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Mechanization and COVID-19 in Myanmar

Effects of COVID-19-restrictions on mechanization service providers and mechanization equipment retailers: Insights from phone surveys in Myanmar[1]

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Abstract: Agrifood sector mechanization service providers (MSP) and mechanization equipment retailers (MER) have increasingly become the providers of mechanical technologies for smallholders in developing countries, including countries like Myanmar. Evidence remains scarce on the effects of COVID-19 on these MSP and MER. This study provides insights into the effects of COVID-19 restrictions on MSP and MER in Myanmar, using unbalanced panel data from five rounds of phone surveys. Direct responses to COVID-19 involving movement restrictions, as well as market disruptions, and growing financial challenges, had significant negative effects on revenue prospects, service delivery, and sales of machines and equipment. Negative revenue prospects during a particular period can further hurt revenue prospects in subsequent periods. This is consistent with the hypotheses that MSP who had incurred high sunk costs in machines can engage in more desperate and, thus, potentially suboptimal business practices to recover the sunk cost. Overall, policies to minimize movement restrictions and various financial struggles and mitigate any pessimism at the beginning of the production season are all important to make sure MSP and MER continue to function effectively under COVID-19.

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

[1]The data that support the findings of this study are available from the corresponding author upon reasonable request.

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 in the agri-food sector (IFPRI 2020; Zidouemba et al. 2020; Minten et al. 2020). These preventative measures, combined with the direct health effects of the disease, can have significant adverse effects on global food security and economic livelihood. As the pandemic persists, it remains critical that policy measures that are aimed at dealing with COVID-19 and other related crises are developed to 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 policymaking process.

One function within the agrifood sector, disruption of which can potentially lead to significant economic losses, is the supply of agricultural mechanization services. The use of mechanical power for farming operations has historically had significant economic effects both on-farm as well as off-farm. In the United States, between 1910 and 1954, the replacement of animal powers by tractors and related equipment alone contributed to raising US GDP by 8% (Steckel & White 2012). In smallholder-dominated Asia, tractors alone accounted for 15-16% of rice production growth during the early phase of the Green Revolution (Barker et al. 1985). Agricultural mechanization through the use of tractors and combine harvesters has spread extensively in the developing world in the last few decades (Diao et al., 2020). In some of the least developing countries like Myanmar, which has seen rapid mechanization growth during the last decade, the economic roles played by mechanization sub-sector actors have expanded substantially (Win et al. 2020). These actors include mechanization service providers (MSP), who serve many smallholders that still account for much of farm production without having the capacity to own machines by themselves, and mechanization equipment retailers (MER), who work through long supply-chains of machines most of which are imported from abroad, or manufactured mostly in a few major cities.

Despite the growing literature on the effects of COVID-19 on the agri-food sector, evidence on MSP and MER remains scarce. MSP, who provide custom hiring mechanization services to farmers, and MER, who sell machines, attachments, and spare parts, have distinct characteristics that are different from other inputs and service providers (SP) 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 can reduce the drudgery for rural workers, including women and children, and the non-farm economy more broadly.

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 the mobility of machines is inherently low (e.g., 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, and 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.

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 a further period. Support may need to be provided early, when a pessimistic outlook exists, to mitigate risky business practices associated with sunk costs for similar future shocks.

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. Given the relatively high frequency of survey rounds, we also 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 MSP and MER have only grown 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 2020), 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, 2017, 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 empirical analyses and methodologies. Section 3 describes the data and descriptive statistics. Section 4 presents and discusses the 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 investigates the static associations between prospects on business outcomes and challenges, coping mechanisms pursued, preferences on different policies by MSP and MER, and indicators of restrictions or disruptions as direct or indirect outcomes of COVID-19 containment measures by the government in 2020.

Specifically, we estimate

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

where y_{it} include 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.

Equation (1) is a linear probability model (LPM) since, as is described later, our outcome variables are binary variables. LPM has advantages over other common binary outcome models like probit or logit. First, LPM is consistent even when ε_{it} is heteroskedastic, while probit or logit models become inconsistent with heteroskedastic error terms (Greene 2003). Second, binary models like probit cannot incorporate unobserved time-invariant fixed effects, and alternatives like the Correlated Random Effects model (e.g., Chamberlain 1984) require stronger assumptions on which observed variables are correlated with the unobserved time-invariant fixed effects. Similar recent studies that use binary outcomes from phone surveys in Myanmar have also used linear probability models (e.g., Headey et al. 2022).

As is described in the data section, our sample of MSP consists of tractor service providers (TSP) and combine harvester service providers (CSP). We estimate equation (1) separately for TSP and CSP because they differ considerably in characteristics and may be affected by and respond to COVID-19-related restrictions in different ways. For example, TSP can be relatively more flexible in revenue generation if, for example, tractors can also be used for nonfarm purposes outside the main agricultural season, mitigating the short-term effects of restrictions. Combine-harvesters are more often moved by transporters than tractors are (e.g., Zhang et al. 2017), and their costs of moving across locations can be of different natures, potentially leading to different effects of movement restrictions. Also, relatively more CSP are located in the Delta zone than TSP are (Win et al. 2020), and COVID-19-related restrictions, if implemented differently across regions within Myanmar, can have different effects on TSP and CSP.

Outcome variables

y_{it} include various 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 for final revenue in 2020 are worse than the revenue earned in 2019, held at the time of each survey round in 2020, and 0 otherwise; (b) facing financial and business challenges (1 if yes and 0 otherwise), including the inability to repay loans or to pay invoices, facing any other increased financial problems (MSP), the perceptions of severe sales reduction of different machines and equipment (MER), facing disruptions in their logistics, and whether facing any of these collectively, inability to deliver existing orders or facing disruption to logistics; (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, commercial banks, or other private individuals, liquidating business assets, or reallocating other earned incomes; (d) most preferred set of policies to mitigate the negative effects associated with COVID-19-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, keeping machine / parts shops open, or expansion of loans for small-enterprises. [2]

Exogenous variables

x_{it} include three types of variables that capture the intensity of constraints faced by respondents due to COVID-19-related regulations, namely (a) movement restrictions on business-related spatial movement, (b) equipment market constraints, and (c) financial constraints that are likely to be exogenous or pre-determined for respondents. Variables (a) include binary variables indicating whether the respondents face movement restrictions within village tracts (for MSP), within townships (for MER), and within states or regions. For MER, related variables also include a sales restriction index, taking the value between 0 and 3 based on the sum of 3 binary variables, i.e., whether being banned from in-store sales, banned from store-front sales, and banned from sales through delivery. Variable (b) is proxied by a variable taking the value between 0 and 2, based on a sum of 2 original binary variables, namely, 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. Variable (c) is proxied by a

[2]We define sales reduction of more than 20% compared to the previous year as "severe", based on interactions with several mechanization sector stakeholders in Myanmar.

variable taking the value between 0 and 4, based on a sum of 4 original binary variables, namely, whether the respondent is still indebted to the formal sector lenders like dealers or banks (for MSP), whether facing loan or credit repayment requirement that cannot be extended, whether facing more requests for late payment from customers compared to the same period in the previous year, and whether facing imminent exhaustion of financial assets within 3 months based on the current rate of cash-flow (for MSP). We use these aggregated sets of explanatory variables, as we found during the preliminary analyses that using the aforementioned variables individually often suffers from multicollinearity problems.

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. A similar measure has been used in past studies (e.g., Takeshima et al., 2020).

x_{it} further include survey round dummy variables, 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 (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 Ayeyarwady, Yangon, or Bago regions (which consist mostly of the Delta zone) or not, whether selling four-wheel tractors or not, and whether franchise dealers or not.

Given that our surveys are entirely phone-based, most outcome variables and explanatory variables are measured as binary variables. Covering many outcome variables through such binary variables keeps our insights informative regarding how MSP and MER have been affected under COVID-19 restrictions and disruptions and what policies can help them in the upcoming production season in 2021.

2.2 Dynamics of MSP revenue prospects under COVID-19-restrictions

Our second set of analyses focuses 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 the production season on the subsequent seasons and potential pathways.

MSP, relative to some of the other SP 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). One of the related hypotheses for MSP is as follows; faced with reduced revenue prospects 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), for fear of being unable to recover the sunk costs. However, a rational decision would likely be to instead reduce machine use in the short term by realizing that desperate machine use today can raise the marginal cost of machine use in the long run. Desperate machine use today can forego higher earnings 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 revenue prospects in subsequent periods, leading to a vicious cycle.

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 in subsequent periods. The dynamic effects of negative revenue prospects on MSP are, therefore, empirical questions worth testing.

Empirical estimation of dynamic effects

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

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

in which y_{it} is one of the outcome variables used for (1), i.e., a binary variable measured as 1 if the prospects of revenue in 2020 are worse than the revenue earned in 2019 held at the time of survey round *t* in 2020, and 0 otherwise. The same set of other variables and parameters from the static panel data method (1) apply. The additional parameter γ measures the dynamic effects on y_{it}. This class of dynamic models, like (2), tend to suffer from potential endogeneity problems, including that between y_{it-1} and c_i (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

Our data consist of 5 rounds of unbalanced panel data of MSP and MER interviewed through phone surveys in May (round-1), June (round-2), July (round-3), November (round-4), and December 2020. Rounds 1 – 3 typically fell during land preparation and planting season, while rounds 4 – 5 fell during harvesting seasons (IFPRI 2021). 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 sizes for MSP and MER surveys across rounds and across different categories are presented in Table 1. In total, we ended up with 1,351 and 330 panel observations of MSP and MER, respectively, who responded to at least two rounds. Among MSP observations, approximately 2/3 are TSP, and 1/3 are CSP. Among MER, slightly more than half are handling four-wheel tractors (4wt) together with other equipment, while the rest handle only other equipment.[3] Among MSP, the composition of TSP and CSP 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 the analyses accordingly.

Rainfall data

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

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/township levels of respondents' locations in Myanmar.

3.2 Descriptive statistics

Table 2 summarizes the descriptive statistics of the outcome variables for MSP and MER, respectively. Overall, most MSP and MER interviewed 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 suggest that average conditions lean toward negative outcomes. About 64% of MSP and 61% of MER reported perceptions of reduced revenue prospects for 2020 compared to the revenue earned in 2019. Many of them also reported a higher rate of perceived prospects of revenue reduction than cost reduction.

A significant fraction of MSP and MER also reported emerging financial and business challenges. A significant share of MSP reported greater financial problems compared to the previous year, and a significant share of MER reported a more than 20% drop in the sale of machines and equipment. 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 3 summarizes the descriptive statistics of explanatory variables. Most MSP and MER faced movement restrictions either within the state/region, township or even within village tracts (MSP). Some MER faced complete bans against selling machines or equipment in-store, at store-front, or through delivery. Significant shares of MSP and MER faced either higher prices or reduced machine availability they had to acquire. While not shown, these patterns are highly correlated with similar market conditions for attachments and spare parts (both imported and locally manufactured). Significant shares of MSP and MER also faced a range of financial constraints 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 (around 30 percentile of historical rainfall distribution).

Descriptive statistics of time-invariant variables suggest that approximately 45% of MER respondents were franchise dealers who had a stronger tie with the suppliers and were selling particular brands of machines. About half of MER were in Yangon, Ayeyarwady, or Bago regions. Among MSP, a majority of CSP were in Ayeyarwady, while a majority of TSP were in Magway regions. On average, MSP have been in business since 2015 or 2016, while MER have been in business since 2009.

4 Results

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

Tables 4 through 8 summarize the results of COVID-19 restrictions on the outcomes of MSP. Similarly, Table 9 through Table 13 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).[4]

As described above, we primarily focus on the collective effects of three types of constraints, movement restrictions, equipment market constraints, and financial constraints. For three types of outcomes, revenues, financial challenges, and business challenges, while still distinguishing statistically significant coefficients from insignificant ones, it is also important, as is shown, that all statistically significant coefficients have positive signs, and thus these three types of constraints have broadly negative effects across various outcomes in consistent manners. Coefficients on movement restrictions can be insignificant if certain financial or business challenges can be resolved without significant physical movement (e.g., if ICT is effective) or if alternative customers (with similar WTP) can be found easily nearby. Coefficients on equipment market constraints can be insignificant if, for example, MSP or MER purchase equipment or services infrequently so that short-term market conditions do not affect them. Coefficients on financial constraints can be insignificant if they have the ability to find alternative finance sources in a timely manner.

As for the other outcomes, coping mechanisms, and policy preferences (Tables 7-8, 12-13), there may also be significant negative coefficients because. This is because, for these outcomes, we asked respondents to indicate the most important coping mechanisms among various options and up to two most preferred policies among multiple options. Coefficients in Tables 7-8 and 12-13, therefore, capture "relative" rather than "absolute" effects.

4.1.1 MSP

Movement restrictions

Mechanization services constrained to movement within the state/region or further within the village tracts had significantly negative effects. These included a greater likelihood of having prospects for revenue losses (Table 4), financial challenges like loan repayment and invoice payments (Table 5), and business challenges like logistic disruptions (Table 6). Effects are sometimes insignificant for certain outcomes, partly for tractors which generally tend to operate in smaller geography in the first place (e.g., Takeshima et al. 2015). However, the effects are often more significant for CSP who tend to have greater mobility in developing countries (e.g., Diao et al., 2020; Zhang et al., 2017). For example, movement restrictions significantly raised the likelihood that CSP will face financial challenges (Table 5). Overall, the negative effects are significant for a range of outcomes, suggesting that movement restrictions imposed as COVID-19 containment measures still had substantially large economic effects on MSP.

Higher price or reduced machines availability, attachments and spare parts

Increased prices and/or reduced availability of machines, attachments, and spare parts, as a result of indirect outcomes of COVID-19 restrictions, had negative effects on many of these outcomes as well. These included a greater likelihood of lower revenue and profit prospects (Table 4), financial challenges like loan repayment and invoice payments (Table 5), and greater business challenges, including the inability to deliver existing orders (Table 6).

Financial constraints due to exogenous factors

[4]We also estimated separate models accounting for cross-sectional dependence using `xtscc` command in STATA (Driscoll & Kraay 1998; 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.

The intensity of exogenous or pre-determined financial constraints, too, had negative effects on a broader range of outcomes. These included perceptions of revenue and profit losses (Table 4), all types of financial challenges (Table 5), and business challenges like the inability to deliver existing orders (Table 6). The broadly significant effects on financial challenges suggest that the breakdown of financial capacity by agents linked with MSP can easily incapacitate MSP's own financial transactions.

Coping mechanisms

MSP pursued different types of major coping mechanisms, depending on the type of restrictions (Table 7). MSP, particularly CSP 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 might offer compensation for movement restrictions that were imposed as COVID-19 mitigation measures. In contrast, MSP facing reduced availability or higher prices of machines and equipment in the market pursued loans from private individuals, possibly because these loans would not require additional compensations (i.e., interest payments). Those facing greater financial constraints were more likely to seek loans from private individuals, asset sales, or diversion of other incomes. Interestingly, those facing financial constraints or unfavorable machine/equipment market conditions were relatively less likely to seek formal sector finance. This is possibly because the formal sector, which assesses borrowers more rigorously, regarded the presence of these constraints by MSP as a greater risk for loan recovery. Overall, the findings 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, although the patterns were generally consistent between TSP and CSP.

Policy preferences

MSP expressed preferences for different policies depending on the types of restrictions and challenges they face (Table 8). MSP facing greater movement restrictions generally prefer financial-support policies focusing on the reduction of taxes/fees or rent/utilities, which can generally reduce financial burdens or financial support that involves an extension of current loan payment periods or provision of additional loans. MSP facing movement restrictions also prefer policies that allow 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 machines availability and equipment also generally prefer policies for reducing taxes/fees, financing/loan extension/debt relief, or rent/utilities, which may ease financial burdens for machine acquisitions. They also prefer policies that allow greater movement of machines across regions or keep machine shops open. Some of the statistically significant negative preferences may also reflect that respondents wanted relatively less of those policies as they recognize that these policies have opportunity costs or are simply not as preferable as other policies.

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

Movement restrictions

Similar to MSP, restrictions on movement or sales have had negative effects on various outcomes for MER. MER that were constrained in machines' movement within townships or within states or regions significantly raised the likelihood of reduced revenue and profit prospects (Table 9). Overall, movement restrictions broadly shifted MER's financial prospects downward. These effects on revenues are broad, consisting of reduced sales, particularly on combine harvesters, or the increased likelihood that the sales of at least some equipment handled by MER dropped. The perceived effects could typically be more than a 20% drop in sales. Movement restrictions also negatively affected business activities, including the likelihood of facing general business issues like disruptions in logistics.

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

The effect of sales bans at various locations, including inside stores, at the storefront, or through deliveries on revenue prospects, conditional on movement restrictions, are somewhat insignificant. This may be because sales of equipment are sometimes made on an 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 storefront.

Nonetheless, these restrictions on sales practices still led to more significant challenges. In particular, to a greater extent, sales restrictions led to a substantial reduction in sales (by more than 20% compared to the same period in the previous year) of certain equipment, including combine harvesters, spare parts, or other equipment than 4wt. 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 equipment deliveries (Table 10). More intense sales restrictions also led to reduced ability to deliver existing orders, possibly because these might have prevented MER from physically handing over equipment to buyers (Table 11).

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

Compared to the case of MSP who are mostly buyers of equipment, MER are both buyers and sellers of equipment. On balance, similar to the case for MSP, higher prices and/or reduced availability of equipment lowered revenue prospects of MER (because reduced availability may indicate reduced sales, even when prices per equipment are high) (Table 9). Such revenue prospects seem particularly driven by reduced sales of 4wt (Table 10). Higher prices and/or reduced availability of equipment also led to increased business challenges, such as reduced ability to deliver existing orders, but also from greater disruption in their logistics (especially dealing with a higher purchase price of equipment) (Table 11).

Financial constraints

Similar to the case for MSP, financial constraints had negative effects on a broader range of outcomes for MER. Facing broader dimensions of financial constraints led to more pessimistic revenue and profit prospects (Table 9), which may be driven particularly by reduced sales of combine-harvesters (Table 10) due particularly to business challenges like the inability to deliver existing orders (Table 11).

Coping mechanisms

Similar to MSP, major coping mechanisms used by MER varied somewhat depending on the types of restrictions they faced (Table 12). MER facing movement restrictions tend to seek more loans from the government, while they are less likely to pursue other coping mechanisms like obtaining loans from private individuals, liquidating assets, or using other incomes. 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 asset inventory. However, the effects of facing bans in sales mode (bans sales in-store, store-front, or through deliveries), conditional on these movement restrictions, often had the opposite effects from movement restrictions. This may be because these restrictions directly limit the stock of equipment. Intuitively, when facing higher price and reduced availability of equipment in the market, MER resort primarily to selling their inventory. Similar to MSP, when facing financial constraints, MER seek more loans from private individuals rather than the government or commercial banks because the formal sector may consider the presence of these financial constraints by MER as a greater risk for loan recovery.

Preferred policies

Preferred policies expressed by MER also vary, depending on the types of restrictions and constraints they face (Table 13). Those facing movement restrictions were relatively more likely to prefer policies that allow greater movement of machines across regions or extend the current loan repayment period, while they were relatively less likely to prefer policies to expand the provision of additional loans, which may simply put MER in greater debt. MER who are banned from sales in some format are more likely to prefer policies that keep machines/parts shops open and policies that reduce rent/utility for warehouses and shops where they have to keep their stocks longer, while less preferring policies to extend current loan repayment period or to allow greater movement of machines across regions as these policies may be ineffective as long as sales are banned. MER facing greater financial constraints prefer policies for loan extensions or debt relief, possibly because these MER consider that these measures can directly help address their financial constraints. In contrast, these MER prefer less the policies that focus on reducing taxes or fees, rent, or utilities, possibly because of concerns that these policies do not directly or sufficiently mitigate their financial constraints.

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 payments than the previous year, or whether customers currently owe loans from MER. They also hold controlling for the survey round dummy variables, their interactions with time-invariant factors (whether the MER is based in one of the

Ayeyarwady, Yangon, or Bago regions that are characterized more as Delta zone, 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 14 present the estimated dynamic effects of revenue perspectives on subsequent periods, estimated through dynamic-panel estimation methods (2).[5, 6] 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 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 and/or higher price of machines and equipment and the extent of financial constraints. 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, samples of TSP only, and different estimation methods (One-step GMM or Two-step GMM).

It is important to note that, as we described earlier, the prospects are for the final revenue that would be earned by the end of 2020 compared to the revenue earned in 2019, held at each round of survey in 2020. This point also clarifies the reviewer's second question as we respond below. The "lower prospects" at t conditional on observed variables X_{it} (all the shocks and constraints), is both further affected by respondent-specific factors (c_i in equation (2)), which may include personalities, and affected by idiosyncratic errors (ε_{it} in equation (2)) which further affect the respondent's prospects randomly, due to factors that are observable to respondents but not to researchers. Our findings do not simply say that respondents were correct about their revenue prospects in the next round, but rather, the prospects in a particular round are explicitly affected by the prospects in the previous round, or in other words, there are dynamic relations in the prospects. If the persistence in negative prospects is simply reflecting that the respondent is 'correct' about their prospects, it may be more likely to be captured in variations in c_i in equation (2), while the prospect in t is not affected by the prospect in $t - 1$. This would be contrary to our findings in Table 14.

Table 15 further shows 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 prospects in the previous period that the revenue for the year 2020 would be lower than the revenue earned in 2019 statistically significantly increases the number of "desperate" business practices that may be suboptimal, used by MSP at the current period with the hope of recovering sunk costs on machines. These effects hold after controlling for other factors, for both all MSP and TSP specifically, and across different estimation methods.

[5]We also 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 the 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.

[6]As is shown in Tables 14 and 15, 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.

Importantly, financing sources for the acquisition of machines can also affect the patterns of these dynamics. For example, if MSP had purchased the machine outright, they may have a different optimal level of service provision in the short run than MSP who own machines through a hire purchase agreement with bank finance and may face repossession if they do not meet the loan repayment schedule. It is not possible in this paper to test this directly as we do not have the information on the financing source of machine acquisition. Significantly positive coefficients on the index of the financial constraint in Tables 14 and 15, however, broadly suggest that facing greater indebtedness (for example, having bought a machine through a hire-purchase agreement with bank finance rather than having bought it outright) further aggravates the negative revenue perceptions, and makes desperate service provisions more likely.

Overall, 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, have 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 to provide 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, indirect changes in machine and equipment markets, and financial constraints. Restrictions on movements generally had negative effects on revenue prospects, sales of various types of machines and equipment, and various financial and business challenges. These generally applied to a range of restrictions, whether the movement was restricted to within region/state, township, or village tract. These negative effects were in addition to the damaging effects caused by indirect outcomes of COVID-19, including higher costs and reduced machine availability, 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 equipment market constraints, and other various types of existing financial constraints led to significant heterogeneity in coping mechanisms pursued and supporting policies preferred by MSP and MER. The heterogeneity is not only 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 constraints, among others.

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 costs made on machines. Consequently, for agents like MSP in Myanmar, mitigating negative business prospects at the beginning of the production season is particularly important.

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Table 1. Samples of MSP and MER

Type of respondents	Sub-categories of respondents	Round-1	Round-2	Round-3	Round-4	Round-5	Interviewed in all of rounds 1 - 3	Interviewed in all of rounds 4 - 5	Among those interviewed in all 5 rounds		Total observations appearing for at least 2-rounds
									Interviewed in all of rounds 1 - 3	Interviewed 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
	Total	329	311	238	244	231	228	231	63	58	1,351
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.

Note: In this and all subsequent tables, TSP = tractor service providers; CSP = combine-harvester service providers; MSP = mechanization service providers; MER = mechanization equipment retailers.

Table 2. Descriptive statistics: outcome variables

Variables	TSP	CSP	MER
holds prospect of lower revenue in 2020 than in 2019	0.629	0.684	0.609
holds prospect that drops in revenue is more than the drop in cost	0.399	0.528	0.403
face challenges in loan repayment	0.216	0.232	
face challenges in payment of invoices	0.131	0.116	
face increased financial problems	0.668	0.655	
sales drop by more than 20% (4wt)			0.511
sales drop by more than 20% (combine harvesters)			0.467
sales drop by more than 20% (spare parts)			0.405
sales drop (any equipment handled)			0.812
sales drop by more than 20% (any equipment handled)			0.576
Business challenges			
cannot deliver existing orders	0.116	0.290	0.230
face disruption to logistics	0.360	0.624	0.497
Coping methods			
obtain loans from government	0.128	0.196	0.103
obtain loans from commercial banks	0.065	0.065	0.161
obtain loans from private individuals	0.224	0.205	0.130
liquidate assets	0.273	0.212	0.152
use other incomes	0.237	0.250	0.082
Preferred policies			
reduce taxes/fees	0.132	0.147	0.497
extend loans/debt relief	0.369	0.287	0.276
allow movement of machines across regions	0.146	0.443	0.245
keep machine/parts shops open	0.127	0.151	0.024
reduce rent / utilities	0.202	0.220	0.303
additional loans for small enterprises	0.353	0.298	0.333
Number of full panel observations (combined)	904	447	330
Average numbers of panel rounds	3.5	2.9	3.3

Source: Authors.
All outcome variables are binary variables, taking value of 1 if yes, and 0 otherwise.

Table 3. Descriptive statistics: exogenous variables

Variables		Unit	TSP	CSP	MER
Time-variant variables					
movement restricted	within village tracts	Yes = 1	0.369	0.062	
	within township	Yes = 1			0.155
	within state/region	Yes = 1	0.967	0.922	0.336
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
sales restriction index (sum of above three variables)		Count			0.379
face higher machines costs than previous year		Yes = 1	0.367	0.278	0.185
face reduced machine availability than previous year		Yes = 1	0.209	0.185	0.376
equipment market constraint index (sum of above two variables)		Count	0.576	0.463	0.561
indebtedness (owe loans to dealers / banks)		Yes = 1	0.488	0.599	0.522
do not receive an extension on current loan payment		Yes = 1	0.397	0.461	0.273
more request for late payment by customers		Yes = 1	0.738	0.710	0.385
imminent risk of financial asset exhaustion		Yes = 1	0.463	0.401	0.443
financial constraints index (sum of above four variables)		Count	2.086	2.171	1.623
rainfall percentile		Percentile (1 = 100%)	0.260	0.326	0.314
Time-invariant variables					
selling four-wheel tractor (4wt)		Yes = 1			0.591
franchise		Yes = 1			0.448
Regions					
Ayeyarwady		Yes = 1	0.156	0.704	
Bago		Yes = 1	0.107	0.165	
Magway		Yes = 1	0.559	0.033	
Mandalay		Yes = 1	0.051	0.031	
Sagaing		Yes = 1	0.114	0.049	
Yangon		Yes = 1	0.006	0.018	
Delta zone (proxied by Ayeyarwady, Yangon and Bago regions)		Yes = 1			0.491
year of establishment		Year	2015.6	2016.3	2009.6
Number of full panel observations (combined)			904	447	330
Average numbers of panel rounds			3.5	2.9	3.3

Source: Authors.

Table 4. Effects of COVID-19 related restrictions on revenue perceptions (MSP)

Variables		holds prospect of lower revenue in 2020 than in 2019		holds prospect that drops in revenue is more than the drop in cost	
		TSP	CSP	TSP	CSP
movement restricted	within village tracts	.100***	.202*	.026	-.043
	within state/region	.139**	.185*	-.078	-.009
equipment market constraints index		.065***	.068*	.091***	.040
financial constraints index		.068***	.051*	.010	.116***
rainfall percentile		Included			
round dummy		Included			
round dummy*time invariant variables		Included			
constant		Included			
Number of observations		904	447	904	447
P-value (H0: variables jointly insignificant)		.000	.000	.000	.000

Source: Authors. *10% **5% ***1%

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

Variables		face challenges in loan repayment		face challenges in payment of invoices		face increased financial problems	
		TSP	CSP	TSP	CSP	TSP	CSP
movement restricted	within village tracts	-.037	.176*	.018	.106*	-.012	.132
	within state/region	.122	.147*	.050	.126*	.086	.061
equipment market constraints index		.050*	.043	.047*	.125***	.003	-.062
financial constraints index		.051***	.140***	-.006	.051*	.087***	.154***
rainfall percentile				Included			
round dummy				Included			
round dummy*time invariant variables				Included			
constant				Included			
Number of observations		904	447	904	447	904	447
P-value (H0: variables jointly insignificant)		.000	.000	.000	.000	.000	.000

Source: Authors. *10% **5% ***1%

Table 6. Effects of COVID-19 related restrictions on business challenges (MSP)

Variables		cannot deliver existing orders		face disruption to logistics	
		TSP	CSP	TSP	CSP
movement restricted	within village tracts	-.002	-.070	-.069	.230*
	within state/region	-.011	-.006	.361***	-.064
equipment market constraints index		.029*	.148***	.027	.057
financial constraints index		.040***	-.005	-.013	-.038
rainfall percentile		Included			
round dummy		Included			
round dummy*time invariant variables		Included			
constant		Included			
Number of observations		904	447	904	447
P-value (H0: variables jointly insignificant)		.000	.000	.000	.000

Source: Authors. *10% **5% ***1%

Table 7. Effects of COVID-19 related restrictions on coping mechanisms (MSP)

Variables		obtain loans from government		obtain loans from commercial banks		obtain loans from private individuals		liquidate assets		use other incomes	
		TSP	CSP	TSP	CSP	TSP	CSP	TSP	CSP	TSP	CSP
movement restricted	within village tracts	.007	.176*	.007	.043*	.092*	-.021	-.040	.198*	-.040	.084
	within state/region	.026	.188***	.006	-.072	-.003	-.109	.174*	.181*	.174*	-.077
equipment market constraints index		-.052**	-.078**	-.049**	-.046*	.086***	.040	.024*	.141***	.024*	.081*
financial constraints index		-.009	-.053**	-.017*	-.020*	.058***	.038*	.047***	.062**	.047***	.075***
rainfall percentile						Included					
round dummy						Included					
round dummy*time invariant variables						Included					
constant						Included					
Number of observations		904	447	904	447	904	447	904	447	904	447
P-value (H0: variables jointly insignificant)		.000	.000	.000	.000	.000	.000	.000	.000	.000	.000

Source: Authors. *10% **5% ***1%

Table 8. Effects of COVID-19 related restrictions on preferred policies (MSP)

Variables	reduce taxes / fees		reduce financing / extend loans / debt relief		allow movement of machines across regions		keep machine/parts shops open		reduce rent / utilities		additional loans for small enterprises	
	TSP	CSP	TSP	CSP	TSP	CSP	TSP	CSP	TSP	CSP	TSP	CSP
movement restricted within village tracts	.102***	.124*	.193***	.323***	.072**	.173*	-.056*	-.136*	-.170	-.433	.263***	.354***
within state/region	.140**	.029	-.005	-.204	.080	-.070	-.106*	-.007	.228**	.326***	-.129	-.134
equipment market constraints index	.051***	-.043	.083***	.052	-.044**	-.008	.021	-.004	.037*	.099*	.012	.043
financial constraints index	-.048***	-.074***	.060**	.059*	.051***	.007	.040***	.037*	-.033*	.018	-.026	.020
rainfall percentile	Included											
round dummy	Included											
round dummy*time invariant variables	Included											
constant	Included											
Number of observations	904	447	904	447	904	447	904	447	904	447	904	447
P-value (H0: variables jointly insignificant)	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000

Source: Authors. *10% **5% ***1%

Table 9. Effects of COVID-19 related restrictions on revenue perceptions (MER)

Variables		holds prospect of lower revenue in 2020 than in 2019	holds prospect that drops in revenue is more than the drop in cost
movement restricted	within township	.132*	.154**
	within state/region	.098**	.037
sales restriction index		.044	.069*
equipment market constraints index		.152***	.010
financial constraints index		.074***	.058*
rainfall percentile		Included	
round dummy		Included	
round dummy*time invariant variables		Included	
constant		Included	
Number of observations		330	
P-value (H0: variables jointly insignificant)		.000	.000

Source: Authors. *10% **5% ***1%

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

Variables		sales drop by more than 20% (4wt)	sales drop by more than 20% (combine harvesters)	sales drop by more than 20% (spare parts)	sales drop (any equipment handled)	sales drop by more than 20% (any equipment handled)
movement restricted	within township	-.083	.060	.068	.050	.083
	within state/region	.108	.265*	-.096	.126**	.176**
sales restriction index		.071	.097**	.083*	.023	.069*
equipment market constraints index		.083*	.038	-.035	.034	.024
financial constraints index		-.031	.065*	.002	-.019	-.017
rainfall percentile				Included		
round dummy				Included		
round dummy*time invariant variables				Included		
constant				Included		
Number of observations		190	105	247	330	330
P-value (H0: variables jointly insignificant)		.000	.000	.000	.000	.000

Source: Authors. *10% **5% ***1%

Table 11. Effects of COVID-19 related restrictions on business challenges (MER)

Variables		cannot deliver existing orders	face disruption to logistics
movement restricted	within township	.022	.237***
	within state/region	-.038	.118*
sales restriction index		.125***	.003
equipment market constraints index		.116***	.082*
financial constraints index		.080**	-.013
rainfall percentile		Included	
round dummy		Included	
round dummy*time invariant variables		Included	
constant		Included	
Number of observations		330	
P-value (H0: variables jointly insignificant)		.000	.000

Source: Authors. *10% **5% ***1%

Table 12. Effects of COVID-19 related restrictions on coping mechanisms (MER)

Variables		obtain loans from govern-ment	obtain loans from commer-cial banks	obtain loans from private in-dividuals	liquidate assets	use other incomes
movement restricted	within township	.117***	.096*	.081	-.098*	-.053*
	state/region	.104***	.107*	-.045*	-.016	.015
sales restriction index		-.040*	-.036*	-.026	.103*	-.040**
equipment market constraints index		-.029*	.008	-.042*	.074***	.030*
financial constraints index		-.063***	-.015	.050*	-.014	.007*
rainfall percentile				Included		
round dummy				Included		
round dummy*time invariant variables				Included		
constant				Included		
Number of observations				330		
P-value (H0: variables jointly insignificant)		.000	.000	.000	.000	.000

Source: Authors. *10% **5% ***1%

Table 13. Effects of COVID-19 related restrictions on preferred policies (MER)

Variables		reduce taxes / fees	reduce financing / extend loans / debt relief	allow movement of machines across regions	keep machine/parts shops open	reduce rent / utilities	additional loans for small enterprises
movement restricted	within township	.055	.126*	.058*	.058	.034	-.229**
	within state/region	.031	-.043	.055	.055	.120*	-.165*
sales restriction index		-.035	-.061*	-.060*	.066**	.088**	-.037
equipment market constraints index		.054*	.056*	.016	-.060*	.055	-.045
financial constraints index		-.093**	.072**	.058	.016	-.057*	.021
rainfall percentile				Included			
round dummy				Included			
round dummy*time invariant variables				Included			
constant				Included			
Number of observations				330			
P-value (H0: variables jointly insignificant)		.000	.000	.000	.000	.000	.000

Source: Authors. *10% **5% ***1%

Table 14. Dynamics of revenue prospects (MSP)

Variables	All		All (Summer)		TSP		TSP (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	**.148****	**.149***	**.179****	**.179***	**.175****	**.160****	**.178****	**.191***
movement restricted within village tracts	.139***	.140***	.145***	.139***	.132***	.119***	.138***	.130**
within state/region	.025	.022	-.053	-.063	-.051	-.045	-.028	-.039
equipment market constraints index	.061**	.057*	.062*	.062*	.076**	.076*	.070*	.072*
financial constraints index	.094***	.109***	.098***	.107***	.103***	.117***	.097***	.105***
rainfall percentile	Included							
round dummy	Included							
round dummy*time invariant variables	Included							
constant	Included							
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
p-value								
Arellano-Bond test: AR(1)	.692	.761	.680	.757	.831	.718	.700	.865
Arellano-Bond test: AR(2)	.869	.848			.601	.703		
Arellano-Bond test: AR(3)	.997	.998			.876	.922		
Not overidentified (Sargan)	.292		.206		.607		.545	
Not overidentified (Hansen)	.238		.139		.771		.506	
Exogeneity of instrument subsets (Hansen test)	.488		.701		.928		.927	

Source: Authors. *10% **5% ***1%

In both Table 14 and Table 15, 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 15. Effects of revenue prospects on the number of seemingly desperate service provisions in the next season (MSP)

Variables	All		All (Summer)		TSP		TSP (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	**.234****	**.269****	**.277****	**.262****	**.287*****	**.238****	**.311****	**.311*****
movement restricted within village tracts	.202***	.193***	.200***	.194**	.219***	.231***	.206***	.207***
within state/region	.100	-.028	-.005	.014	-.028	-.108	-.035	-.008
equipment market constraints index	.100**	.098**	.149***	.133***	.140***	.103*	.150***	.139***
financial constraints index	.144***	.144***	.131***	.131***	.122***	.124***	.126***	.122***
rainfall percentile	Included							
round dummy	Included							
round dummy*time invariant variables	Included							
constant	Included							
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
p-value								
Arellano-Bond test: AR(1)	.685	.556	.337	.322	.311	.236	.305	.308
Arellano-Bond test: AR(2)	.118	.131			.125	.175		
Arellano-Bond test: AR(3)	.777	.735			.418	.441		
Not overidentified (Sargan)	.549		.858		.425		.934	
Not overidentified (Hansen)	.681		.772		.858		.905	
Exogeneity of instrument subsets (Hansen test)	.199		.284		.861		.401	

Source: Authors. *10% **5% ***1%

Appendix A: Additional results

Table 16. 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	660.7115	.000	803.1750	.000	922.1867	.000
Inverse normal	-10.3996	.000	-14.9320	.000	-17.6178	.000
Inverse logit t	-20.3288	.000	-27.0248	.000	-35.5315	.000
Modified inverse χ^2	4.5758	.000	9.0191	.000	12.7310	.000
Number of panel respondents	291		291		291	
Average number of periods	3.53		3.53		3.53	

Source: Authors.

Note: p-value**s** 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.