IFPRI Discussion Paper 02021

May 2021

**Effects of COVID-19 Restrictions on Mechanization Service Providers
and Mechanization Equipment Retailers**

Insights from Phone Surveys in Myanmar

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Abstract

COVID-19 continues to plague global food security not only directly through health effects but also indirectly through responses that restrict key economic functions of the agri-food sector. Despite the growing literature on the effects of COVID-19 on the agri-food sector, evidence on certain players like mechanization service providers (MSP) and mechanization equipment retailers (MER) remain scarce. This study provides insights into the effects of COVID-19 restrictions on MSP and MER in Myanmar, where the majority of MSP and MER are relatively new and potentially vulnerable to these economic shocks, using an unbalanced panel data from five rounds of phone surveys. We find that direct responses to COVID-19 involving movement restrictions, as well as disruptions in the market that led to increased cost and reduced availability of machinery and equipment, and growing financial challenges, had significantly negative effects on revenue prospects, service delivery, sales of machines and equipment by MSE and MER. Our analyses based on rare multi-round surveys during a single production season also reveal important dynamics in MSP's decision-making; negative revenue prospects at particular period can further hurt revenue prospects in subsequent periods, which is consistent with the hypotheses that agents like MSP who had incurred significant sunk-cost in machines can engage in more desperate and thus potentially suboptimal business practice to recover the sunk-cost. This may result in a vicious cycle of declining revenues in the future in the face of shocks like COVID-19. Overall, evidence suggests that, policies to minimize movement restrictions, various financial support, and mitigate any pessimism at the beginning of production season are all important to make sure MSP and MER continue to function effectively during the COVID-19 pandemic that persists in 2021.

Keywords: Mechanization service provider, mechanization equipment retailers, COVID-19, Myanmar

Acknowledgments

We would like to thank the United States Agency for International Development (USAID), Livelihoods and Food Security Trust Fund (LIFT), Michigan State University, International Fund for Agricultural Development, and the CGIAR Research Program on Policies, Institutions, and Markets (PIM), which is led by the International Food Policy Research Institute (IFPRI) and carried out with support from the CGIAR Trust Fund, for providing financial support to conduct this study. Authors also benefited from dialogues with Ben Belton, Xiaobo Zhang, Scott Justice, Bart Minten, Duncan Boughton, Xinshen Diao. Authors are responsible for the remaining errors.

1 Background

The COVID-19 pandemic and measures to contain its spread have had serious effects on society and the economic functions of small businesses, including those in the agri-food sector (IFPRI 2020a; Laborde et al. 2020; Bartik et al. 2020). These preventative measures, combined with the direct health effects of the disease, are expected to have significant adverse effects on global food security and economic livelihood in the short-, medium- and long-term. As the pandemic persists, it remains critical that policy measures to contain the spread of COVID-19 are developed in ways that effectively support the agri-food sector. An understanding of the effects of these preventative measures on actors in the agri-food sector is integral to the policy making process.

Despite the growing literature on the effects of COVID-19 on the agri-food sector, evidence on key actors like mechanization service providers (MSP) and mechanization equipment retailers (MER) remains scarce. MSP, who provide custom-hiring services to farmers, and MER, who sell machines, attachments and spare parts, have distinct characteristics that are different from other inputs and service providers in the agri-food sector. In developing countries, land preparation, harvesting, and other farm operations have increasingly become mechanized (Diao et al. 2020). Mechanical power has the potential to reduce the drudgery for rural workers, including women and children, and the non-farm economy more broadly, and is an important input in food production.

A key question on how COVID-19 restrictions on movement and sales practices have impacted MSP and MER remains. Movement restriction may not have constraining effects on MSP if mobility of machines is inherently low. MSP would only serve local customers as observed for tractors in Asian countries decades ago (e.g., IRRI 1983) and some African countries (Takeshima et al. 2015). However, if the mobility is sufficiently high, movement restrictions can be binding constraints. Equivalently, if disruptions to the acquisition of machines, equipment, attachments occur prior to or early in the production season, or late in the season, changes to market conditions may have less effect on MSP or MER. However, these effects may be more severe if machines, equipment, or attachments continue to be acquired during the production season.

Another key question is how sudden changes in revenue prospects for the upcoming production season affect MSP business practices, particularly the desperate, suboptimal use of their machines, to recover sunk costs. These risky practices may result in a vicious cycle where machines may be inoperable for period of time further reduce revenues in the medium-term. Support may need to be provided early, when a pessimistic outlook exists, to mitigate risky business practices associated with sunk costs for similar shocks in the future.

This paper aims to fill some of these knowledge gaps by providing insights from multi-round phone surveys administered to MSP and MER in Myanmar in 2020 and early-2021. Given the relatively high-frequency of survey rounds, which is quite rare for MSP and MER, we assess the dynamic effects of revenue prospects in the early period on those in subsequent periods. Myanmar is also a particularly suitable country to assess these effects as growth of MSP and MER has occurred quite recently (Belton et al. 2017, 2018, 2019; Win et al. 2020), compared to many other Asian countries. Therefore, Myanmar can be more fragile and less resilient to shocks like COVID-19 than other Asian countries where the sector is more mature.

Moreover, this study contributes to the growing literature on the effects of COVID-19 on the agri-food sector (IFPRI 2020a), including in Myanmar (Boughton et al., 2021), and on agricultural mechanization, mechanization service provisions and mechanization equipment retailers in developing countries (e.g., Takeshima et al. 2015, 2018, Diao et al. 2020), and in Myanmar

(Belton et al. 2017, 2018, 2019; Win et al. 2020). The study also adds to the literature on the effects of sunk costs on dynamic decision-making (e.g., Staw 1976; Dawes 1998).

This paper is structured in the following way. Section 2 describes the data and descriptive statistics. Section 3 describes empirical analyses and methodologies. Section 4 presents and discusses results. Lastly, Section 5 concludes.

2 Empirical analyses

Our empirical analyses consist of the static and dynamic aspects of the association between COVID-19 related restrictions, indirect effects on the market and financial challenges, and perceptions by MSP and MER.

2.1 Static effects of COVID-19 restrictions on perceptions by MSP and MER

Our first set of analyses investigate the associations between a range of prospects on business outcomes and challenges, coping mechanisms pursued, and preferences on different policies by MSP and MER, and indicators of restrictions or disruptions as direct or indirect outcomes of COVID-19 containment measures taken by the government in 2020.

Specifically, we estimate

$$y_{it} = \alpha + c_i + \beta x_{it} + \varepsilon_{it} \quad (1)$$

where variables y_{it} include various outcome indicators of interests for respondent i at survey round t , x_{it} are a set of time-variant exogenous variables related to the COVID-19 restrictions or disruptions. Parameters β are a set of coefficients on the associations between y_{it} and x_{it} . Parameters α , c_i , and ε_{it} are estimated intercept, respondent-specific fixed effects that are unobserved and time-invariant, and idiosyncratic error terms, respectively.

Outcome variables

Variables y_{it} generally include several categories of outcomes for both MSP and MER; (a) revenue and profit prospects from their respective business for the current production season, measured as 1 if the prospects are worse than the same season during the previous year, and 0 otherwise; (b) facing business challenges (1 if yes and 0 otherwise), including the inability to deliver existing orders, inability to get loans extended, facing disruptions in their logistics, insufficient protective equipment, and whether facing any of these collectively; (c) pursuing a particular coping mechanism to deal with business and financial challenges (1 if yes and 0 otherwise), including seeking loans from the government, seeking loans from commercial banks, seeking loans from other private individuals, liquidating business assets, or reallocating earning from other income sources, whether reducing operating costs, new inventory or maintenance and repairs (exact set of outcomes differ between MSP and MER depending on their relevance); (d) preferring particular set of policies to mitigate the negative effects associated with COVID-19-related restrictions and disruptions (1 if yes and 0 if otherwise), including reduction of taxes / fees, reduction of financing costs / loan extension / debt relief, reduction of rent / utility for business assets like warehouse or shops, easing of movement restrictions of machines across regions, reduction of social insurance premiums for employees, or general support to farmers that can indirectly support MSP and MER. For MSP, the set of policies also include those that allow nonfarm use of machines, keep machine / parts shops open, or expansion of loans for small-enterprises. Furthermore, an additional set of outcome variables for MSP include the efficiency of service provided

(timeliness), and the emergence of new financial problems. An additional set of outcome variables for MER include the perceptions of severe sales reduction of different machines and equipment.¹

Exogenous variables

Variables x_{it} include the following set of time-variant exogenous variables. The first set of variables include restrictions on business-related spatial movement, specifically (a) whether facing movement restrictions of various types (1 if yes and 0 otherwise) including, movement restrictions within village tracts (for MSP), within townships, within states or regions, or movement restrictions within any other arbitrary boundaries set by the local authorities. For MER, related variables also include whether facing bans on a certain mode of sales activities (1 if yes and 0 otherwise), including in-store sales, store-front sales, or sales through deliveries. The second set of variables relate to the local market conditions which are likely to have been affected indirectly by COVID-19 measures, including (b) whether the market prices are higher than those during the same period in the previous year for machines and equipment transacted by MER or used by MSP, and whether the availability of these machines and equipment is less than that during the same period in the previous year. The third set of variables include exogenous financial challenges experienced by the respondent at each survey round, including (c) whether the respondent is still indebted to the formal sector lenders like dealers or banks (for MSP), whether the respondent is facing loan or credit repayment requirement that cannot be extended, whether the respondent is facing more requests for late-payment from customers compared to the same period in the previous year, whether the respondent is facing imminent exhaustion of financial assets within 3 month based on the current rate of cash-flow (for MSP).

Variables x_{it} also include rainfall level relative to the historical norm, measured as the percentile with respect to the rainfall distribution in the corresponding month of the survey in the past 40 years. Measuring in this way can assess the level of current rainfall by considering historical median and variations, and has been used in past studies (e.g., Takeshima et al. 2020a).

Variables x_{it} also include survey round dummy variables to capture specific effects common to all respondents at each survey round, as well as their interactions with a few key time-invariant variables, which can capture heterogeneity in these survey-round specific effects. For MSP, these time-invariant variables include their home states/regions, whether providing tractor-based mechanization-service or not (which can be land preparation in the plant season, and transportation during the harvesting season), and how many years they have been in their business. For MER, these time-invariant variables include whether the MER is based in the Irrawaddy Delta and surrounding states/regions (Ayeyarwady, Yangon and Bago regions) or not, whether selling four-wheel tractors or not, and whether franchise dealers or not.

Given that our surveys were entirely phone-based where in-depth probing of quantitative information is challenging, most outcome variables and explanatory variables are measured as binary variables. While the nature of measurements for the outcome variables may be somewhat limiting, covering a number of outcome variables keeps our insights informative regarding how MSP and MER have been affected under COVID-19 restrictions and disruptions, and what types of policies may be effective for them in the upcoming production season in 2021.

¹We define sales reduction of more than 20 percent compared to the previous year as “severe”, based on interactions with several mechanization sector stakeholders in Myanmar.

2.2 Dynamics of MSP revenue prospects under COVID-19 restrictions

Our second set of analyses focus on the dynamic effects, as was described briefly in the introduction section. Specifically, we assess the dynamic effects of having more pessimistic revenue prospects at the beginning of production season, on the subsequent seasons, and potential pathways.

MSP, relative to some of the other service providers in the agri-food sector, can be characterized as having high sunk costs incurred on capital assets, including machines they had purchased outright or had invested significant payments toward eventual ownership. The presence of sunk costs in the face of economic crises like COVID-19 restrictions is an important issue. The potentially negative effects of sunk costs incurred on assets on the economic efficiency of the agents in the subsequent period have long been discussed in the literature (e.g., Staw 1976; Dawes 1998). In the case of MSP, one of the related hypotheses is as follows; faced with reduced revenue prospects from service provisions under COVID-19 restrictions, MSP may resort to more desperate uses of their machines, such as using machines on poorer-than-desired farm conditions, servicing farmers at a further distance, servicing smaller groups/acreages at a time, excessively reducing service fees, or accepting more late payments (thus taking risks on payment recovery), to recover the sunk costs. While a rational decision would be to instead either reduce the use of machines to the level where marginal returns are higher than true marginal costs of using the machines for service, or to liquidate machines altogether if necessary. Desperate use of machines can lead to lower-than optimal revenues in the long run. While it may increase short-term earning, it can forego higher-earning that could have been made in the future if machines were not used desperately during the current period and kept in better condition. In such a case, having a negative revenue prospect can result in lower revenues prospects in subsequent periods, leading to a vicious cycle where MSP may make more desperate decisions to continue to recover their sunk costs.

Of course, sunk costs may not lead to these behaviors. For example, if machine markets are highly efficient where machines can be easily resold and sunk costs can be easily recovered. In such a case, negative revenue prospects in the current period should have a limited effect on the revenue prospects on subsequent periods. The dynamic effects of negative revenue prospects on MSP are, therefore, empirical questions that are worth testing.²

Empirical estimation of dynamic effects

We empirically test this hypothesis in dynamic-panel estimation method:

$$y_{it} = \alpha + c_i + \gamma y_{it-1} + \beta x_{it} + \varepsilon_{it} \quad (2)$$

²We do not engage in an in-depth investigation of the relationship between sunk cost and their effects on subsequent behaviors. We, however, show some examples in the case of MSP in developing countries, because they are somewhat unique in terms of the importance of sunk costs associated with their key business capital asset (machines), and yet the evidence is scarce. Testing this for MSP in Myanmar is also important, as it informs policymakers of the importance of supporting actors like MSP psychologically at an appropriate timing during a crisis such as COVID-19 related economic disruption and restrictions.

in which the set of notations indicate the same set of variables and parameters from the static panel data method (1). The additional parameter γ measures the dynamic effects on dependent variable y_{it} .³

This class of dynamic models, like (2), tend to suffer from potential endogeneity problems, including that between y_{it-1} and c_i , that can lead to the classical dynamic panel bias (Nickell 1981). We therefore employ Generalized Methods of Moment (GMM)-based estimation methods for (2) which can mitigate the effects of potential endogeneity associated with parameter γ , developed by Arellano & Bond (1991), and further by Blundell & Bond (1998). We present the results of the Blundell & Bond (1998) estimator (also known as the “System GMM” estimator (Roodman & 2009)). We also demonstrate that the results are robust across two major types of GMM estimations methods (one-step GMM and two-step GMM estimators) within the System GMM estimator.

3 Data and descriptive statistics

3.1 Dataset and sample size

The data used in this study consist of 5 rounds of an unbalanced panel data of MSP interviewed in May (round-1), June (round-2), July (round-3), November (round-4), and December 2020 (round-5), and MER interviewed in May (round-1), June (round-2), July (round-3), November (round-4), and January 2021 (round-5). Rounds 1 – 3 typically fell on land preparation and planting season, while rounds 4 – 5 fell on harvesting seasons. Both MSP and MER were purposively sampled, using the contact information obtained from previous studies (Belton et al. 2017, 2018, and 2019), as well as snow-balling methods.

The sample size for MSP and MER surveys across rounds and across different categories are presented in Table 1. In total, we ended up with 1,494 observations from the MSP survey and 372 observations from the MER survey. Among them, 89 MSP and 42 MER were single-round observations. There are 1,405 for MSP and 330 for MER observations who responded to at least two rounds, which will be primarily used in our analyses. Among these observations, approximately 2/3 are tractor service providers (T-SP) and 1/3 are combine-harvester service providers (CH-SP), with a small fraction of threshers, reapers and other machines. Among MER, slightly more than half are handling four-wheel tractors (4wt) together with other equipment, while the rest handle only other equipment.⁴ Among MSP, the composition of T-SP and CH-SP also varies between round-3 and round-4, where major farm operations switch from land preparation or planting activities to harvesting, and we therefore split of the analyses accordingly.

Rainfall data

The primary data is complemented by monthly rainfall data at the township levels for the year 2020 and historical data since 1980 from the Climate Hazards group Infrared Precipitation with Stations (CHIRPS) (Funk et al. 2015). Averages are extracted for the rainfall data at ward/townships levels of respondents’ locations in Myanmar.

³While equations (1) and (2) are different, the validity of one does not invalidate the other. Rather, while (1) can be viewed as a reduced-form, (2) can be viewed as a structural equation, each modeling the relations between y and x while focusing on different aspects of these relations.

⁴Other equipment handled by MER included combine harvesters, power tillers, attachments like disc-plow / rotary tillers, reapers, threshers, water pumps, and spare parts.

3.2 Descriptive statistics

Table 2 and Table 3 summarize the descriptive statistics of the outcome variables y for MSP and MER, respectively. Overall, these suggest that the majority of MSP and MER interviewed had experienced unfavorable outcomes (or perceptions thereof). Note that, most MSP and MER reporting “No” (other than coping methods and policy preferences) indicated “no change” from the previous year, rather than any “improvement”. Therefore, for those variables, values > 0 would generally suggest that average conditions lean toward negative outcomes (for details of descriptive statistics from each round, see Takeshima et al. (2020b-2020i) and Takeshima et al. (2021a, 2021b)). About 64 of MSP and 61 percent of MER reported reduced revenues compared to the same period in the previous year, and a significant fraction of them also reported revenue reductions of more than 10 percent, and a higher rates of revenue reduction than cost reduction which result in reduced profit.

A significant fraction of MSP and MER also reported emerging financial challenges, and business challenges. A significant share of MSP reported delays in service provision compared to the previous year, and a significant share of MER reported a more than 20 percent drop in the sale of machines and equipment compared to the same period in the previous year. MSP and MER also resorted to diverse coping methods, indicating heterogeneous responses. Lastly, MSP and MER reported a relatively diverse set of preferences for policy measures to mitigate the negative effects of COVID-19 disruptions.

Table 4 summarizes the descriptive statistics of explanatory variables x for MSP and MER. A majority of MSP and MER indicated that they faced restrictions in movement either within state/region, township, or even within villages (MSP), or other geographical boundaries defined by the local authority (MER), or other types of restrictions for moving machines and equipment (MSP). A fraction of MER faced complete bans against selling machines or equipment in-store, at store-front, or through delivery. Approximately 18.5 of MSP and 37.6 percent of MER faced either higher prices or reduced availability of machines they had to acquire. While not shown, these patterns were highly correlated with similar market conditions for attachments and spare parts (both imported and locally manufactured). A significant share of MSP and MER also faced a range of financial challenges at the beginning of each survey round, including indebtedness, loans that could not be extended, greater credit demand from customers, and risk of imminent exhaustion of financial assets for their business. Lastly, MSP and MER were generally in areas where rainfall leading up to the time of the survey had been less than the historical standard (on average around 30 percentile of historical rainfall distribution).

Descriptive statistics of time-invariant variables suggest that, approximately 45 percent of MER respondents were franchise dealers who had a stronger tie with the suppliers and selling particular brands of machines. About half of MER were in Delta or Bago regions and most MSP were either in the Delta and Bago regions or Dry Zone (Magway, Mandalay and Sagaing regions). On average, MSP have been in business since 2015, while MER have been in business since 2009.

4 Results

4.1 Static effects of COVID-19 restrictions on perceptions by MSP and MER

Table 5 through Table 9 summarize the results of COVID-19 restrictions on the outcomes of MSP. Similarly, Table 10 through Table 14 summarize the results for MER. Note that, standard errors reported account for potential serial correlation across respondents and across

township clusters, through the multiway clustering method in panel data analyses (Cameron et al. 2011).⁵

4.1.1 MSP

Movement restrictions

Mechanization services constrained to movement within the village, township, or state/regions had significantly negative effects. These included a greater likelihood of having prospects for moderate to severe revenue losses (Table 5), less timely delivery of mechanization services, or financial status of MSP (Table 6), and a greater likelihood of facing a range of business challenges (Table 7). These effects do not hold for all aspects of outcomes, partly because tractors generally tend to operate in a smaller geography in the first place (e.g., IRRI 1983; Takeshima et al. 2015). However, other machines like combine-harvesters tend to have greater mobility in developing countries (e.g., Diao et al. 2020; Zhang et al. 2017). Overall, the negative effects are still significant for a range of outcomes, suggesting that movement restrictions imposed as COVID-19 containment measures still had substantially large economic effects for MSP.

Higher price or reduced availability of machines, attachments and spare parts

Increased prices or reduced availability of machines, attachments, spare parts, as a result of indirect outcomes of COVID-19 restrictions, had negative effects on many of these outcomes as well. These included negative effects of the revenue and profit prospects (Table 5), less timely delivery of mechanization services, or financial status of MSP (Table 6), and a greater likelihood of facing a range of business challenges (Table 7).

Coping mechanisms

MSP pursued different coping mechanisms, which varied depending on the type of restrictions (Table 8). MSP facing movement restrictions generally resorted to seeking loans from the formal sector including government and commercial banks, or through asset sales. This may be because MSP expected that governments or the formal sector may offer compensation for movement restrictions that were imposed as COVID-19 mitigation measures. In contrast, MSP facing reduced availability of machines and equipment pursued loans from private individuals, possibly because these loans would not require additional compensation (i.e. interest payments). Those facing a more imminent exhaustion of financial capital were also more likely to seek formal sector loans. MSP who did not receive loan extensions, clearly resorted to other means such as the use of other incomes or asset sales to compensate. This suggest that the combinations of movement restrictions effects on machine markets and other types of financial challenges have led to significant heterogeneity in coping mechanisms pursued by MSP.

MSP Policy Preferences

MSP expressed preferences for different types of policies depending on the types of restrictions and challenges they face (Table 9). MSP facing greater movement restrictions generally prefer financial support policies focusing on the reduction of taxes/fees, or rent/utilities, that

⁵We also estimated separate models accounting for certain cross-sectional dependence using methods by Driscoll & Kraay (1998), implemented by `xtscc` command in STATA (Hoechle 2007). These estimates generally lead to more statistically significant results. Therefore, our main results presented here are more conservative estimates in terms of statistical significance.

can generally reduce financial burdens. Given the general pessimistic revenue prospects, these MSP may not have been interested in financial support that involves additional loan-taking. MSP facing movement restrictions also prefer policies that allowed non-farm use of machines, which may be restricted in particular local communities. These MSP usually do not prefer policies for keeping machine parts/shops open, because these policies are less relevant to addressing the movement restrictions.

MSP facing higher prices or reduced availability of machines and equipment generally prefer policies for reducing financing/loan extension/debt relief, which may ease financial burdens for machine acquisitions. MSP facing indebtedness naturally prefer policies reducing financing/loan extension/ debt relief, or expanded provisions of loans specifically designated for small-enterprises that include MSP. In contrast, MSP who were facing challenges in getting loan extension (conditional on being indebted) prefer an opposite set of policies, possibly because they do not find it viable to pursue further loans or extensions. Instead, they prefer policies that allow greater movement of machines across regions or kept machine shops open. The preferred set of policies also varied depending on whether MSP face more customers asking for later-payment than in the same period in the previous year, or MSP face more imminent exhaustion of financial capital. Some of the statistically significantly negative preferences may also reflect that respondents wanted less of those policies as they recognize that these policies have opportunity costs.

Other factors

All of the aforementioned effects hold when controlling for the survey-round dummy, their interactions with time-invariant factors (MSP's home states/regions, whether operating tractors for service provisions or not, years of establishment of MSP business), and rainfall relative to the historical norm.

4.1.2 MER

Similar to MSP, restrictions on movement or sales have had negative effects on various outcomes for MER.

Movement restrictions

Equipment retailers that were constrained in the movement of machines within townships, or within state or region, or any other geographical boundaries, significantly raised the likelihood of reduced revenue prospects. Those facing movement within other geographical boundaries than township or state/regions are also significantly more likely to report the prospects that revenues may drop by more than 10 percent, which can be considered a severe contraction. Overall, movement restrictions broadly shifted MER's financial prospects downward. These effects on revenues are broad, consisting of the reduced sales on a range of equipment, including four-wheel tractors, attachments like disc-plows / rotary tills, or the increased likelihood that the sales of at least some equipment handled by MER dropped. The perceived effects could be more than a 20 percent drop in sales. Movement restrictions also negatively affected business activities, including the ability to deliver existing orders.

Restrictions in sales in-store, store-front, or through delivery

The effect of bans on in-store sales, at the store-front, or through deliveries on revenue prospects, conditional on movement restrictions, are somewhat insignificant. This may be

because sales of equipment are sometimes made on individual basis where buyers make purchasing decisions based on the brand and other specifications rather than if they are sold in the store or at the store-front.

Nonetheless, these restrictions on sales practices still led to greater challenges. In particular, restrictions on sales through deliveries sometimes led to a significant reduction in sales (by more than 20% compared to the same period in the previous year) of certain equipment, including combine harvesters or spare parts. This holds even after controlling for restrictions on geographical boundaries on movement that MER face, possibly because, even in areas where movements are allowed, any additional disruptions may affect deliveries of equipment (Table 12). Restrictions on store-front sales also led to reduced ability to deliver existing orders, possibly because these might have prevented MER from handing over equipment to buyers in store-front spaces (Table 11).

Higher price or reduced availability of equipment, attachments and spare parts

Compared to the case of MSP who are largely buyers of equipment, the effects of higher prices or reduced availability of equipment, attachments and spare parts on MER are somewhat less clear. This is because MER are sellers of equipment. For example, the higher price of equipment actually reduced the likelihood of severe revenue reduction (of more than 10%) (Table 10). However, many of them may still have experienced minor revenue reduction, and reduced availability of equipment and actually lowered revenue prospects of MER (because reduced availability may indicate reduced sales, even when prices per equipment are high) (Table 10). Generally, higher prices and reduced availability of equipment led to increased challenges, not only the reduced ability to deliver existing orders, but also from greater disruption in their logistics (especially dealing with a higher purchase price of equipment). Other challenges included greater difficulty in recovering loans from buyers, possibly because reduced availability of equipment might have relatively increased transactions with more distant buyers (albeit within geographical boundaries where movement is allowed) from whom loan recovers can be more difficult (Table 11).

Coping mechanisms

Similar to MSP, coping mechanisms used by MER varied somewhat depending on the types of restrictions they faced (Table 13). MER facing movement restrictions tend to seek more loans from the government, while they are less likely to pursue other coping mechanisms like reducing new inventory, maintenance/repairs. Similar to MSP, this may be because MER expect that the governments may offer compensation for movement restrictions that they imposed, while thinking these movement restrictions are rather temporary and thus keeping their inventory or continuing to repair or maintain their assets. However, the effects of facing bans in sales mode (bans sales in-store, store-front, or through deliveries), conditional on these movement restrictions, had the opposite effects from movement restrictions. This may be because these restrictions directly limit the stock of equipment. Effects of price and availability of equipment generally do not affect the relative importance of different coping mechanisms, suggesting that these equally affect both financial and asset-holding capacities.

Preferred policies

Preferred policies expressed by MER also vary, depending on the type of restrictions they faced under COVID-19 (Table 14). Those facing movement restrictions were relatively more

likely to prefer policies that allow greater movement of machines across regions, while they were relatively less likely to prefer policies on financial support like reducing taxes/fees or rent/utility. MER who are banned from sales through deliveries are more likely to prefer reduced rent/utility for warehouses and shops where they have to keep their stocks longer, while those banned from store-front sales prefer the greater movement of machines across regions. Financial support like loan extensions or debt relief were preferred by MER with indebted customers or facing reduced availability of equipment. The latter may be because these MER own certain business assets (possibly including land or building) with outstanding loan payments, and reduced availability of equipment in the market (which they buy and resell) reduces their prospects for paying off these loans.

Other factors

All of the aforementioned effects hold when controlling for the existing financial challenges faced by MER, such as the challenges in receiving loan payment deferment, whether customers were asking for more late-payment than the previous year, or whether customers currently owe loans from MER. They also hold controlling for the survey-round dummy, their interactions with time-invariant factors (whether Delta/Bago regions or not, whether selling four-wheel tractors or not, whether franchise dealers or not) and rainfall relative to the historical norm.

4.2 Dynamic effects of pessimistic revenue perspectives among MSP

Table 15 present the estimated dynamic effects of revenue perspectives on subsequent periods, estimated through dynamic-panel estimation methods (2).^{6, 7}

Consistent with the hypotheses discussed above, we find robust evidence that negative revenue prospects for MSPs result in persistent effects and a vicious cycle of negative revenue in the subsequent periods. Specifically, the ranges of estimated coefficients on revenue prospects at $t - 1$ suggest that having negative revenue prospects in the previous survey round raises the likelihood of similarly negative revenue prospects in the current survey round by 15 – 20 percentage points. This holds even after controlling for the effects of other potentially negative factors at t , such as reduced availability of machines and equipment and various financial challenges. The effects also hold after controlling for rainfall and the survey round dummy interacted with time-invariant variables. The estimated effects are robust and hold broadly across different sub-samples, including samples from summer 2020 only, or samples of tractor service providers only, and different estimation methods (one-step GMM or two-step GMM).

Table 16 further show some evidence of the possible causes of the observed persistence of negative revenue prospects by MSP. Again, as is consistent with the hypotheses discussed above, having negative revenue prospects in the previous period results in a statistically

⁶While the issue of potential nonstationarity is relatively less important given that our surveys contain 5 rounds at most, we nonetheless tested unit root for samples with sufficient length of panels (responding in 3 rounds or more). We used the Fisher-type panel unit-root test (Choi 2001), which can be implemented in panel data that are both unbalanced and contain gaps like ours, which can be implemented with STATA command xtunitroot. Appendix A shows the results, suggesting that at least one panel is stationary, which ensures that our dynamic panel analyses are not capturing a spurious relationship between our dependent variable and its lagged value.

⁷As is shown in Table 15 and Table 16, all specification tests (p-values of various null hypotheses) suggest that estimates are consistent, given the level of auto-correlation, orthogonality of excluded instrumental variables, orthogonality and exogeneity of appropriately lagged dependent variables that are also used as excluded instrumental variables.

significant increase in the number of “desperate” business practices that may be suboptimal with the hope of recovering sunk costs on machines. These effects hold after controlling for other factors, for various sub-set of samples, and across different estimation methods.

These results showcase insights that are somewhat unique to MSP, who engage in capital-intensive service provisions. For these agents, shocks at the beginning of the business season can have dynamic effects throughout the season, possibly aggravating the overall damages. The results suggest that the timing of effective policy interventions is important. For example, it is important to provide sufficient support to mitigate negative business prospects for the coming season, at the beginning of the production season.

5 Conclusions

COVID-19, and policy responses against it, has affected economic activities in countries around the world, including the agri-food sector in Myanmar (Boughton et al. 2021). Some aspects of these effects can be particularly severe depending on the type of agri-food sector agents, given their unique characteristics. This paper aimed at providing some insights for mechanization service providers (MSP) and mechanization equipment retailers (MER), based on multi-rounds of phone surveys administered in Myanmar between May 2020 through January 2021.

The analyses generally revealed negative but also potentially complex effects on MSP and MER of direct restrictions imposed as COVID-19 responses, and indirect changes in machine and equipment markets, and financial challenges. Restrictions on movements generally had negative effects on revenue prospects, timeliness of mechanization service provisions, sales of various types of machines and equipment, and overall business transactions. These generally applied to a range of restrictions, whether the movement was restricted to within region/state, township, or village tract, or other locally-defined boundaries, and whether bans were imposed for sales of machines or equipment in-store, at the store-front, or through delivery. These negative effects were in addition to the damaging effects caused by indirect outcomes of COVID-19, including higher costs and reduced availability of machines, equipment, and repair services in the market, as well as a range of financial challenges already faced by MSP and MER.

The results also suggest that the combinations of movement restrictions, effects on machine markets, and other various types of existing financial challenges led to significant heterogeneity in coping mechanisms pursued and supporting policies preferred by MSP and MER. While the heterogeneity is partly in response to the heterogeneity in the exposure and the effects felt by the movement restrictions imposed under COVID-19, but also appear to be in response to the heterogeneity in exposures to indirect outcomes of COVID-19, including market conditions, and individual-specific pre-existing financial challenges, among others.

These findings suggest that policies of easing movement restrictions and even facilitating the movement of some machines and equipment, as well as financial support in various dimensions, are generally effective in supporting MSP and MER. Minimizing movement constraints is likely to be critical for required mechanization service in the coming production season. For example, by granting of exemptions or other measures, facilitating the movement of agricultural equipment, including imports (both domestic transportation and import process). Various actions under the former COVID-19 Economic Relief Plan (CERP) were also likely to have been effective; these included facilitating the importation of agricultural equipment, offering credit guarantee schemes to ease the impact of COVID-19 on private sector firms, treating some MER and MSP as small and medium enterprises and supporting them as part of financial support for small and medium enterprises, and temporary relief on taxes or financing costs, rent payments. It is

also important to maintain flexibility in these policies, as the nature of challenges faced by MSP, MER can vary between types of primary machines and equipment used or handled, sizes and franchise status, locations (regions and states).

Lastly, the rare high-frequency, multi-round interviews of MSP originally intended for frequent monitoring during COVID-19 also allowed us to gain important insights into the dynamics of revenue-prospects changes among MSP. Importantly, we find that negative revenue prospects in the early part of the season can lead to a vicious cycle of suboptimal, desperate use of machines and further aggravation of revenue prospects in later periods. This is consistent with the hypotheses that may be unique to agents like MSP, whose short-term decision-making can be irrational and affected by the presence of large sunk-cost made on machines. Consequently, for agents like MSP in Myanmar, mitigating negative business prospects at the beginning of the production season is particularly important, and this remains so for the upcoming production season in 2021.

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Table 1. Panel samples of mechanization service providers and mechanization equipment retailers

Type of respondents	Sub-categories of respondents	Round-1	Round-2	Round-3	Round-4	Round-5	Inter-viewed in all of rounds 1 - 3	Inter-viewed in all of rounds 4 - 5	Among those inter-viewed in all 5 rounds		Total observations
									Inter-viewed in all of rounds 1 - 3	Inter-viewed in all of rounds 4 - 5	
MSP	Tractors	286	285	226	56	51	216	51	57	33	904
	Combine harvesters	43	26	12	188	180	12	180	6	25	447
	Others	14	10	4	14	12	3	12	0	5	54
	Total	343	321	242	258	243	231	243	63	63	1,405
MER	4wt	40	50	45	32	28	35	28	18	14	195
	Others	24	35	30	25	21	19	21	10	14	135
	Total	64	85	75	57	49	54	49	28	28	330

Source: Authors based on IFPRI (2020b).

Note: The sample sizes in this table refer to the number of respondents that were interviewed in at least two out of the five rounds, and thus constitute the panel samples.

Table 2. Descriptive statistics – Outcome variables (MSP)

Variables	Units	Values
revenue is lower than 2019	Yes = 1	0.643
revenue is lower than 2019 by more than 10%	Yes = 1	0.222
revenue drops more than the cost	Yes = 1	0.439
mechanization service is slower than previous year	Yes = 1	0.340
mechanization service is earlier than previous year	Yes = 1	0.115
wait-time is longer for customers	Yes = 1	0.612
provide more financial assistance to customers than previous year	Yes = 1	0.081
face challenges in loan repayment	Yes = 1	0.221
face challenges in payment of invoices	Yes = 1	0.125
face increased financial problems	Yes = 1	0.662
Business challenges		
cannot deliver existing orders	Yes = 1	0.169
existing loans cannot be extended	Yes = 1	0.122
disruption to logistics	Yes = 1	0.447
face any business challenges	Yes = 1	0.589
Coping methods		
obtain loans from government	Yes = 1	0.174
obtain loans from commercial banks	Yes = 1	0.078
obtain loans from private individuals	Yes = 1	0.251
liquidate assets	Yes = 1	0.299
use other incomes	Yes = 1	0.275
Preferred policies		
reduce taxes/fees	Yes = 1	0.135
extend loans/debt relief	Yes = 1	0.341
allow non-farm use of machines	Yes = 1	0.076
allow movement of machines across regions	Yes = 1	0.246
keep machine/parts shops open	Yes = 1	0.136
reduce rent / utilities	Yes = 1	0.209
loans for small-enterprises	Yes = 1	0.333
Number of full panel observations (combined)		1,405
Average numbers of panel rounds		2.9

Source: Authors based on IFPRI (2020b).

Table 3. Descriptive statistics – Outcome variables (MER)

Variables	Units	Values
negative revenue prospect (revenue is lower than 2019)	Yes = 1	0.609
revenue is lower than 2019 by more than 10%	Yes = 1	0.285
revenue drops more than the cost	Yes = 1	0.403
sales dropped by more than 20% (4wt)	Yes = 1	0.511
sales dropped by more than 20% (combine harvesters)	Yes = 1	0.467
sales dropped by more than 20% (disc-plows/rotally tillers)	Yes = 1	0.467
sales dropped by more than 20% (spare parts)	Yes = 1	0.405
sales dropped (any equipment handled)	Yes = 1	0.812
sales dropped by more than 20% (any equipment handled)	Yes = 1	0.576
Business challenges		
cannot deliver existing orders	Yes = 1	0.230
disruption to logistics	Yes = 1	0.497
challenges in recovering loans from borrowers	Yes = 1	0.094
face any business challenges	Yes = 1	0.633
Coping methods		
obtain loans from government	Yes = 1	0.103
obtain loans from commercial banks	Yes = 1	0.161
obtain loans from private individuals	Yes = 1	0.130
reduction of operating costs	Yes = 1	0.073
liquidate assets	Yes = 1	0.152
use other incomes	Yes = 1	0.082
Preferred policies		
reduce taxes/fees	Yes = 1	0.497
extend loans/debt relief	Yes = 1	0.276
allow non-farm use of machines	Yes = 1	0.303
allow movement of machines across regions	Yes = 1	0.245
keep machine/parts shops open	Yes = 1	0.024
provide general support to farmers	Yes = 1	0.212
Number of full panel observations (combined)		330
Average numbers of panel rounds		3.3

Source: Authors based on IFPRI (2020b).

Table 4. Descriptive statistics – Exogenous variables

Table 11: Descriptive statistics		Exogenous variables	
Variables	Unit	Type of respondents	
		MSP	MER
<i>Time-variant variables</i>			
movement restricted within village tracts	Yes = 1	0.271	
movement restricted within township	Yes = 1	0.510	0.155
movement restricted within state/region	Yes = 1	0.169	0.336
movement restricted within other geographical boundary	Yes = 1	0.238	0.082
banned from in-store sales	Yes = 1		0.079
banned from store-front sales	Yes = 1		0.091
banned from delivery	Yes = 1		0.209
face other restrictions for machine movements	Yes = 1	0.727	
face higher machines costs than previous year	Yes = 1	0.334	0.185
face reduced availability of machines than previous year	Yes = 1	0.199	0.376
indebtedness (owe loans to dealers / banks)	Yes = 1	0.522	
no loan extension (do not receive an extension on current loan payment)	Yes = 1	0.418	0.273
more request for late-payment by customers	Yes = 1	0.724	0.385
imminent risk of financial asset exhaustion	Yes = 1	0.443	
indebtedness of customers (customers still owe loans from respondent)			0.506
rainfall percentile	Percentile (1 = 100%)	0.293	0.314
<i>Time-invariant variables</i>			
tractor service provider	Yes = 1	0.643	
selling four-wheel tractor (4wt)	Yes = 1		0.591
franchise	Yes = 1		0.448
regions			
Ayeyarwady	Yes = 1	0.336	
Bago	Yes = 1	0.129	
Magway	Yes = 1	0.389	
Mandalay	Yes = 1	0.049	
Sagaing	Yes = 1	0.090	
Yangon	Yes = 1	0.008	
Delta or Bago region	Yes = 1		0.491
year of establishment	Year	2015.9	2009.6
Number of full panel observations (combined)		1,405	330
Average numbers of panel rounds		2.9	3.3

Source: Authors based on IFPRI (2020b).

Table 5. Effects of COVID-19 related restrictions on revenues (MSP)

Variables	revenue is lower than 2019	revenue is lower than 2019 by more than 10%	revenue drops more than the cost
movement restricted within village tracts	.214***(.062)	-.051 (.041)	-.092 (.066)
movement restricted within township	.082 (.055)	-.052 (.043)	-.087* (.050)
movement restricted within state/region	.208***(.077)	.046 (.060)	.004 (.073)
movement restricted within other geographical boundary	.102***(.037)	.089**(.034)	.078 (.051)
face other restrictions for machine movements	.052 (.052)	.118***(.041)	.023 (.044)
face higher machines costs than previous year	.022 (.028)	-.049 (.032)	.037 (.036)
face reduced availability of machines than previous year	.106***(.040)	.019 (.034)	.087**(.039)
indebtedness	-.005 (.025)	.004 (.028)	.132***(.032)
no loan extension	.115***(.023)	.059* (.030)	-.011 (.034)
more request for late-payment by customers	.137***(.039)	.052 (.033)	.123***(.037)
imminent risk of financial asset exhaustion	-.016 (.029)	-.072**(.031)	-.102***(.029)
rainfall percentile	.118 (.165)	.106 (.130)	-.028 (.172)
Round dummy	Included	Included	Included
Round dummy * time-invariant variables	Included	Included	Included
Constant	Included	Included	Included
Number of observations	1405	1405	1405
P-value (H0: variables jointly insignificant)	.000	.000	.000

Source: Authors based on IFPRI (2020b). Asterisks indicate the statistical significance:

*10%

**5%

***1%

Numbers in parentheses are standard errors.

Table 6. Effects of COVID-19 related restrictions on mechanization service provisions (MSP)

Variables	mechaniza- tion service is slower than previ- ous year	mechaniza- tion service is earlier than previ- ous year	wait-time is longer for customers	provide more finan- cial assis- tance to customers than previ- ous year	face chal- lenges in loan repay- ment	face chal- lenges in payment of invoices	face in- creased fi- nancial problems
movement restricted within village tracts	.109* (.063)	-.096 (.059)	-.089 (.082)	.038 (.050)	.098 (.082)	-.027 (.057)	.101 (.071)
movement restricted within township	.116* (.063)	-.140** (.059)	-.061 (.090)	.021 (.047)	.143* (.073)	-.059 (.057)	.115* (.066)
movement restricted within state/region	.092 (.077)	-.049 (.066)	-.013 (.104)	-.001 (.050)	.119* (.071)	.006 (.053)	.073 (.058)
movement restricted within other geographical bound- ary	.140***(.048)	.019 (.033)	.198***(.047)	-.037 (.026)	.011 (.046)	.104***(.033)	.042 (.040)
face other restrictions for machine movements	.050 (.040)	.018 (.031)	-.063 (.049)	.006 (.031)	-.102** (.047)	.019 (.034)	-.061 (.048)
face higher machines costs than previous year	-.023 (.034)	.053** (.023)	-.023 (.040)	-.015 (.021)	.067***(.024)	.038 (.025)	-.023 (.035)
face reduced availability of machines than previous year	.062* (.033)	-.031 (.022)	.078* (.040)	-.022 (.021)	-.022 (.033)	.062** (.031)	-.013 (.031)
indebtedness	.023 (.031)	.027 (.032)	-.061* (.033)	.051***(.016)	.240***(.034)	.030 (.029)	.123***(.032)
no loan extension	-.062**(.027)	.018 (.027)	.056**(.027)	-.027 (.023)	.007 (.031)	-.040 (.025)	.160***(.036)
more request for late-payment by customers	.145***(.035)	.005 (.023)	.231***(.032)	.063***(.017)	-.066* (.036)	.015 (.020)	.023 (.040)
imminent risk of financial asset exhaustion	.019 (.035)	-.035 (.022)	.187***(.029)	-.002 (.022)	.051** (.022)	-.064***(.022)	.132***(.033)
rainfall percentile	-.013 (.183)	-.042 (.104)	.082 (.159)	-.164 (.105)	-.100 (.101)	.021 (.131)	.011 (.159)
Round dummy	Included	Included	Included	Included	Included	Included	Included
Round dummy * time-invariant variables	Included	Included	Included	Included	Included	Included	Included
Constant	Included	Included	Included	Included	Included	Included	Included
Number of observations	1405	1405	1405	1405	1405	1405	1405
P-value (H0: variables jointly insignificant)	.000	.000	.000	.000	.000	.000	.000

Source: Authors based on IFPRI (2020b). Asterisks indicate the statistical significance:

*10% **5% ***1%

Numbers in parentheses are standard errors.

Table 7. Effects of COVID-19 related restrictions on financial challenges (MSP)

Variables	cannot de- liver exist- ing orders	existing loans can- not be ex- tended	disruption to logistics	facing any business challenges
movement restricted within village tracts	.021 (.051)	.002 (.078)	.080 (.093)	.090 (.088)
movement restricted within township	.014 (.059)	-.003 (.067)	.111 (.089)	.182** (.071)
movement restricted within state/region	.022 (.055)	.019 (.066)	.084 (.074)	.148** (.073)
movement restricted within other geographical boundary	.253*** (.042)	.070** (.028)	.130** (.052)	.254*** (.037)
face other restrictions for machine movements	-.124*** (.044)	-.047 (.033)	-.071 (.055)	-.105** (.051)
face higher machines costs than previous year	-.009 (.023)	.021 (.020)	.025 (.037)	.027 (.040)
face reduced availability of machines than previous year	.087* (.036)	-.026 (.025)	.083*** (.031)	.047 (.042)
indebtedness	.049 (.032)	.126*** (.022)	-.076 (.048)	.004 (.005)
no loan extension	.003 (.031)	.096*** (.024)	-.002 (.029)	.082** (.032)
more request for late-payment by customers	.051*** (.019)	.014 (.023)	-.035 (.032)	.043 (.032)
imminent risk of financial asset exhaustion	.012 (.026)	.044* (.022)	.014 (.040)	.110*** (.027)
rainfall percentile	.104 (.149)	.057 (.104)	-.171 (.136)	-.110 (.137)
Round dummy	Included	Included	Included	Included
Round dummy * time-invariant variables	Included	Included	Included	Included
Constant	Included	Included	Included	Included
Number of observations	1405	1405	1405	1405
P-value (H0: variables jointly insignificant)	.000	.000	.000	.000

Source: Authors based on IFPRI (2020b). Asterisks indicate the statistical significance: *10% **5% ***1%

Numbers in parentheses are standard errors.

Table 8. Effects of COVID-19 related restrictions on coping mechanisms (MSP)

Variables	obtain loans from gov- ernment	obtain loans from com- mercial banks	obtain loans from private in- dividuals	liquidate assets	use other incomes
movement restricted within village tracts	.142** (.061)	.015 (.048)	.019 (.084)	-.043 (.081)	-.041 (.096)
movement restricted within township	.132** (.058)	.008 (.037)	-.049 (.074)	-.083 (.083)	-.123 (.075)
movement restricted within state/region	.094 (.060)	-.028 (.042)	-.069 (.085)	-.009 (.091)	-.106 (.080)
movement restricted within other geographical boundary	.017 (.039)	.058** (.026)	-.054* (.031)	.157*** (.046)	.003 (.042)
face other restrictions for machine movements	-.023 (.034)	.015 (.028)	-.077** (.035)	.002 (.050)	.079 (.054)
face higher machines costs than previous year	-.072** (.031)	-.034 (.023)	.015 (.029)	.022 (.042)	-.004 (.039)
face reduced availability of machines than previous year	-.030 (.034)	-.050** (.020)	.130*** (.038)	.089** (.040)	.037 (.039)
indebtedness	-.031 (.031)	-.059*** (.021)	.183*** (.033)	.024 (.043)	.032 (.036)
no loan extension	-.080*** (.024)	-.065*** (.019)	-.009 (.003)	.151*** (.026)	.117*** (.041)
more request for late-payment by customers	-.032 (.028)	.005 (.017)	.024 (.022)	.052* (.031)	.044 (.038)
imminent risk of financial asset exhaustion	.050** (.021)	.042*** (.015)	.007 (.031)	-.035 (.031)	.029 (.034)
rainfall percentile	.111 (.157)	-.013 (.079)	-.030 (.142)	-.010 (.137)	.056 (.161)
Round dummy	Included	Included	Included	Included	Included
Round dummy * time-invariant variables	Included	Included	Included	Included	Included
Constant	Included	Included	Included	Included	Included
Number of observations	1405	1405	1405	1405	1405
P-value (H0: variables jointly insignificant)	.000	.000	.000	.000	.000

Source: Authors based on IFPRI (2020b). Asterisks indicate the statistical significance:

*10% **5% ***1%

Numbers in parentheses are standard errors.

Table 9. Effects of COVID-19 related restrictions on preferred policies by MSP

Variables	reduce taxes/fees	extend loans/debt relief	allow non- farm use of machines	allow move- ment of ma- chines across re- gions	keep ma- chine / parts shops open	reduce rent / utilities	loans for small-enter- prises
movement restricted within village tracts	.056 (.057)	.043 (.083)	.090** (.041)	.001 (.081)	-.131** (.054)	.070 (.074)	.147* (.081)
movement restricted within township	.137***(.046)	-.114 (.075)	.079**(.031)	.034 (.076)	-.080* (.045)	.255***(.055)	-.070 (.070)
movement restricted within state/region	.057 (.053)	-.054 (.083)	.020 (.030)	.038 (.090)	-.019 (.054)	.293***(.071)	-.046 (.090)
movement restricted within other geographical boundary	-.019 (.029)	.066 (.050)	.066** (.031)	.069 (.061)	-.006 (.036)	.099** (.040)	-.257***(.055)
face other restrictions for machine movements	.016 (.027)	-.002 (.045)	-.021 (.027)	-.036 (.046)	.054 (.035)	-.095** (.040)	-.019 (.049)
face higher machines costs than previous year	.029 (.028)	.025 (.043)	-.010 (.014)	-.062* (.031)	.041 (.029)	.068**(.031)	.026 (.025)
face reduced availability of machines than previous year	.005 (.023)	.091** (.036)	-.012 (.019)	.002 (.038)	.004 (.028)	.027 (.041)	-.036 (.035)
indebtedness	-.012 (.027)	.263***(.029)	-.025 (.022)	-.130***(.032)	-.028 (.031)	.002 (.026)	.267***(.032)
no loan extension	-.042* (.025)	-.071**(.030)	.009 (.018)	.196***(.037)	.042* (.022)	-.054** (.027)	-.175***(.033)
more request for late-payment by customers	-.100***(.034)	.095***(.033)	-.009 (.021)	.096***(.032)	.112***(.022)	.005 (.036)	-.047 (.036)
imminent risk of financial asset exhaustion	-.075***(.020)	-.020 (.029)	.065***(.019)	.019 (.024)	.011 (.016)	-.020 (.028)	-.073**(.032)
rainfall percentile	.023 (.102)	.232 (.150)	.051 (.125)	-.114 (.133)	-.018 (.116)	-.188 (.175)	.229 (.189)
Round dummy	Included	Included	Included	Included	Included	Included	Included
Round dummy * time-invariant variables	Included	Included	Included	Included	Included	Included	Included
Constant	Included	Included	Included	Included	Included	Included	Included
Number of observations	1405	1405	1405	1405	1405	1405	1405
P-value (H0: variables jointly insignificant)	.000	.000	.000	.000	.000	.000	.000

Source: Authors based on IFPRI (2020b). Asterisks indicate the statistical significance:

*10% **5% ***1%

Numbers in parentheses are standard errors.

Table 10. Effects of COVID-19 related restrictions on revenues (MER)

Variables	revenue is lower than 2019	revenue is lower than 2019 by more than 10%
movement restricted within township	.184* (.099)	-.030 (.096)
movement restricted within state/region	.141**(.052)	.037 (.071)
movement restricted within other geographical boundary	.253**(.114)	.396***(.139)
Banned in store sales	-.025 (.113)	.185 (.111)
Banned store-front sales	-.158 (.125)	-.184 (.114)
Banned delivery	.090 (.078)	.005 (.128)
face higher machines costs than previous year	.048 (.115)	-.094* (.050)
face reduced availability of machines than previous year	.214***(.065)	.071 (.054)
no loan extension	.139**(.064)	.005 (.069)
more request for late-payment by customers	.184**(.084)	.139 (.091)
indebtedness of customers	-.096 (.081)	-.054 (.075)
rainfall percentile	.500***(.173)	.168 (.144)
Round dummy	Yes	Yes
Round dummy * time-invariant variables	Yes	Yes
Constant	Yes	Yes
Number of observations	330	330
Number of panel respondents	100	100

Source: Authors based on IFPRI (2020b). Asterisks indicate the statistical significance:

*10% **5% ***1%

Numbers in parentheses are standard errors.

Table 11. Effects of COVID-19 related restrictions on mechanization service provisions (MER)

Variables	cannot deliver existing orders	disruption to logistics	challenges in recovering loans from borrowers	Business issue
movement restricted within township	.017 (.087)	.108 (.088)	.038 (.066)	.209** (.091)
movement restricted within state/region	-.001 (.054)	.107 (.089)	-.081* (.047)	.107 (.075)
movement restricted within other geographical boundary	.159* (.084)	.040 (.101)	-.114 (.076)	-.022 (.105)
Banned in store	-.077 (.097)	.056 (.164)	-.044 (.097)	-.104 (.173)
Banned in front	.355*** (.101)	.000 (.094)	-.074 (.075)	.060 (.079)
Banned deliver	.101 (.094)	-.115 (.076)	-.042 (.057)	.008 (.061)
face higher machines costs than previous year	.097 (.075)	.129* (.066)	.021 (.048)	.144** (.056)
face reduced availability of machines than previous year	.108* (.064)	-.075 (.075)	.072* (.042)	.030 (.054)
no loan extension	-.049 (.065)	.028 (.073)	.116* (.059)	.148** (.065)
more request for late-payment by customers	-.145* (.082)	.081 (.094)	.119** (.043)	.111 (.106)
indebtedness of customers	-.017 (.078)	-.159** (.075)	-.089 (.064)	-.198*** (.072)
rainfall percentile	-.046 (.178)	.364 (.242)	-.253* (.131)	.124 (.305)
Round dummy	Yes	Yes	Yes	Yes
Round dummy * time-invariant variables	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes
Number of observations	330	330	330	330
Number of panel respondents	100	100	100	100

Source: Authors based on IFPRI (2020b). Asterisks indicate the statistical significance: *10% **5% ***1%

Numbers in parentheses are standard errors.

Table 12. Effects of COVID-19 related restrictions on financial challenges (MER)

Variables	sales dropped by more than 20% (4wt)	sales dropped by more than 20% (com- bine har- vesters)	sales dropped by more than 20% (disc- plows/rotal ly tillers)	sales dropped by more than 20% (spare parts)	sales dropped (any equip- ment han- dled)	sales dropped by more than 20% (any equipment handled)
movement restricted within township	-.060 (.133)	.116 (.182)	.213 (.162)	.114 (.125)	.062 (.063)	.127 (.097)
movement restricted within state/region	.186 (.148)	.243 (.159)	.017 (.091)	-.083 (.111)	.139** (.055)	.211** (.091)
movement restricted within other geographical boundary	.331** (.147)	.261 (.224)	.324** (.125)	.084 (.157)	.024 (.085)	.188 (.122)
Banned in store	-.056 (.246)	-.172 (.271)	-.012 (.259)	-.103 (.123)	-.021 (.064)	.069 (.134)
Banned in front	-.157 (.248)	-.180 (.283)	-.387 (.266)	-.168* (.096)	-.117 (.083)	-.194 (.143)
Banned deliver	.170 (.114)	.257** (.101)	.067 (.101)	.239** (.102)	.078 (.063)	.142* (.084)
face higher machines costs than previous year	.009 (.107)	-.115 (.162)	.075 (.124)	-.050 (.059)	-.022 (.100)	-.046 (.084)
face reduced availability of machines than previous year	.016 (.110)	-.024 (.131)	.070 (.117)	-.035 (.061)	.070 (.045)	.042 (.053)
no loan extension	.017 (.112)	.070 (.142)	.033 (.110)	.211*** (.063)	-.010 (.061)	.068 (.058)
more request for late-payment by customers	.163 (.133)	-.061 (.204)	-.022 (.154)	.050 (.131)	.125 (.092)	.150 (.118)
indebtedness of customers	-.322** (.133)	-.175 (.230)	-.176 (.159)	-.160 (.121)	-.199* (.098)	-.264** (.114)
rainfall percentile	.012 (.356)	.450 (.382)	-.163 (.462)	.252 (.227)	-.084 (.254)	.031 (.219)
Round dummy	Yes	Yes	Yes	Yes	Yes	Yes
Round dummy*time-invariant variables	Yes	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	190	105	165	247	330	330
Number of panel respondents	63	40	53	78	100	100

Source: Authors based on IFPRI (2020b). Asterisks indicate the statistical significance:

*10% **5% ***1%

Numbers in parentheses are standard errors.

Table 13. Effects of COVID-19 related restrictions on coping mechanisms (MER)

Variables	obtain loans from govern- ment	obtain loans from commercial banks	obtain loans from private in- dividuals	reduction of operating costs	liquidate assets	use other incomes
movement restricted within township	.154***(.054)	.138 (.084)	.087 (.082)	.073 (.054)	-.151**(.062)	-.076 (.060)
movement restricted within state/region	.133***(.043)	.136 (.085)	-.041 (.033)	.026 (.043)	-.027 (.058)	-.103**(.046)
movement restricted within other geographical boundary	.132***(.045)	.126 (.083)	-.011 (.070)	-.032 (.068)	-.065 (.079)	-.059 (.059)
Banned in store	-.068* (.036)	-.040 (.081)	-.091 (.086)	.031 (.055)	.055 (.107)	.106 (.065)
Banned store-front sales	-.978* (.049)	-.193**(.084)	-.057 (.085)	.107 (.066)	.284***(.075)	.130**(.053)
Banned deliver	-.046 (.051)	.007 (.071)	.016 (.049)	.002 (.048)	.058 (.073)	.021 (.043)
face higher machines costs than previous year	-.044 (.045)	.010 (.050)	-.066 (.044)	-.003 (.042)	.104* (.056)	.047 (.044)
face reduced availability of machines than previous year	-.023 (.032)	-.008 (.049)	-.031 (.049)	-.016 (.025)	.034 (.044)	-.004 (.046)
no loan extension	-.024 (.023)	.032 (.043)	.070 (.054)	.110*** (.033)	.135***(.046)	.063 (.047)
more request for late-payment by customers	-.051 (.039)	-.021 (.066)	-.003 (.068)	.104**(.050)	.060 (.075)	.010 (.042)
indebtedness of customers	-.106**(.040)	-.045 (.070)	.083 (.054)	-.065 (.054)	-.134* (.068)	-.087* (.048)
rainfall percentile	.074 (.067)	.330***(.114)	-.172 (.132)	.097 (.087)	.028 (.129)	-.055 (.094)
Round dummy	Yes	Yes	Yes	Yes	Yes	Yes
Round dummy * time-invariant variables	Yes	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	330	330	330	330	330	330
Number of panel respondents	100	100	100	100	100	100

Source: Authors based on IFPRI (2020b). Asterisks indicate the statistical significance:

*10% **5% ***1%

Numbers in parentheses are standard errors.

Table 14. Effects of COVID-19 related restrictions on preferred policies by MER

Variables	Reduce taxes / fees	Reduce financing / extend loans / debt relief	Reduce rent / utility for warehouse, shops	Allow movement of machines across regions	Reduce social insurance premiums	General support to farmers
movement restricted within township	-.045 (.080)	.167 (.114)	-.064 (.086)	.074 (.083)	.033 (.034)	-.220* (.118)
movement restricted within state/region	-.049 (.084)	-.006 (.063)	.055 (.073)	.097 (.093)	.018 (.034)	-.166 (.114)
movement restricted within other geographical boundary	-.490***(.086)	.147 (.160)	-.360***(.076)	.215* (.109)	.066 (.053)	.059 (.140)
Banned in store	.144 (.141)	-.052 (.132)	.054 (.114)	-.095 (.087)	-.021 (.034)	-.046 (.094)
Banned in front	.072 (.089)	-.015 (.092)	.076 (.088)	.211***(.067)	.052 (.051)	-.148 (.100)
Banned deliver	-.074 (.078)	-.140* (.078)	.217** (.084)	.003 (.072)	.017 (.027)	.042 (.085)
face higher machines costs than previous year	.103 (.071)	-.062 (.061)	.105 (.068)	-.064 (.064)	-.022 (.034)	-.078 (.088)
face reduced availability of machines than previous year	.046 (.073)	.137***(.042)	.025 (.069)	-.069 (.054)	-.008 (.020)	-.026 (.055)
no loan extension	-.041 (.118)	-.031 (.062)	.101 (.072)	.030 (.082)	-.006 (.018)	.024 (.052)
more request for late-payment by customers	-.071 (.146)	-.021 (.072)	-.095 (.082)	.101 (.102)	.017 (.026)	-.083 (.076)
indebtedness of customers	-.110 (.127)	.195** (.092)	-.055 (.090)	-.073 (.104)	-.051* (.030)	.128 (.081)
rainfall percentile	-.343 (.319)	-.062 (.190)	.231 (.144)	-.013 (.186)	-.092 (.106)	.047 (.140)
Round dummy	Yes	Yes	Yes	Yes	Yes	Yes
Round dummy * time-invariant variables	Yes	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	330	330	330	330	330	330
Number of panel respondents	100	100	100	100	100	100

Source: Authors based on IFPRI (2020b). Asterisks indicate the statistical significance: *10% **5% ***1%

Numbers in parentheses are standard errors.

Table 15. Dynamics of revenue prospects (MSP)

Variables	All		All (Summer)		Tractor service providers		Tractor service providers (Summer)	
	One-step GMM	Two-step GMM	One-step GMM	Two-step GMM	One-step GMM	Two-step GMM	One-step GMM	Two-step GMM
lagged value of negative revenue prospect	.150***	.154**	.160**	.170*	.178***	.167**	.168**	.180*
	(.067)	(.078)	(.080)	(.093)	(.069)	(.081)	(.081)	(.094)
movement restricted within village tracts	.162*	.171	.112	.082	.091	.062	.121	.096
	(.097)	(.106)	(.119)	(.141)	(.129)	(.141)	(.132)	(.153)
movement restricted within township	.001	.017	-.042	-.054	-.062	-.074	-.028	-.042
	(.092)	(.102)	(.117)	(.141)	(.126)	(.139)	(.129)	(.152)
movement restricted within state/region	.053	.050	.017	-.019	-.018	-.044	.007	-.016
	(.094)	(.102)	(.122)	(.143)	(.134)	(.145)	(.136)	(.156)
movement restricted within other geographical boundary	-.041	-.082	-.074	.014	-.118	-.093	-.107	-.043
	(.066)	(.079)	(.198)	(.238)	(.112)	(.131)	(.211)	(.243)
face other restrictions for machine movements	.014	-.004	-.159	-.120	-.100	-.028	-.140	-.120
	(.062)	(.075)	(.093)	(.087)	(.089)	(.089)	(.120)	(.112)
face higher machines costs than previous year	-.026	-.037	-.022	-.026	-.017	-.015	-.023	-.030
	(.042)	(.045)	(.048)	(.052)	(.046)	(.048)	(.050)	(.054)
face reduced availability of machines than previous year	.161***	.156***	.179***	.182***	.199***	.205***	.199***	.205***
	(.049)	(.054)	(.058)	(.063)	(.060)	(.064)	(.061)	(.065)
indebtedness	.054	.071**	-.027	-.029	.007	.015	-.024	-.033
	(.035)	(.036)	(.044)	(.045)	(.043)	(.045)	(.046)	(.047)
no loan extension	.151***	.159***	.086*	.080*	.128***	.115**	.105**	.105**
	(.039)	(.044)	(.046)	(.048)	(.045)	(.049)	(.048)	(.050)
more request for late-payment by customers	.199***	.212***	.333***	.372***	.295***	.310***	.326***	.356***
	(.046)	(.051)	(.060)	(.065)	(.059)	(.067)	(.061)	(.066)
imminent risk of financial asset exhaustion	.008	.017	.083*	.100**	.059	.088*	.065	.087*
	(.039)	(.046)	(.043)	(.045)	(.046)	(.048)	(.046)	(.048)
rainfall percentile	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Round dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Round dummy * time-invariant variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sample size	835	835	531	531	564	564	484	484
Sample size of panel	464	464	308	308	288	288	275	275
Number of instruments	52	52	31	31	50	50	30	30
<i>p-value</i>								
Arellano-Bond test: AR(1)	.709	.814	.691	.878	.836	.798	.664	.862
Arellano-Bond test: AR(2)	.590	.536			.296	.443		
Arellano-Bond test: AR(3)	.811	.809			.903	.790		
Not overidentified (Sargan)	.331	.331	.066	.066	.546	.546	.255	.255
Not overidentified (Hansen)	.322	.322	.058	.058	.823	.823	.249	.249
Exogeneity of instrument subsets (Hansen test)	.648	.648	.893	.893	.667	.667	.949	.949

Source: Authors based on IFPRI (2020b). Asterisks indicate the statistical significance: *10% **5% ***1%

Numbers in parentheses are standard errors adjusted using Windmeijer's (2005) finite-sample correction for the two-step covariance matrix.

Excluded instruments include first differences of dependent variables $\Delta y_{i,t-1} = y_{i,t-1} - y_{i,t-2}$, and $\Delta y_{i,t-2} = y_{i,t-2} - y_{i,t-3}$, which seem to satisfy the validity of instrumental variables based on a range of specification tests shown in the table.

Table 16. Effects of revenue prospects on the number of seemingly desperate service provisions in the next season (MSP)

Variables	All		All (Summer)		Tractor service pro- viders		Tractor service pro- viders (Summer)	
	One-step GMM	Two-step GMM	One-step GMM	Two-step GMM	One-step GMM	Two-step GMM	One-step GMM	Two-step GMM
lagged value of negative revenue prospect	.191* (.107)	.236** (.108)	.292** (.129)	.272** (.125)	.283*** (.101)	.274** (.110)	.336*** (.129)	.324*** (.122)
movement restricted within village tracts	.214 (.161)	.150 (.174)	.207 (.201)	.215 (.191)	.116 (.227)	.193 (.250)	.160 (.214)	.170 (.202)
movement restricted within township	.042 (.162)	-.029 (.177)	-.010 (.210)	-.000 (.202)	-.096 (.239)	-.004 (.268)	-.052 (.225)	-.045 (.214)
movement restricted within state/region	.002 (.165)	-.024 (.178)	.052 (.218)	.079 (.211)	-.046 (.242)	.076 (.266)	-.030 (.231)	-.001 (.223)
movement restricted within other geographical bound- ary	.234** (.115)	.292*** (.106)	-.324 (.324)	-.422 (.320)	.100 (.161)	.137 (.180)	-.370 (.389)	-.468 (.343)
face other restrictions for machine movements	-.169 (.123)	-.145 (.131)	-.212 (.246)	-.273 (.268)	-.059 (.181)	.032 (.257)	-.283 (.322)	-.361 (.327)
face higher machines costs than previous year	.080 (.065)	.078 (.067)	.115 (.072)	.106 (.073)	.059 (.072)	.059 (.075)	.092 (.077)	.081 (.077)
face reduced availability of machines than previous year	.020 (.079)	.066 (.081)	.106 (.093)	.081 (.090)	.152* (.088)	.101 (.091)	.127 (.096)	.102 (.093)
indebtedness	.118* (.066)	.093 (.068)	.074 (.071)	.063 (.074)	.091 (.068)	.099 (.073)	.085 (.074)	.073 (.073)
no loan extension	.179*** (.066)	.199*** (.073)	.209*** (.067)	.203*** (.070)	.193*** (.065)	.177** (.078)	.215*** (.070)	.212*** (.071)
more request for late-pay- ment by customers	.457*** (.071)	.471*** (.075)	.440*** (.088)	.450*** (.086)	.427*** (.087)	.452*** (.095)	.467*** (.091)	.470*** (.089)
imminent risk of financial asset exhaustion	.139** (.064)	.136** (.066)	.128* (.070)	.122* (.073)	.152** (.069)	-.107 (.076)	.180** (.073)	.181** (.075)
rainfall percentile	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Round dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Round dummy * time-in- variant variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sample size	863	835	531	531	564	564	484	484
Sample size of panel	473	464	308	308	288	288	275	275
Number of instruments	52	52	31	31	50	50	30	30
<i>p-value</i>								
Arellano-Bond test: AR(1)	.671	.561	.301	.275	.336	.353	.301	.218
Arellano-Bond test: AR(2)	.242	.240			.102	.114		
Arellano-Bond test: AR(3)	.532	.472			.882	.937		
Not overidentified (Sargan)	.404	.404	.342	.342	.283	.283	.342	.460
Not overidentified (Hansen)	.581	.581	.180	.180	.939	.939	.180	.333
Exogeneity of instrument subsets (Hansen test)	.593	.593	.216	.216	.948	.948	.216	.316

Source: Authors based on IFPRI (2020b). Asterisks indicate the statistical significance: *10% **5% ***1%

Numbers in parentheses are standard errors adjusted using Windmeijer's (2005) finite-sample correction for the two-step covariance matrix.

Excluded instruments include first differences of dependent variables $\Delta y_{i,t-1} = y_{i,t-1} - y_{i,t-2}$, and $\Delta y_{i,t-2} = y_{i,t-2} - y_{i,t-3}$, which seem to satisfy the validity of instrumental variables based on a range of specification tests shown in the table.

Appendix A: Additional results

Table 17. Panel unit-root tests of revenue prospect variable, for panels of MSP with 3 rounds of more periods

Test statistics	Number of lag = 1		Number of lag = 2		Number of lag = 3	
	Statistics	p-value	Statistics	p-value	Statistics	p-value
Inverse χ^2	652.4790	.000	652.4790	.000	652.4790	.000
Inverse normal	-7.1384	.000	-7.1384	.000	-7.1384	.000
Inverse logit t	-17.6437	.000	-17.6437	.000	-17.6437	.000
Modified inverse χ^2	4.3190	.000	4.3190	.000	4.3190	.000
Number of panel respondents	291		291		291	
Average number of periods	3.56		3.56		3.56	

Source: Authors based on IFPRI (2020b).

Note: p-values are based on Philips-Perron tests, and correspond to the null hypothesis that all panels contain unit roots. P-values close to 0 suggest the rejection of this hypothesis, which support the alternative hypothesis that at least one panel is stationary.

Panel respondents are those with at least 3 rounds of responses, which is necessary for testing unit-root.

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