail X Sept '20	-4.631	2.862
	(14.416)	(13.853)
Retail X June '21	80.720***	81.125***
	(14.988)	(13.442)
Retail X Sept '21	44.693***	40.810***
	(14.766)	(13.811)
pctBroken	-1.622***	-1.189***
	(0.272)	(0.294)
F-test: Mill X Sept '20=Mill X Sept '21	2.09	11.90***
F-test: Retail X Sept '20=Retail X Sept '21	16.53***	10.61***
Mill and vendor fixed effects	No	Yes
Observations	2,190	2,190
R-squared	0.798	0.793

Note: * p<.1, ** p<.05, *** p<.01. Robust standard errors in parentheses. Mill margin is the difference between milled rice price and paddy price. Retail distribution margin is the difference between retail rice price and milled rice price.
Source: Miller survey–June and Sept 2021 rounds; Vendor survey–June and Sept 2020, June and Sept 2021 rounds.

5.2.2 Spatial price dispersion

With paddy prices and milling margins holding relatively steady over time, the results suggest that Myanmar's inflating rice prices are likely driven by increased marketing costs between mills and

vendors in the value chain.[12] Yet, the simple price comparisons above only provide surface level insight on price formation, and they control for a limited set of potential confounding factors. Table 6 therefore presents results of the second regression models discussed in Section 3.[13] Columns 1, 3, and 5 of Table 6 provide explanatory variables into price dispersion in the rice value chain over time, while Columns 2, 4, and 6 add to that detail fixed effects controls for all time invariant factors at the mill and vendor levels.

Estimations show significant relationships between each distance metric and the log ratio of prices (i.e., price dispersion). An extra 1,000 km of distance between a mill and a vendor is associated with a 6 percent increase in rice price dispersion (Column 1, estimation without fixed effects). Distance through Yangon and travel time estimates between mills and vendors show similar results (Columns 3 and 5). Further, relationships between each of the distance metrics and the log ratio of prices have changed over time. In the full fixed effects estimations, the distance effect on price dispersion in September 2020 was smaller than June 2020 (the reference period), but the estimates in 2021–after the coup–are significantly larger. In other words, after the coup, distances between mills and vendors have had a larger effect on price differences.

With observed seasonality in rice prices in Myanmar, it is important to compare September 2021 to the same period in 2020 (not just to June 2020, as our regression specification does). We do this with an F-test of coefficient equality. In each estimation, the null hypothesis that the impacts of distance are the same is rejected, thereby confirming that year-on-year changes in distance impacts on price dispersion were significantly higher after the coup.

With the importance of rice export markets in price formation, we also test whether distance from a vendor to a land border has differential effects on the log ratio of prices over time. Our regressions show clearly that vendors farther from the border have greater price dispersion (relative to mill prices) in June 2020 (positive and significant coefficients in Columns 1, 3, and 5). To phrase it differently, a vendor that is 1,000km closer to a border crossing has a decrease in price dispersion by 4.5 percent (Column 1). Thus, proximity to a border may have a stabilizing impact on prices through competition for exports.

The evolution of the estimates of distance to border over time reveal the importance of border exports in rice price formation. The estimated relationships to price dispersion are much larger in both September 2020 and June 2021, both times when border trade was largely operating smoothly. Estimates are lower in June 2020 and September 2021, both times when border trade was slowed or halted altogether to prevent transmission of COVID-19. In the estimations with fixed effects, a vendor 1,000km closer to a border crossing had approximately 18 percent lower price dispersion in September 2020 and June 2021 relative to June 2020. Estimates for September 2021 are also significantly higher than those for June 2020, but the effect size is about 40 percent smaller.

In addition to the distance and spatial price formation effects, the regression estimates also present evidence that violent events increase price dispersion between mills and vendors. In the specifications without fixed effects, an additional 10 violent events in the month-of and month before the price measurement is associated with a 1 and 2 percent increase in price dispersion at the mill and vendor levels, respectively (5 of 6 coefficients are significant). The impact of 10 violent events is approximately equivalent to 167-333 km of distance between mills and vendors. In the fixed effects estimations, the coefficients for vendor township violence are lower and no longer significant, but miller township violent events show similar effect sizes and continue to be significant.

Finally, we find no evidence that the main ethnic groups in miller and vendor townships affect price formation between mills and vendors. The coefficient for the indicator variable of same ethnic

[12] See appendix 2 for a comparison with prices in export markets.

[13] Robustness checks are shown in Appendix 3.

group is insignificant in each regression, in contrast to findings in other settings (Aker et al. 2014, Robinson 2016). However, this does not imply that ethnicity is unimportant in rice price formation in Myanmar's value chain. Millers and food vendors are linked through (sometimes long) networks of traders and dealers, thus the main ethnic group in the area surrounding each mill and vendor may not capture ethnicities of specific actors on either side of a particular transaction along the value chain. This issue deserves further investigation.

Table 6. OLS and Fixed Effects estimates of distance relationships to price dispersion between rice mills and food vendors

Dep var = |ln(Pvendor/Pmiller)|	(1)	(2)	(3)	(4)	(5)	(6)
Sept '20	-0.066***	-0.082***	-0.056***	-0.081***	-0.022***	-0.056***
	(0.002)	(0.009)	(0.002)	(0.007)	(0.002)	(0.008)
June '21	0.028***	-0.006	0.016**	-0.026	0.062***	0.001
	(0.005)	(0.012)	(0.004)	(0.014)	(0.006)	(0.008)
Sept '21	0	-0.062***	0.01	-0.070***	0.030***	-0.055***
	(0.004)	(0.006)	(0.004)	(0.005)	(0.005)	(0.008)
Distance	0.059***	-0.015				
	(0.004)	(0.014)				
Distance X Sept '20	-0.007***	-0.008*				
	(0.001)	(0.003)				
Distance X June '21	0.020***	0.030**				
	(0.003)	(0.008)				
Distance X Sept '21	0.010***	0.038***				
	(0.002)	(0.006)				
Dist_Yangon			0.056***			
			(0.002)			
Dist_Yangon X Sept '20			-0.018***	-0.008		
			(0.001)	(0.005)		
Dist_Yangon X June '21			0.040***	0.058***		
			(0.001)	(0.008)		
Dist_Yangon X Sept '21			0.001	0.047***		
			(0.001)	(0.004)		
Travel time					0.007***	0.000
					(0.000)	(0.001)
Travel time X Sept '20					-0.004***	-0.002***
					(0.000)	(0.000)
Travel time X June '21					-0.002***	0.001**
					(0.000)	(0.000)
Travel time X Sept '21					-0.002***	0.002**
					(0.000)	(0.000)
Dist_border	0.045***		0.039***		0.068***	
	(0.001)		(0.000)		(0.001)	
Dist_border X Sept '20	0.096***	0.177***	0.090***	0.177***	0.072***	0.158***
	(0.002)	(0.025)	(0.003)	(0.024)	(0.003)	(0.024)
Dist_border X June '21	0.089***	0.184***	0.087***	0.185***	0.074***	0.178***
	(0.007)	(0.018)	(0.006)	(0.019)	(0.009)	(0.016)
Dist_border X Sept '21	-0.023**	0.107***	-0.034***	0.103***	-0.036**	0.102***
	(0.006)	(0.018)	(0.006)	(0.017)	(0.007)	(0.016)
Mill violent events (twp)	0.001*	0.001*	0.001	0.001*	0.001**	0.001**
	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	0.000
Vendor violent events (twp)	0.002***	0.001	0.002***	0.001	0.002***	0.001*
	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)
Major ethnic group same (twp)	0.009	0.002	0.008	0.002	0.011	0.002
	(0.007)	(0.002)	(0.007)	(0.002)	(0.008)	(0.002)
Percent broken	0.003**	0.002**	0.002**	0.002**	0.003**	0.002**
	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)
Constant	0.131***	0.194***	0.130***	0.187***	0.084**	0.186***
	(0.014)	(0.006)	(0.013)	(0.006)	(0.015)	(0.009)
F-test: Distance X Sept '20 = Distance X Sept '21	222***	31**	701***	41***	631***	65***
F-test: Dist_border X Sept '20 = Dist_border X Sept '21	996***	26**	1409***	27**	657***	16**
Mill and vendor fixed effects	No	Yes	No	Yes	No	Yes
Observations	126,679	126,679	126,679	126,679	125,193	125,193
R-squared	0.119	0.602	0.122	0.603	0.127	0.609

* p<.1, ** p<.05, *** p<.01. Standard errors in parentheses clustered by time period. Distance metrics dropped in columns (2), (4), and (6) for collinearity with fixed effects. 'Distance' = distance between miller and vendor ('000 km). 'Dist_Yangon' is distance between miller and vendor through Yangon ('000 km). 'Travel time' is the travel time between miller and vendor (hours). 'Dist_border' is the vendor distance to nearest land border ('000 km). 'twp' = Township.
Source: Miller survey - June '21 and Sept '21 rounds; Vendor survey - June '20, Sept '20, June '21 and Sept '21 rounds.

6. DISCUSSION

Our results point clearly to increasing distribution margins and higher rice price dispersion between mills and food vendors in Myanmar after the military coup on February 1, 2021. The relationships between distance and price dispersion have increased, implying that the price gap between mills and vendors has widened especially for those food vendors further away from major rice producing and milling regions, resulting in increased prices for consumers especially in these more remote regions. The increased distribution margins are explained by two primary factors.

First, transportation is less secure and generally more difficult after the coup. Violence significantly increases price dispersion in our estimations. Transportation restrictions and curfews at different administrative levels–enforced at unpredictable times and locations–add friction to the intranational transit of rice. In September 2021, almost 30 percent of the food vendors indicated problems with acquiring food supply from outside the village, the highest value in all the surveys fielded in the 1.5 years prior. Second, fuel prices in Myanmar increased sharply following the military coup. While this partly reflects changes in international oil prices, the depreciation of the MMK, international trade and logistical port problems, and issues with the local distribution of fuel further exacerbated that increase.

The widening distribution margins in Myanmar's rice sector following the military coup have important implications for consumers and producers alike. Other things equal, consumers pay higher prices for rice, and a smaller share of the retail rice price is passed through the value chain to producers, who receive lower prices than they would have had with a more fluid supply chain mid-stream. We simulate welfare costs of these market disruptions in a simplified partial-equilibrium framework in Table 7.[14]

Table 7: Economic costs of increased distribution costs

		Parameters	Elasticity scenarios	
		Supply elasticity ε_s	0.05	0.30
		Demand elasticity ε_d	0.37	0.37
Variables	Units	Observed in 2020		
Producer price	USD/ton	362	327	341
Consumption price	USD/ton	431	437	451
Marketing margin	USD/ton	69	109	109
Production	Million tons	12.6	12.5	12.4
Exports	Million tons	2.3	2.3	2.3
Consumption	Million tons	10.3	10.2	10.1
Change consumer surplus (CS)	Million USD		57	202
Change producer surplus (PS)	Million USD		437	256
Economic costs	Million USD		494	458

Source: Authors' calculations

The aim of this exercise is to estimate the costs of local output market disruptions, with everything else held constant. This is obviously an unrealistic assumption as there have been changes in international prices and in local supply and demand conditions (UNDP 2021, Boughton et al. 2021).

[14] We take as the base scenario the situation in 2020. In the short run, supply will not adjust but in the medium run, it will because of changed prices. We use average prices and increases in marketing margins over the two periods considered (average of increases in June and September 2021 compared to the same months in 2020). Production estimates are those from USDA (2021b). Exchange rates used are 1,500 MMK/USD.

However, this assessment might be informative in illustrating the economic impact of those output market disruptions on their own. To do this simplified assessment, we follow Dorosh et al. (2019) and assume fixed exogenous exports and endogenous local price levels and rely on similar short- and medium-run supply and demand elasticities. The simulations illustrate the impact of the increased output market inefficiencies on consumer and producer surplus. In either scenario, the economic welfare costs of the output market disruptions to producers and consumers combined are estimated to amount to almost 0.5 billion USD over a full year.

7. CONCLUSIONS

This paper studies Myanmar's rice value chain during a tumultuous period, after a military coup and during continued challenges from COVID-19. These events caused significant disruptions for food vendors and especially rice mills, a crucial node in the value chain. Still, we see signs of significant resilience. Food vendors indicated that rice availability was not substantially lower than normal. Rice millers, for their part, adapted to the large banking disruptions with increased reliance on cash as well as 'hundi' payments. Rice milling margins were mostly stable over the study period. Nevertheless, despite the resilience of agri-food system actors, consumer rice prices significantly increased after the coup. In particular, price gaps widened between mills and food vendors, and increasingly so as distances increased, likely driven by transportation restrictions and rising fuel costs. Violent events also increased price dispersion in our data.

Proximity to export markets further decreases price dispersion, though the effect diminishes when border trade and movement is restricted. In months when border trade was operating smoothly, proximity to a border is linked with lower price dispersion, suggesting that ties to export markets can anchor rice prices. However, in the months when borders were partially closed and trade was disrupted, the relationship weakens and proximity to borders has a smaller impact on price dispersion. These results highlight the importance of maintaining open borders in food markets, perhaps especially so during times of crisis. The results overall indicate that the most severe effect of the coup on retail prices were found in the most isolated areas further away from export opportunities and from the major production zones in the country and that were affected by violence.

Our focus in this paper is narrow–the short-term impacts on Myanmar's rice value chain. Although rice is an important global commodity and Myanmar's most important crop for local consumers and farmers alike, future research should expand the scope and analyze political upheaval impacts on other commodities and in other contexts. Further, the medium- and longer-term impacts of the coup remain to be seen on agricultural market functioning. In particular, rising costs of inputs – especially fertilizer – along with persistent credit challenges (Boughton et al. 2021) pose serious threats to farm production and the agri-food system more broadly in the medium- and longer-terms. Future research should therefore assess and monitor persistent impacts of the coup.

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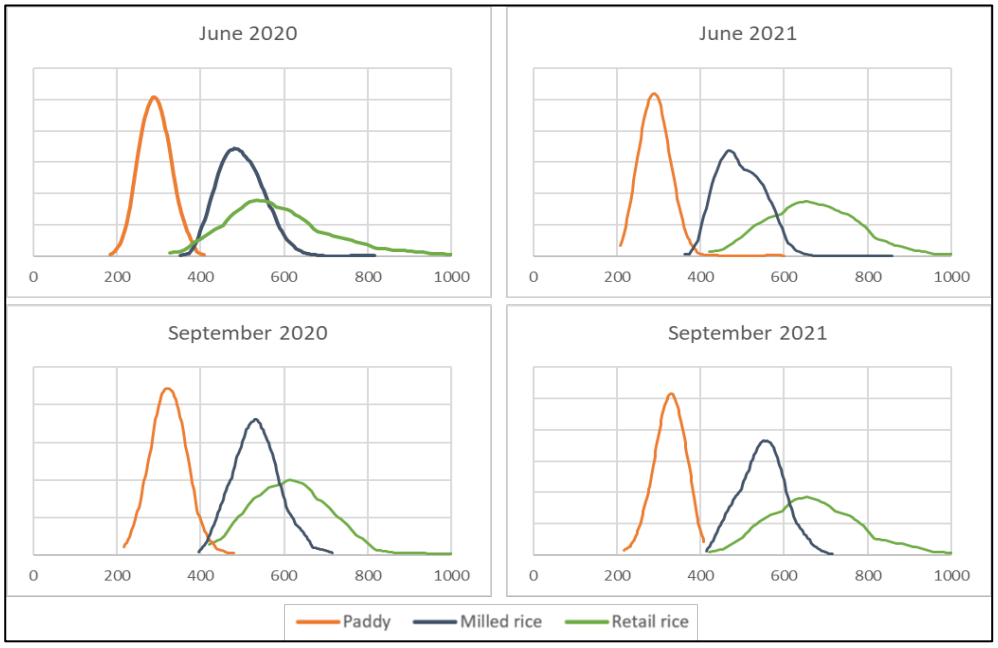
APPENDIX

Appendix 1. Rice price distributions

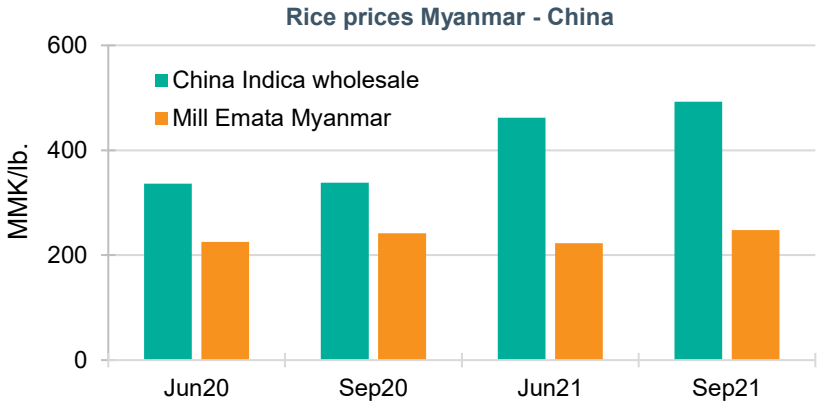
Figure A1. Emata rice price distributions in the value chain over time (MMK/kg; kernel density estimations)



Appendix 2. Rice prices in Myanmar and China

To understand what changes have happened with respect to export markets, we compare Myanmar's Emata rice prices with rice prices in China given that China is typically the major export destination of Burmese rice (USDA 2021a, Diao et al. 2021). We use the Chinese national wholesale price for Indica as the reference. While Myanmar typically exports low-quality rice to China and the wholesale price of Indica might therefore be a bad benchmark, it should however be a reference point for rice market behavior in China. That comparison is shown in Figure A1. We see that the gap between the Myanmar mill price and the Chinese wholesale market price has significantly grown since the coup, indicating the increasing transaction costs of doing trade and confirming the increasing marketing margins for local trade and international trade.

Figure A2: Average price differences with the main export market



Source: Vendor survey MAPSA and Fewsnet (https://fews.net/)

Appendix 3: Robustness check

Table A1. Robustness check: Mill-vendor pair fixed effects estimates of distance relationships to price dispersion between rice mills and food vendors

Dep var = |ln(Pvendor/Pmiller)|	(1)	(2)	(3)
Sept '20	-0.083***	-0.076***	-0.057***
	(0.010)	(0.009)	(0.010)
June '21	0.001	-0.017	0.009
	(0.013)	(0.016)	(0.012)
Sept '21	-0.061***	-0.062**	-0.055**
	(0.009)	(0.012)	(0.013)
Sept '20 X distance	-0.004		
	(0.004)		
June '21 X distance	0.021**		
	(0.007)		
Sept '21 X distance	0.037***		
	(0.006)		
Sept '20 X dist_Yangon		-0.013	
		(0.007)	
June '21 X dist_Yangon		0.047***	
		(0.006)	
Sept '21 X dist_Yangon		0.037**	
		(0.010)	
Sept '20 X Travel time			-0.002**
			(0.001)
June '21 X Travel time			0.001*
			0.000
Sept '21 X Travel time			0.002**
			(0.001)
Sept '20 X dist_border	0.181***	0.178***	0.162***
	(0.021)	(0.020)	(0.020)
June '21 X dist_border	0.189***	0.191***	0.182***
	(0.020)	(0.022)	(0.018)
Sept '21 X dist_border	0.114***	0.107***	0.109***
	(0.014)	(0.013)	(0.015)
Mill violent events (twp)	0.001*	0.001	0.001**
	0.000	0.000	0.000
Vendor violent events (twp)	0.002	0.001	0.002
	(0.001)	(0.001)	(0.001)
Percent broken	0.002**	0.002**	0.002**
	0.000	0.000	0.000
Constant	0.183***	0.183***	0.181***
	(0.007)	(0.007)	(0.007)
F-test: Sept '20 X Dist = Sept '21 X Dist	33**	39***	97**
F-test: Sept '20 X dist_border = Sept '21 X dist_border	15**	15**	9*
Mill-vendor pair fixed effects	Yes	Yes	Yes
Observations	102,096	102,096	100,740
R-squared	0.638	0.639	0.643

* p<.1, ** p<.05, *** p<.01. Standard errors in parentheses clustered by time period. Distance metric levels and ethnicity variable dropped for collinearity with fixed effects. 'Distance' = distance between miller and vendor ('000 km). 'Dist_Yangon' is distance between miller and vendor through Yangon ('000 km). 'Travel time' is the travel time between miller and vendor (hours). 'Dist_border' is the vendor distance to nearest land border ('000 km). Mill-vendor pairs with only one time period dropped due to fixed effects.

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