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COVID-19 disruptions and pivoting in SMEs in the hidden middle of Kenya's potato and fish value chains

RESEARCH PAPER

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Abstract

Small and medium enterprises (SMEs) in Kenya were severely affected by the COVID-19 pandemic and restrictions put in place to contain it. This study assesses the impact of these restrictions on the midstream of the potato and fish value chains, with a focus on traders and processors, and investigates the short- and longer-term responses and 'pivoting' strategies deployed by these firms. Longitudinal data were collected from 937 respondents with three recall periods: (1) the pre-pandemic situation (2019); (2) the period of strictest restrictions, necessitating immediate adaptations by firms (2020); and (3) a period of anticipated recovery with longer-term business adaptation strategies (2021). Firms in both value chains reported a dramatic drop in turnover in 2020. Potato SMEs partially recovered in 2021, but fish SMEs reported further declines in turnover. In the face of restrictions, SMEs shifted toward more localized procurement and sales, shorter supply chains (often by-passing intermediaries and increasing use of contracts), use of smaller vehicles, and toward the adoption of information and communication technology (ICT) to search for and engage with business partners. Smaller firms and the biggest of businesses were more resilient and less subject to large fluctuations in business turnover, suggesting an inverted U-shape relationship between firm size and impact. Firms located close to production areas and selling primarily within their own county were also less affected. We provide recommendations for increasing business resilience to shocks based on these findings.

Keywords: COVID-19, pivoting, value chains, potatoes, fish, small and medium enterprises (SMEs), Kenya
JEL codes: L22, L25, O33, Q13

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1. Introduction

Potato and fish value chains in Kenya were severely affected by the COVID-19 pandemic and measures put in place by the government to contain it. In Kenya, as in many other countries, lockdowns, curfews, travel restrictions, and other restrictive measures were introduced in March 2020, soon after the outbreak of the pandemic. Over time, many of these restrictions were removed, relaxed, reintroduced, or strengthened in the attempt to achieve a balance between public health and economic priorities under changing circumstances. Small and medium enterprises (SMEs) in Kenya have been reported among the most severely impacted by COVID-19 restrictions in the world (Nordhagen *et al.*, 2021). This study was conducted to assess the impacts of the pandemic and investigate the responses deployed by SMEs in the midstream of the potato and fish value chains, with a focus on traders and processors.

In Kenya, potatoes are the second most important food crop after maize. They are grown largely for commercial purposes. Most production is traded domestically over long distances through traders. There are over 200 companies that process potatoes, ranging from large-scale processors to cottage industries. Imports of processed potato products are on the rise due to the rapid emergence of supermarkets and fast food chains although these chains still handle a small share of total potato consumption. It is projected that 14% of the demand for crisps (what US calls potato chips) and 27% of ready-cut frozen chips (what US calls French fries) will be met through imports by 2024 (IFC, 2019). Nairobi alone has more than 800 restaurants selling chips, the great majority of them independent (non-chain) SME outlets.

The Kenyan fishery sector provides food, jobs, and income to a large population. Over 80% of supply comes from capture fisheries in Lake Victoria, and is traded over long distances. Intensive fish culture using high-density polyethylene cages and semi-intensive pond-based aquaculture is also growing rapidly. While most of the fish produced in Kenya is domestically traded, about a quarter of fish consumed in the country is imported and about 10% of the fish produced locally is exported (primarily as processed frozen fillets). Processing, transport logistics and cold storage logistics SMEs play critical roles in the fish supply chain.

Potatoes and fish are sold as fresh, processed, and frozen. Most output is sold in domestic markets. There are many small farms and SMEs in farm production, processing, and trade, as well as a few large-scale firms, mainly in processing and retail. The SMEs themselves range over very small to small to medium firms. This is a good context to analyze: (1) the diversity of strategies deployed by the actors to cope with (short-term) and adapt to (long-term/forward-looking) the changing circumstances brought by the pandemic; and (2) how the characteristics of midstream SMEs mitigated or exacerbated the impacts of the pandemic.

Resilience to shocks depends on actors' adaptive capacity and on the responses they put in place (Béné *et al.*, 2016; Upton *et al.*, 2021). Capacities for pivoting – defined as 'major, discrete adaptation that substantially alters supply chains, via changes in market channels, technologies, and commercial organization' (Reardon *et al.*, 2021b) – in response to shocks are highly heterogenous (Winston, 2014). Furthermore, actors seldom act alone in their pivoting strategies, but do so in complementary ways with other segments actors (co-pivoting) (Reardon *et al.*, 2021b).

A growing body of literature on the impact of COVID-19 on agri-food value chains in developing countries has been published over the last couple of years, including on our target commodities (e.g. Alam *et al.*, 2022; Fiorella *et al.*, 2021; Vargas *et al.*, 2021). However, as noted by Béné *et al.* (2021), many such studies have been anecdotal. Furthermore, many studies have focused on the impacts of the shock on the upstream and downstream of the value chain – that is, the farmers/fishers, the consumers, or on exports and imports (Stoian *et al.*, 2021), but there has been far less empirical analysis of how SMEs in the midstream – in wholesale, transport, and processing, have pivoted and co-pivoted in response to the COVID-19 shock. The midstream typically accounts for a share of total value chain costs and value added similar to the share of farmers, and is often a vibrant, dynamic, growing, and important set of sectors – and yet it is often called the 'missing middle' and neglected in, hidden from the policy debate, and thus has been called the 'hiddle middle' (Reardon, 2015).

Drawing on recently published theoretical work (Reardon *et al.*, 2021b) we address these gaps in the literature by looking for evidence of 'pivoting' and 'co-pivoting' behavior among potato and fish value chain actors during the pandemic. We seek to understand differences and commonalities in pivoting strategies deployed by firms across the target value chains, and among different types of businesses within each chain. We address the following two research questions: (1) How did businesses pivot in terms of geography of procurement and distribution, industrial organization (e.g. type of and relations with business partners), transport and logistics, and increased adoption of information and communication technology (ICT) to mitigate (or cope with) the pandemic shocks? (2) What kinds of firms were most hurt by and most vulnerable to the shocks, before and after pivoting? For the first research question we built on existing literature and hypothesized pivoting behaviors that businesses might have adopted.

First, it has been observed in some countries that enterprises operating in short, local food supply chains have been less affected by COVID-19 restrictions (Thilmany *et al.*, 2021). Therefore, we hypothesized that firms could have pivoted toward more localized procurement and sales, and shorter supply chains.

Second, Reardon *et al.* (2021b) observe that COVID-19 resulted in pivoting in firms' industrial organization, with reconfiguration of the supply chain and major changes in types of and relations with business partners, including for transport and logistics, with some food industry firms pivoting to e-procurement to source from farmers and processors. This was facilitated by the development of business to business (B2B) e-platforms, helping large companies and SMEs to address logistics and search-cost constraints. In parallel, some SME food retailers and processors turned to e-commerce sales to consumers (Onjewu *et. al*, 2022). Therefore, we hypothesized that firms in Kenya met the challenge of reduced business operations and challenges in transportation by shifting toward more use of ICT in general and e-commerce in particular, and found other ways to cut transaction costs such as shifting to smaller vehicles and cutting out trader margins by buying direct from farmers.

For the second research question (how much and who was most hurt before and after pivoting), we explored how the scale and territorial focus of procurement and sales (local vs distant) conditioned how much the firms were hurt by the pandemic shock. There are opposing potential hypotheses.

On the one hand, small firms might be more resilient to shocks compared with larger firms as they are more flexible and nimble (Gilbert, 2005; Parker and Ameen, 2018). Thilmany *et al.* (2021) noted that, in face of the pandemic, small enterprises made agile pivots to new market channels and buyers by leveraging relationships in local food supply chains. Moreover, it has been argued that, compared with larger firms, small-scale firms have the advantage of strategic flexibility to technological changes, including digital transformation, thus attenuating the negative impact of the COVID-19 on their performance (Guan *et al.*, 2022).

On the other hand, larger firms have a greater capacity to diversify sources and sales destinations and thus manage risks and have a greater cash buffer to deal with the COVID-19 shocks (Ozdemir *et al.*, 2022; Reardon and Swinnen, 2020) and other disruptions (Ambulakr *et al.*, 2015). Smaller firms have less of this capacity and tend also to source from and supply a more local territory and thus are more vulnerable to the conditions in that territory.

Our study is characterized by several elements of novelty. First, it focuses on the businesses operating on the midstream of the value chain that have been neglected by most COVID-19 related studies, as noted above. Second, it looks at the impact on domestic rather than international trade, which is still largely a minor share of overall food output and consumption in Sub-Saharan Africa (Liverpool Tasie *et al.*, 2020). Third, it analyses the impact of COVID-19 on market structure, for instance on pivoting from distant to localized procurement and distribution, which has been neglected in the literature. Finally, it analyzes SME coping strategies over a longer period than most COVID-19 related studies, by covering the 2019 (pre-pandemic period), 2020 (introduction of restrictions) and 2021 (anticipated recovery and emergence of longer-term adaptation strategies). We are not aware of any other study which has adopted this approach.

The study's findings inform the management strategies of firms in agri-food supply chains in developing regions and are relevant to managers or management scholars interested in deepening their understanding of business resilience to shocks and associated adaptation strategies.

The paper is organized as follows: Section 2 presents study methods and analytical approaches. Section 3 presents and discusses the main results. The final section summarizes and discusses implications.

2. Methodology

2.1 Sampling and data collection

This study utilized longitudinal data collected from actors in potato and fish value chains in six counties in Kenya. The counties were selected purposively to represent three key production areas and two main consumption areas for commodities in the two value chains.[1]

The survey was conducted in August-September 2021 and focused on the trading and processing nodes of the value chain. Respondents were divided into two categories: (1) traders, including small-scale itinerant traders and brokers who operate primarily in rural areas and procure directly from farmers and fisherfolk, and wholesalers who are mainly located in urban areas, procure mainly from other traders, and sell across counties; (2) processors, including small-scale processors and medium-large processors (the latter in the potato value chain only).

[1] The map of survey locations is presented in the Appendix.

For the potato value chain, the targeted production counties were Nakuru (the second largest potato farming county in Kenya), Meru (where some small-scale irrigation – and, hence, off-season production – and a few large-scale potato farms with on-farm storage facilities exist), and Bomet (uniquely characterized by widespread contract farming with large-scale processors of potato crisps (what US calls potato chips).

For the fish value chain, targeted production counties were Nakuru (the location of Lake Naivasha, an important capture fishery), Meru (an area with rapidly growing small-scale pond-based aquaculture), and Kisumu (on Lake Victoria, a major hub for fish production and trade, including cross-border trade due to the proximity to Uganda). Kisumu is also an important consumption zone in addition to being a site of production.

For both potato and fish value chains, Nairobi and Mombasa were chosen as the two largest cities and consumption centers. In the case of fish, Mombasa doubles as a major production county for marine fish species, and a gateway for imported frozen fish.

Survey respondents in these counties were identified and randomly selected from several existing lists which were consolidated by commodity for sampling purposes. For potato supply chain actors, the lists included: officially registered wholesalers at county level, processors registered with the Kenya Bureau of Standards (KEBS), and small traders and informal processors from existing lists available from the National Potato Council of Kenya (NPCK). Actors in the fish value chain were located through lists available from the Kenya Marine and Fisheries Research Institute (KMFRI) and Maseno University (MU). Data were collected from 518 and 419 actors in the potato and fish value chain, respectively, for a total sample of 937 respondents.

The survey covered three periods: period 1: representing the situation prior to the pandemic (2019); period 2: characterized by high stringency of government-imposed restrictions and short-term coping strategies by value chain actors (2020); and period 3: characterized by partial restrictions still largely in place and emergence of longer-term adaptation to the pandemic (2021).

The Oxford COVID-19 Government Response Tracker[2] was used to identify the restrictions imposed by the Government of Kenya and their stringency. An adapted version of the Oxford COVID-19 Stringency Index was developed to focus only on restrictions most relevant to businesses, namely: workplace closure (Oxford category c2), restrictions on gatherings (c4), public transport closure (c5), stay at home requirements (c6) and restrictions on internal movement (c7). The evolution of the calculated Stringency index and weekly COVID-19 cases in Kenya since February 2020 is shown in Figure 1.

[2] https://www.bsg.ox.ac.uk/research/research-projects/coronavirus-government-response-tracker.

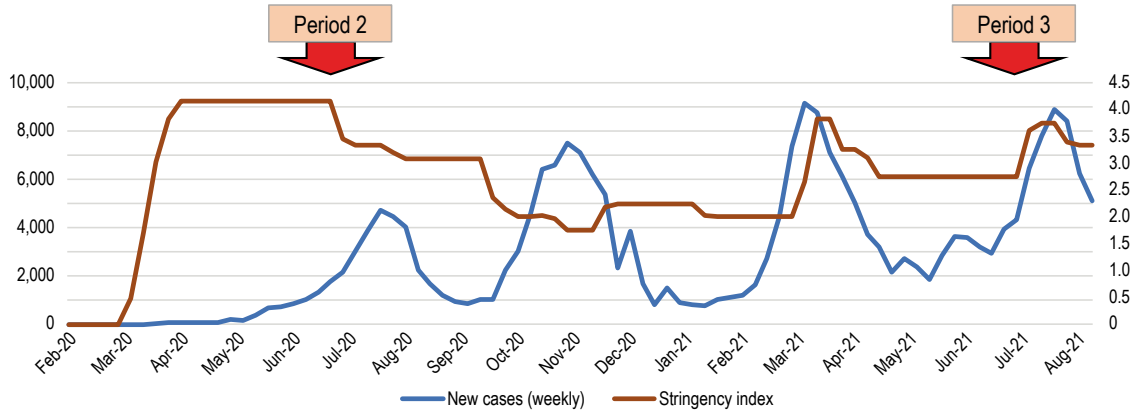

Figure 1. Reported COVID-19 cases, stringency of restrictions, and surveyed periods.

Furthermore, we considered the issue of seasonality. The potato value chain in Kenya is characterized by high seasonality of production and marketing because storage is extremely limited, and most farmers sell their potatoes immediately after harvest. Potatoes are typically harvested twice a year, with some limited off-season production occurring in swamps, valley bottoms, and irrigated areas. July-August and January-February are the main production and marketing seasons. In contrast, seasonality for fish is determined more by demand than supply. Fish is generally available year-round, thanks in part to aquaculture, with demand peaking around key holidays and festivals.

The best period to investigate the impact of government restrictions and the immediate responses of traders and processors to the pandemic was deemed July 2020, when restrictions were strictly enforced, although below their initial peak, and the first potato season after the emergence of COVID-19 was in full swing. To control for the effect of other seasonal factors and facilitate comparability, the same month of the previous year (2019) was considered as the base period representing the pre-COVID situation. July 2021 was chosen to explore whether the value chain actors and functions had recovered from the initial shock, and identify longer-term adaptation strategies. A structured questionnaire consisting of closed and open-ended questions was administered to respondents using Computer-Assisted Telephone Interviews (CATI).[3]

2.2 Empirical analysis methods

We first generated descriptive summary statistics of the characteristics and pivoting behaviors of value chain actors. We compared over the three periods.

We then implemented Ordinary Least Squares (OLS) regressions to assess the factors associated with the relative change in gross turnover over the study periods (2020 vs 2019, and 2021 vs 2020). We estimated Equation 1:

$$y_i = \alpha + x_i\beta + \varepsilon_i \quad (1)$$

Where y_i is the continuous dependent variable measuring the change in firm i's gross turnover over two consecutive years (2019 to 2020 and 2020 to 2021); x_i is a vector of explanatory variables including the location of the business (rural, peri-urban, urban; Nairobi, Mombasa, or 'production zones'), key socio-demographic characteristics of the business owner (gender, age, education), firm size, and territorial focus of procurement and sales (local vs distant); and ε_i is the error term. We estimated Equation 1 separately for fish and potatoes.

A variety of econometric tests were used to validate the regression models (Wooldridge, 2015). Heteroskedasticity was detected in the OLS models after conducting the Breusch-Pagan test and addressed by estimating heteroskedasticity-robust standard errors. Multi-collinearity was tested for in the OLS models using the variance-inflation factors (VIF). After the VIF test, several commercial behavior indicators were dropped from the model to deal with multi-collinearity, leaving only two commercial behavior indicators (proportion procured from own county in 2019 and proportion sold within own county in 2019) which were not highly correlated with the other independent variables.

[3] The survey was administered using the KoBo® Toolbox platform (www.kobotoolbox.org) by enumerators hired and trained by NPCK, MU and KMFRI. The research protocol and the questionnaire were reviewed and received ethical approval by the Institutional Research Ethics Committee (IREC) of the International Livestock Research Institute (ILRI). Prior to the interviews, each respondent was informed about the purpose of the study, the scope of the interview, and confidentiality issues. Consent was sought for each respondent before participation. All interviews were conducted in local languages for ease of comprehension. Responses were checked daily by a supervisor to ensure accuracy and consistency.

Finally, Probit regressions were estimated to understand the factors associated with the gross turnover of fish traders and processors in 2021, as compared to 2020. We estimated the following model:

$$y_i^* = \delta + x_i\gamma + \varepsilon_i$$

$$y_i = \begin{cases} 1, \textit{if } y_i^* > 0 \\ 0, \textit{otherwise} \end{cases}$$

$$\Pr(y_i = 1 | x_i) = \Phi(x_i'\gamma) \quad (2)$$

Where y_i^* is a latent unobserved variable whose counterpart, y_i, is observed in dichotomous form only; where $y_i = 1$ if the change in the firm's gross turnover for the product between 2021 and 2020 is positive and $y_i = 0$ if otherwise; and x_i is a vector of explanatory variables as defined in Equation 1. $\Phi(\cdot)$ is the standard normal cumulative distribution function (CDF); γ is a vector of parameters to be estimated; and ε_i is an error term. The Pearson goodness of fit test was used to evaluate the Probit models.

3. Results and discussion

3.1 Key characteristics of traders and processors

Table 1 summarizes characteristics of surveyed traders and processors for both value chains. Distinctions between each category of actor in the potato value chain are well defined, whereas fish value chain actors often combine partially overlapping roles (e.g. serving as both small traders and processors). For example, in the potato value chain, small traders appear to serve primarily as rural collectors in the main potato production zones, whereas in the fish value chain small traders are found in both production and consumption zones, and are often involved in retail sales, alongside other activities.

In the potato sample, traders are mostly located in the three production zones with small-scale traders and itinerant brokers, which mostly operate near farming areas, representing the majority of actors in this category. Similarly, most traders in the fish value chain are based in production zones. However, one quarter are located in Mombasa which, in addition to being classified as a consumption zone, is also an important supply side location for fish.

Differences in the location of processors in the two chains are more marked. For fish, most processing occurs on a very small scale (only one business in the whole sample could be classified as medium-large). Due to the high perishability of fish, small-scale processing typically occurs near production areas and serves to increase the product's shelf-life. Conversely, potato processors in the sample are relatively evenly distributed between production and consumption areas, reflecting the heterogenous nature of this business that includes small-scale processing and large-scale capital-intensive businesses, both of which operate close to potato production zones and in major cities.

Most actors in the sample are located in either urban or peri-urban areas. In both value chains, most small-scale traders, regularly operate in rural areas, but have peri-urban trading bases. Potato and fish wholesalers and medium-large potato processors are predominantly urban (data not shown).

The potato value chain is male dominated (72% of respondents) but 65% of actors in the fish value chain are female. However, women in the fish value chain are most heavily represented among small traders (79%) and least represented among wholesalers (56%) suggesting lower relative levels of representation in higher value activities (shown in our data analysis but not displayed here).

There are relatively few youths (aged 29 or under) in the midstream of either chain, but the average age of fish value chain actors skews somewhat lower than that of actors in the potato supply chain. Three percent

Table 1. Summary of respondent characteristics by value chain and segment.[1]

	Potato			Fish		
	Traders	**Processors**	**Overall**	**Traders**	**Processors**	**Overall**
Respondents						
Respondents (n)	305	213	518	278	141	419
Respondents (%)	59	41	100	66	34	100
Counties						
Mainly production						
Nakuru (%)	24	17	21	31	16	26
Meru (%)	24	18	21	10	25	15
Bomet (%)	25	10	19	N/A	N/A	N/A
Kisumu (%)	N/A	N/A	N/A	17	30	22
Mainly consumption						
Nairobi (%)	13	29	20	18	16	17
Mombasa (%)	14	26	19	25	14	21
Location						
Urban (%)	29	54	40	54	58	56
Peri-urban (%)	51	44	49	38	33	36
Rural (%)	19	1	12	8	9	8
Gender						
Female (%)	27	29	28	68	61	65
Age range						
Age 20-29 (%)	4	2	3	13	0	15
Age 30-39 (%)	20	16	18	32	17	31
Age 40-49 (%)	35	40	37	38	28	36
Age 50-59 (%)	27	24	26	13	33	15
Age 60+ (%)	14	19	16	4	18	4

[1] N/A = not applicable.

of potato value chain actors are aged 29 or under, as compared to 15% of those in the fish value chain. The most common age bracket in both chains is 40-49, accounting for over one third of all respondents.

Table 2 presents the details of the main product forms sold by potato processors in 2019. Smaller processors sold mainly potato chips (what US calls 'French fries'), whereas larger 'industrial' processors sold mainly potato crisps (what US calls potato chips) and chilled or frozen ready-cut chips. All traders dealt exclusively in raw, unprocessed potatoes.The fish value chain is characterized by diverseproduction and trading practices. Tilapia (primarily sourced from capture fisheries and farms in lakes) is the most commonly traded and processed fish. Marine species and Nile Perch (*Lates niloticus*) are also traded widely. The former is commonly traded by small traders, concentrated in Mombasa on the Kenyan coast. The latter, a high value species harvested from capture inland fisheries, is more important for larger traders. Nile Perch is also an important fish for larger scale processors while small processors are most likely to deal with Mukene or Omena (small pelagic species harvested from freshwater capture fisheries in the Great Lakes).

Fresh fish is by far the predominant product form traded by larger traders. Larger traders are also more likely to deal with frozen fish. In contrast, small traders and processors are equally likely to trade in fresh fish and fried fish, with dried/smoked fish the next most important product type. This points to larger traders having more access to facilities (e.g. ice and cold storage) needed to maintain fresh fish in good condition or deal in frozen fish, whereas small traders and processors are more likely to sell preserved product forms (fried, dried). This also suggests a significant overlap in roles between small traders and small processors, and a relatively low degree of specialization among these actors.

Table 2. Main potato product form sold by potato processors in 2019.

Product form	Respondents (%)
Fried chips (US, 'French fries')	43
Crisps (US, 'potato chips')	27
Chilled ready-cut chips	12
Washed and peeled whole potatoes	10
Washed & peeled chopped/sliced potatoes	4
Frozen ready-cut chips	3
Washed potatoes	1
Total	100

3.2 Impacts of COVID-19 restrictions on business operations, prices and market concentration

Table 3 presents five sets of indicators of the depth of impact of the COVID-19 pandemic on surveyed businesses, by year (2019, 2002, and 2021): the share of businesses operating during July; the mean number of days operated per week; the average volumes traded during those weeks; the fish purchase price; and market concentration (indicated by the Gini index of sales).[4]

18% of potato traders and 16% of processors stopped operations in 2020, but almost all these businesses were operational again in 2021. In the fish value chain, there was no significant change in the number of traders during the observed period, in part because some of them started the business only in 2020 or 2021. Significantly more of the fish processors in the sample operated in 2021 than in 2020 or 2019, perhaps implying that the fish value chain has a higher turnover of entrants than the potato value chain.

The average number of days operated by potato businesses fell by about half in July 2020, compared to 2019. This decline was larger for traders than processors. The average number of operational days increased sharply in 2021 but remained significantly lower than in 2019. A similar, although far less pronounced temporal pattern was found in the fish value chain, with some reduction in 2020 followed by a partial recovery in 2021. A possible explanation for these differences is that the fish value chain is relatively a-seasonal in terms of supply (fish are available year-round), leading to a high degree of specialization in fish related activities, which become a central element in the livelihood portfolios of those involved. By contrast, the supply of potatoes is highly seasonal, leading actors in the trading segments to enter and exit opportunistically.

The average quantity of product handled per week during July followed a similar but even more dramatic decline than in the number of operational days per week, indicating that the average quantity traded on an operational day declined alongside the number of operational days. Again, this decline was particularly severe in the potato value chain, and more acute among potato traders (-85%) than processors (-62%). In

[4] The Gini index is a statistical measure of dispersion that is commonly used to measure income distribution inequality (Gini, 1921). It ranges from 0 (complete equality) to 1 (complete inequality) (Farris, 2010). The Gini index has been used to measure market concentration together with other measures such as the Herfindahl-Hirschman index (HHI) and concentration ratios (CRs) (Nguyen *et al*., 2020; Skuflic *et al*., 2011; Tanusondjaja *et al*., 2021). We chose the Gini index to measure the distributional inequality in the total volume of sales by fish and potato actors (market shares) in July 2019, 2020, and 2021. This is because the Gini index measures the inequality of market shares across all actors, whereas HHI and CRs focus on sales among a small number of large actors (Tanusondjaja *et al*., 2021). Moreover, the Gini index is sensitive to the number of actors with close to zero market shares, in contrast with the HHI which measures the diversity of the shares and remains almost unaffected by the number of actors with close to zero market shares.

Table 3. Business operations, prices, and market concentration in July 2019, 2020, and 2021.[1]

	Year			Paired *t*-tests		
Indicators	**July 2019**	**July 2020**	**July 2021**	**Diff 1 (2020-2019)**	**Diff 2 (2021-2020)**	**Diff 3 (2021-2019)**
Potato traders						
% of firms operating business	100	82	99	-18.0***	17.0***	-1.0*
Mean days operated/week (days)	4.5	2.1	2.8	-2.4***	0.7***	-1.7***
Gross turnover (tons/week)	14.9	2.2	4.6	-12.7***	2.5***	10.3***
Procurement price index (2019=100)	100	73	82	-27.2***	8.7***	18.4***
GINI index of sales	0.54	0.57	0.55	0.03	-0.02	0.01
Potato processors						
% of firms operating business	100	84	100	-16.0***	16.0***	0.0
Mean days operated/week (days)	5.6	3.5	4.1	-2.0***	0.6***	-1.5***
Gross turnover (tons/week)	21.9	8.2	12.7	-13.7***	4.5***	-9.2***
Procurement price index (2019=100)	100	81	92	18.9***	11.0***	-7.9***
GINI index of sales	0.55	0.63	0.63	0.08	0.00	0.08
Fish traders						
% of firms operating business	94	92	92	-1.4	0.0	-1.4
Mean days operated/week (days)	5.9	5.5	5.6	-0.4***	0.1	-0.3***
Gross turnover (tons/week)	2.1	1.1	0.9	-0.9**	-0.2	-1.1***
Procurement price index (2019=100)	100	124	125	23.8*	1.3	25.1**
GINI index of sales	0.72	0.88	0.87	0.15	0.00	0.15
Fish processors						
% firms operating business	90	89	96	-1.4	7.8***	6.4***
Mean days operated/week (days)	6.0	5.6	5.8	-0.5***	0.3***	-0.2**
Gross turnover (tons/week)	4.1	1.9	1.5	-2.2	-0.4	-2.6
Procurement price index (2019=100)	100	110	112	10.0***	1.7	11.7***
GINI index of sales	0.70	0.95	0.94	0.25	-0.01	0.24

[1] Paired *t*-tests: *** $P<0.01$, ** $P<0.05$, * $P<0.1$ indicate statistical significance at 1, 5, and 10%, respectively.

2021, the weekly volumes handled by potato businesses recovered, but they remained significantly lower than during the pre-pandemic period (-69 and -42% for traders and processors, respectively).

Actors in the fish value chain experienced an average drop in sales of around 50% in July 2020, relative to July 2019. However, this decline was statistically significant for traders only. Unlike for potatoes, sales volumes declined further in 2021 for both fish traders and processors, indicating a prolonged deterioration in business conditions: the volumes handled by traders and processors in 2021 were 57 and 63% lower than 2019, respectively.

In both value chains a large majority of actors who reported a change in sales in 2020 relative to 2019, or 2021 relative to 2020, reported that the COVID-19 pandemic was the main reason (around 75%), or a contributing reason (20-25%), while very few reported that the pandemic was not a factor.

The average purchase prices of potatoes fell sharply in July 2020 relative to July 2019. Potato traders experienced a larger drop than processors (27 vs 19%). As most potato traders source their product directly from farmers whereas processors source mostly through traders, this result may suggest that lower farm prices were not passed on entirely to buyers, perhaps due to elevated costs of doing business, particularly related to transport. Potato prices recovered somewhat in 2021 relative to 2020 but remained significantly below 2019 rates (-18 and -8% for traders and processors, respectively).

Conversely, average purchase prices for fish increased sharply and significantly in 2020 relative to 2019 and were even higher in July 2021 (although not significantly). This pattern was consistent across almost every species of fish. Prices paid in 2021 by traders and processors were 25 and 12% higher than in 2019, respectively.

The divergent pattern in prices for the two sets of commodities may be explained by differences in seasonality, and by differences in COVID-19 containment measures affecting the respective value chains. The sharp drop in potato prices is likely linked to the coincidence with a seasonal peak in supply that occurs around July, coupled with a combination of more limited market access due to transport and mobility restrictions, and lower consumer demand linked to these restrictions and their income effects. This combination resulted in a temporary surplus of potatoes, perhaps heightened by limited access to cold storage facilities, pushing down prices.

In contrast, in the case of fish, curfews prevented fishing activities at night, which is normally the most preferred fishing time, and imports of fish by sea from China were disrupted temporarily (Love *et al.*, 2021). Our survey data also indicate that overland trade from Uganda was interrupted. These factors most likely contributed to constrained supply, even relative to lower demand, pushing up average fish prices.

Finally, we hypothesized that sales among actors in each value chain node might become more concentrated following the shock of the pandemic. The fish value chain appears much more concentrated (as indicated by the Gini coefficient of sales) than the potato chain, in all surveyed years and for both segments (traders and processors). This likely reflects a high degree of heterogeneity in the roles of fish actors who often perform multiple overlapping roles (e.g. processor + wholesaler, or broker + retailer). This may translate into fish actors operating across a wider range of scales than potato actors, and hence more uniformity and a lower level of market concentration per node among the latter. However, as expected, a trend toward greater concentration in the wake of COVID-19 could be observed in both value chains, starting from 2020, although not statistically significant.

3.3 Pivoting in response to COVID-19 related disruptions

As indicated in the introduction, we hypothesized a variety of pivoting behaviors that businesses might adopt to overcome disruptions to their operations arising from COVID-19. These included: changing the locations to or from which products were sold or sourced; sourcing from or selling to new types of suppliers or buyers; changing the mode of transport used for procurement or delivery; and increasing the use of ICT. We discuss findings regarding these and other adaptive behaviors in the next subsections.

- *Changes in geography of procurement and distribution, and in business partners*

Following the introduction of COVID-19 related restrictions, businesses in the fish value chain pivoted toward localized procurement and sales, and shorter supply chains, confirming out hypothesis.[5] In 2020, fish traders and processors both significantly increased the share of fish purchased from the county their business was based in (from about 45 to 50% for both types of actor, as shown in Table 4).

[5] These results are highly aggregated and do not allow us to ascertain whether changes in the geography (share of local vs distant procurement/sale) was determined by pivoting of actors or by the fact that actors with certain behaviors were more (or less) impacted by COVID-19 restrictions. In other words, an increase in local sales might not be necessarily due to the actors pro-actively changing their strategy towards more local sales but, instead, by actors which were already selling locally (i.e. within the own county) being better able to maintain their business operating than other actors. Therefore, while we identify a degree of pivoting at the meso-scale, additional data and analyses would be required to draw conclusions about pivoting at the individual level.

Findings for the potato value chain are more complex. In 2020, traders and processors both purchased significantly higher shares of potato from sellers located in other counties, compared to 2019 (up from 20 to 34%, and from 33 to 45%, respectively). This result might be explained by the location of many of these businesses, particularly processors, in Nairobi and Mombasa. While some, especially larger, processors, have the ability to purchase potato directly from production areas, most rely mainly on large traders who are based in their same county. We therefore hypothesize that a relative increase in direct purchases from more distant production areas occurred in response to reduced reliance on intermediaries based in Nairobi and Mombasa, whose operations might have been more seriously affected by the transport restrictions. The latter case seems confirmed by the drastic drop in the proportion of potato purchased from intermediaries in 2020 (from 75 to 54%, and from 60 to 46% for traders and processors, respectively), whereas in 2021, procurement largely reverted to 2019 pattern.

In terms of product distribution, both potato traders and processors had a significantly higher share of local sales in 2021, compared to the pre-pandemic situation (up from 61 to 73%, and from 88 to 90% for traders and processors, respectively). However, the two types of actor followed different paths, with higher local sales for traders and lower local sales for processors in 2020, when restriction were strictest. During the same period, direct sales to consumers by both these actors also increased, again mainly at the expense of traders. In 2021, traders seem to have reverted to their pre-pandemic behavior, while processors' share of local procurement remained significantly higher than in 2019.

Fish processors have also displayed a significantly higher tendency to sell fish products locally since 2020 (up from 74 to 80% in 2020, and 84% in 2021). No significant changes in the typology of fish suppliers emerged, but both fish traders and processors significantly increased the share of direct sales to consumers (up from 42 to 48%, and from 53 to 62%, respectively), at the expense of traders.

Some actors increased the use of contractual arrangements to help maintain business transactions under COVID-19 conditions. Surveyed firms reported an increase in the use of both formal contracts and informal contractual agreements with suppliers and customers. In the potato value chain, only traders reported a significant increase in the use of informal agreements, and only with customers (9%). In the fish value chain, fish traders reported a significant increase in the use of formal contracts with suppliers and customers (5 and 7%, respectively), and informal agreements (6 and 10%, respectively). Fish processors reported even a more marked increase in the use of formal contracts with suppliers and customers (38 and 6%, respectively) and informal agreements (10 and 12%, respectively).

■ *Changes in transport*

In the wake of the pandemic, surveyed actors consistently reported a shift toward use of smaller vehicles. Potato traders and processors, who typically receive supplies and distribute goods by privately-owned trucks and cars reported a significant drop in the use of these in 2020, and partially in 2021, in comparison to the pre-pandemic situation. They compensated by a significant increase in use of public transport (Table 5). Potato processors also reported a dramatic increase in the proportion of sales to buyers who took away the goods by bicycle, animal, or on foot.

Fish traders, who usually receive most of their supplies by public transport and privately-owned motor vehicles, reported a significant decrease in the latter, which was compensated by a higher share of goods delivered by bicycle, animal, or on foot. Similarly, in 2020 fish processors received a higher share of their supplies by bicycle, animal, or on foot, and these also became more important for the distribution of their goods (mostly substituting for public transport). These changes are consistent with the lower volumes of goods traded and more localized sales, as discussed above, and with increased difficulty in accessing transport, including more limited access to larger trucks, and higher transport costs, as reported by respondents.

Table 4. Shares of local procurement and sales, and business partners in July 2019, 2020, and 2021.[1]

	Year			Paired *t*-tests		
Indicators	**July 2019**	**July 2020**	**July 2021**	**Diff 1 (2020-2019)**	**Diff 2 (2021-2020)**	**Diff 3 (2021-2019)**
Potato traders						
% procured in own county	80	66	81	14.0***	14.5***	0.5
% sold in own county	61	66	73	5.4*	6.2**	11.6***
% bought from producers	70	64	74	-6.2**	9.8***	3.7***
% bought from small intermediaries	30	17	25	-12.2***	7.6***	-4.6***
% bought from large intermediaries	0	0	0	-0.06	0	-0.06
% bought from other suppliers	0	18	1	18.5	-17.5	1
% sold to small intermediaries	60	49	60	-10.8***	10.8***	-0.02
% sold to large intermediaries	15	5	12	10.4***	7.1***	-3.3***
% sold directly to consumers	25	28	27	2.8***	-0.4	2.4***
% sold to other buyers	0	18	1	18.5	-17.4	1.02
Potato processors						
% procured in own county	67	55	67	-12.1***	11.6***	-0.5
% sold in own county	88	75	90	-13.5***	15.4***	1.9**
% bought from producers	40	38	39	-2.1	1.9	-0.2
% bought from small intermediaries	44	42	54	-2.3	11.9***	9.6***
% bought from large intermediaries	16	4	7	-12.0***	2.6*	-9.4***
% bought from other suppliers	0	16	0	16.4	-16.4	0.0
% sold to small intermediaries	19	12	17	-6.2***	4.2***	-1.9**
% sold to large intermediaries	19	19	19	0.0	-0.2	-0.2
% sold directly to consumers	61	51	64	-10.5***	12.8***	2.3**
% sold to other buyers	1	18	1	16.7	-16.8	-0.1
Fish traders						
% procured in own county	46	50	49	4.1*	-1.5	2.6
% sold in own county	72	75	71	3.1	-3.2*	-0.1
% bought from producers	58	57	55	-1.2	-2.2	-3.4
% bought from small intermediaries	21	21	21	0.6	-0.2	0.4
% bought from large intermediaries	13	12	13	-0.9	1.6*	0.7
% bought from other suppliers	8	10	10	1.5	0.8	2.3
% sold to small intermediaries	44	40	41	-4.1**	1.3	-2.9*
% sold to large intermediaries	5	2	3	-3.4***	1.1	-2.4**
% sold directly to consumers	42	48	45	5.4***	-2.6	2.9
% sold to other buyers	9	11	11	2.1	0.3	2.4
Fish processors						
% procured in own county	45	50	50	4.8*	0.6	5.4**
% sold in own county	74	80	84	5.9*	3.9	9.8***
% bought from producers	37	33	38	-3.7	4.8*	1.1
% bought from small intermediaries	37	41	38	3.9	-2.4	1.5
% bought from large intermediaries	16	14	19	-1.3	4.3	3.0
% bought from other suppliers	11	12	5	1.0	-6.6	-5.6
% sold to small intermediaries	33	22	24	-10.2***	1.7	-8.5***
% sold to large intermediaries	3	2	1	-0.4	-1.1*	-1.5*
% sold directly to consumers	53	62	69	9.2***	6.3**	15.5***
% sold to other buyers	11	13	6	1.4	-6.9	-5.5

[1] Paired *t*-tests: *** $P<0.01$, ** $P<0.05$, * $P<0.1$ indicate statistical significance at 1, 5, and 10%, respectively.

■ *Changes in use of ICT tools*

Traders and processors were asked whether they had used ICT for their business in 2019 (pre-pandemic) and 2021 (post pandemic emergence). Specifically: (1) whether they had ever concluded business transactions with suppliers or customers over the phone or through an online platform/website (such as the Viazi Soko, a web-based digital platform hosted by the National Potato Council of Kenya to connect potato buyers and sellers); (2) whether they had ever sought suppliers or customers through social media (e.g. one of the several Facebook or WhatsApp groups that are increasingly used to discuss business and find partners); and (3) whether they had ever made or received payments electronically (e.g. through the popular M-Pesa mobile phone-based money transfer service)[6]. Respondents who had made use of any of these technologies in 2021 were asked whether their use had started or increased in response to the pandemic.

ICT use is far more common in the fish value chain than the potato value chain (Table 6). Most fish traders and processors use phones to conclude business transactions with suppliers and customers and have made or received electronic payments. In the potato value chain, only about one quarter of traders and processors do so. Furthermore, about one quarter of fish traders and processor seek suppliers and customers online or through social media and use online platforms/websites to conclude transactions.

Use of these tools by potato actors is largely negligible. These differences might reflect the more fragmented nature of the fish chain, characterized by a large number of small actors involved in small business transactions, the unpredictability of supply of fish from capture fisheries which can fluctuate widely from day to day, the highly perishable and high value nature of the product which elevates the level of risk inherent in each transaction and necessitates rapid sales to avoid spoilage, and the more diverse sources of fish products compared to potatoes. All these aspects likely drive a greater need for spatial and temporal coordination among actors in the fish value chain, compared to the potato chain, and thus the use of ICT as a means of reducing transaction costs (Reardon *et al.*, 2021a).

Comparison between 2019 and 2021 underlines the increase in the use of ICT during the pandemic. As shown in Table 6, fish traders and processors significantly increased adoption of all ICT, except for electronic payments by fish processors, which were already used by over 80% of respondents in 2019. Between 5 and 23% of new ICT adopters (depending on the specific form of ICT) reported having started these practices in response to the pandemic and, more notably, between 34 and 76% of those who had already adopted ICT in 2019 reported to have increased their use by 2021, specifically because of COVID-19.

In the potato value chain, significantly more traders adopted phones for concluding business transactions and electronic payments for sending or receiving money in 2021 than in 2019, but there were no changes in the adoption of other ICT. There was not significantly more adoption of any form of ICT by potato processors following the pandemic. However, between 8% and 61% of potato traders and processors who had already adopted phones, electronic payments, and internet-based services to seek suppliers prior to COVID-19, indicated that they had increased their use in the post-pandemic period.

Importantly, in both value chains, very few actors who had started or increased their use of ICT due to COVID-19 restrictions indicated that they expected to cease or reduce the practice once the pandemic had ended.

[6] The Kenyan government advised the public to embrace mobile money during the period of acute pandemic. This was aided by a waiver imposed on transactions costs for mobile money services. There were no commissions for costs below Ksh 1,000 (about USD 8.3). This initiative may have contributed to increased use of mobile transfer services during this period.

Table 5. Procurement and distribution by type of transportation in July 2019, 2020 and 2021.

	Year			Paired *t*-tests		
Indicators	**July 2019**	**July 2020**	**July 2021**	**Diff 1 (2020-2019)**	**Diff 2 (2021-2020)**	**Diff 3 (2021-2019)**
Potato traders						
% supplied by large truck/ship/plane	42	30	39	-12.1***	9.1***	-3.0
% supplied by car/small truck	35	23	34	-12.3***	10.9***	-1.4
% supplied by public transport	22	28	25	6.0***	-2.7	3.3**
% supplied by bicycle/animal/on foot	0	0	0	0	0	0
% supplied by other transport means	0	18	1	18.5	-17.3	1
% distributed by large truck/ship/plane	47	33	44	-13.4***	10.5***	-2.9
% distributed by car/small truck	30	13	24	-16.6***	10.8***	-5.8***
% distributed by public transport	22	34	29	11.5***	-4.8**	6.7***
% distributed by bicycle/animal/on foot	1	1	2	0.0	0.4	0.5
% distributed by other transport means	0	19	2	18.5	-17.0	1.5
Potato processors						
% supplied by large truck/ship/plane	45	42	48	-2.9	5.9*	3.0
% supplied by car/small truck	52	30	47	-22.3***	17.3***	-5.0***
% supplied by public transport	3	11	5	8.4***	-6.3***	2.1
% supplied by bicycle/animal/on foot	0	0	0	0.4	-0.5	-0.1
% supplied by other transport means	0	16	0	16.4	-16.4	0.0
% distributed by large truck/ship/plane	40	31	40	-8.7***	8.4***	-0.3
% distributed by car/small truck	28	17	26	-10.3***	8.5***	-1.8
% distributed by public transport	5	6	4	1.2	-1.8	-0.7
% distributed by bicycle/animal/on foot	4	25	30	22.0***	4.6*	26.6***
% distributed by other transport means	24	20	0	-4.2	-19.7	-23.8
Fish traders						
% supplied by large truck/ship/plane	14	15	15	1.0	0.1	1.2
% supplied by car/small truck	23	19	22	-3.5***	2.8**	-0.7
% supplied by public transport	39	36	34	-3.2	-1.9	-5.1**
% supplied by bicycle/animal/on foot	17	20	19	3.5**	-0.6	2.9*
% supplied by other transport means	8	10	10	2.2	-0.4	1.8
% distributed by large truck/ship/plane	11	10	11	-0.7	1.3	0.5
% distributed by car/small truck	3	2	2	-1.3*	0.7	-0.6
% distributed by public transport	48	46	46	-2.2	-0.4	-2.6
% distributed by bicycle/animal/on foot	31	33	31	2.6	-2.3	0.3
% distributed by other transport means	7	9	10	1.6	0.7	2.4
Fish processors						
% supplied by large truck/ship/plane	19	16	20	-2.8	4.0***	1.2
% supplied by car/small truck	12	12	12	-0.1	-0.4	-0.5
% supplied by public transport	48	46	50	-2.8	4.0	1.2
% supplied by bicycle/animal/on foot	10	15	14	4.3**	-0.6	3.7
% supplied by other transport means	10	12	5	1.4	-7.0	-5.6
% distributed by large truck/ship/plane	6	5	4	-1.1	-0.1	-1.3
% distributed by car/small truck	2	0	0	-1.9	-0.1	-2.0
% distributed by public transport	27	22	25	-5.7**	2.9	-2.9
% distributed by bicycle/animal/on foot	53	61	67	8.2**	5.9*	14.0***
% distributed by other transport means	12	12	4	0.6	-8.5	-7.9

[1] Paired *t*-tests: *** $P<0.01$, ** $P<0.05$, * $P<0.1$ indicate statistical significance at 1, 5, and 10%, respectively.

Table 6. Use of ICT in July 2019 and 2021.

Indicators	Year		Paired *t*-tests	COVID-related new adopters (%)	COVID-related higher use by existing adopters (%)
	2019	2021	Diff		
Potato traders					
Business transaction with suppliers over phone (%)	24	27	3.0***	11	21
Business transaction with customers over phone (%)	22	25	3.3***	72	10
Business transaction with suppliers through online platform/ website (%)	1	1	0.0	0	0
Business transaction with customers through online platform/website (%)	1	1	0.3	25	0
Sought suppliers online or through social media (%)	4	4	0.3	8	8
Sought customers online or through social media (%)	4	4	0.3	69	3
Made or received payments electronically (%)	44	47	2.9***	6	31
Potato processors					
Business transaction with suppliers over phone (%)	24	24	0.0	0	61
Business transaction with customers over phone (%)	24	25	0.9	27	2
Business transaction with suppliers through online platform/ website (%)	0	0	0.5	100	0
Business transaction with customers through online platform/website (%)	0	0	0.5	0	0
Sought suppliers online or through social media (%)	7	7	0.0	0	40
Sought customers online or through social media (%)	7	8	0.9	37	14
Made or received payments electronically (%)	52	53	0.9	2	57
Fish traders					
Business transaction with suppliers over phone (%)	82	88	6.5***	7	49
Business transaction with customers over phone (%)	80	86	6.5***	7	52
Business transaction with suppliers through online platform/ website (%)	20	22	2.5***	11	34
Business transaction with customers through online platform/website (%)	17	20	2.9***	14	39
Sought suppliers online or through social media (%)	27	29	2.5***	15	43
Sought customers online or through social media (%)	24	30	6.1***	20	43
Made or received payments electronically (%)	73	77	3.9***	5	59
Fish processors					
Business transaction with suppliers over phone (%)	87	91	4.9***	5	71
Business transaction with customers over phone (%)	83	89	6.4***	7	69
Business transaction with suppliers through online platform/ website (%)	20	23	2.8**	12	50
Business transaction with customers through online platform/website (%)	14	18	4.3**	23	50
Sought suppliers online or through social media (%)	29	32	2.8**	9	64
Sought customers online or through social media (%)	28	31	2.8**	9	72
Made or received payments electronically (%)	83	84	1.4	2	76

[1] Paired *t*-tests: *** $P<0.01$, ** $P<0.05$, * $P<0.1$ indicate statistical significance at 1 and 5%, respectively.

■ *Other adaptations to COVID-19 disruptions*

The survey also investigated other measures taken to adapt to COVID-19 disruption. They were drawn from the analytical framework developed by the CGIAR COVID-19 Hub (2021) for analyzing and addressing

value chain fractures brought by the pandemic and prior studies on SME coping strategies under COVID-19 (Belton *et al.*, 2021; Liverpool-Tasie *et al.*, 2020).

As shown in Figure 2, in both the potato and fish value chains, over 90% of respondents changed their business working hours, and almost 40% transported their products over a different or longer routes to avoid curfews or travel restrictions. Around 70% of businesses in the fish value chain reduced the number of permanent or seasonal employees hired, as did 40% in the potato value chain. A similar pattern was found for reductions in wages paid (reported by 60 and 30% of businesses, respectively), while only a few indicated that they had increased wages. These results suggest the need to reduce operating costs in face of lower business turnover, but perhaps also challenges in accessing labor as workers might have migrated back to rural areas (Liverpool-Tasie *et al.*, 2021).

While these responses were largely consistent across the two chains, the mobilization of own savings and assets, and increased use of credit, including value chain financing, for maintaining business operations were far more common in the fish than the potato value chain. We speculate that the higher predisposition to offer and receive cash credit or value chain financing can be explained by underlying long-term relationships and trust within fish value chains, which trade year-round, as compared to the highly seasonal spot market that dominates potato transactions.

Another explanation might relate to the characteristics of the primary production, where fishing activities require continual outlay on daily operating costs (e.g. fuel, labor), as compared to farming where costs tend to be lower and expenditures less frequent (i.e. concentrated particularly around planting and harvesting time). It is commonly observed that credit relations between larger traders, smaller traders, and primary producers are pervasive and persistent in capture fisheries value chains (Nunan *et al.*, 2020), whereas agricultural credit provision from traders to crop farmers tends to be comparatively limited (Adjognon *et al.*, 2017).

Very limited government or NGO support was received by value chain actors to help them overcome challenges associated with COVID-19. Less than 2 and 4% of respondents in the potato and fish value chain, respectively, received government aid. However, while no actor in the potato chain reported having received support from other organizations, about 7% of fish respondents did so. This support was received

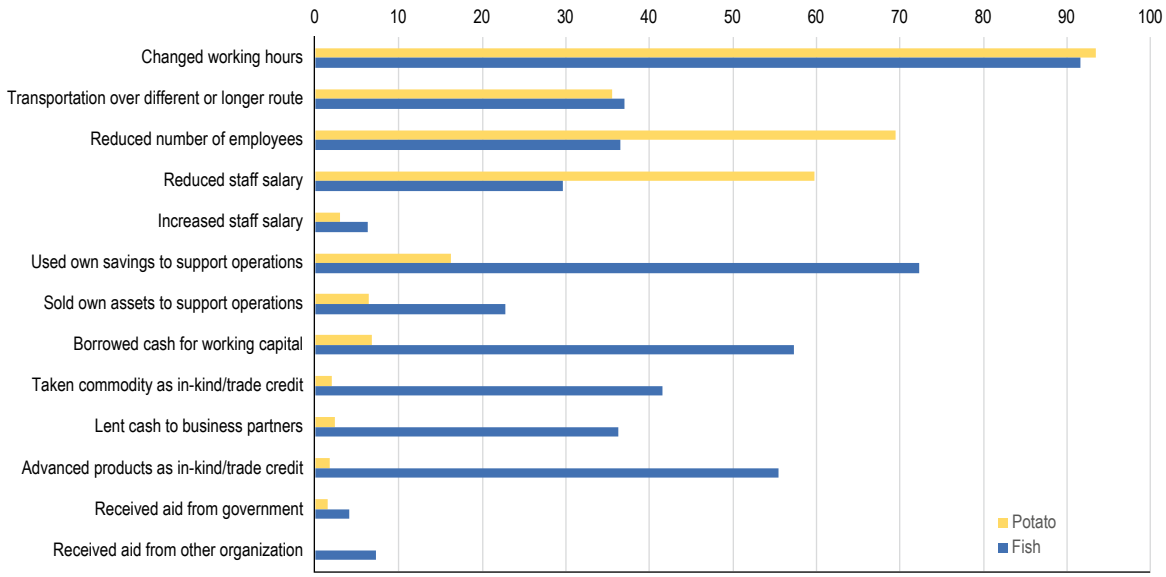

Figure 2. Share of respondents reporting specific responses to COVID-19 disruption.

primarily from Beach Management Units (fisheries co-management organizations) and *chama* (informal micro-savings groups).

■ *Patterns in resilience of business operations*

The turnover (average weekly sales) of traders and processors in both value chains was significantly lower in July 2020 than in the same period of 2019. Between 94 and 100% of all actors reported a drop in turnover (Table 7). In 2021, potato actors consistently reported a recovery in their business operations. Only 14% of traders and 7% of processors indicated a further deterioration in business conditions. However, responses were mixed in the fish value chain, with 45% of traders and 32% of processors reporting lower turnover in 2021 than in 2020, likely due to protracted challenges related to continued restrictions in fishing activities and high cost of fuel.

■ *Econometrics of resilience of business operations*

We conducted econometric analyses to identify the characteristics that made a business more or less vulnerable to the pandemic and related government restrictions in 2020, and more or less likely to recover in 2021. Independent variables in the regressions included: (1) the location of the business (rural, peri-urban, urban; Nairobi, Mombasa, or 'production zones'); (2) key socio-demographic characteristics of the owner (gender, age, education); (3) firm size; (4) territorial focus of procurement and sales (local vs distant). We hypothesized that smaller firms, more informally managed and mostly displaying less spatial 'extroversion' might have been less affected by the shock in 2020. Firm size was proxied by the level of business turnover in 2019, the pre-pandemic year. Table 8 and 9 show the regression results with the dependent variable being the change in gross turnover over the two consecutive years).[7]

In line with our hypothesis, we found that the larger the potato and fish traders in 2019, the larger the negative impact of COVID-19 on business operations in 2020. However, in both value chains, large trading firms (proxied by size squared) appeared less affected by the shock. This can be explained by the largest actors possessing more capital, connections, networks, and access to transport and ICT which would partially offset the challenges brought by the pandemic.

Furthermore, potato traders based in producing counties and those who primarily sold their products within their county, were less affected by the restrictions. Potato traders furthest away from production areas, namely Mombasa, were more likely to report higher loss in turnover. Fish traders based in producing counties and mainly selling locally were most affected, while having the business located in rural areas reduced the loss in turnover.

[7] Log-linear OLS models were also estimated, and results compared. The explanatory power of the models and the estimated parameters were not significantly different; therefore, we retained and interpreted the results of the linear models,

Table 7. Share of respondents experiencing change in turnover, by year.

		Potato		Fish	
		2020 vs 2019	**2021 vs 2020**	**2020 vs 2019**	**2021 vs 2020**
Traders	Higher turnover (%)	0	86	6	55
	Lower turnover (%)	100	14	94	45
Processors	Higher turnover (%)	1	93	5	68
	Lower turnover (%)	99	7	95	32

Table 8. Ordinary least squares regressions of relative change in potato gross turnover 2020 vs 2019 (absolute values).[1]

Variables	**Potato traders**	**Potato processors**	
Product form	**Unprocessed potato**	**Crisps, chilled/ frozen ready-cut chips**	**Other product forms**
Firm size (gross turnover 2019, tons/week)	0.005***	-0.005	0.009
	(0.002)	(0.005)	(0.006)
Firm size squared	-4.71e-05*	2.82e-05	-0.0002**
	(2.70e-05)	(5.78e-05)	(9.32e-05)
County dummies (base: Nairobi)			
Producing county	-0.142**	0.303*	0.070
	(0.055)	(0.159)	(0.044)
Mombasa	0.093**	0.253**	-0.055
	(0.041)	(0.102)	(0.053)
Location dummies (base: urban)			
Peri urban	0.050	-0.069	0.007
	(0.054)	(0.056)	(0.038)
Rural	0.051	0.160**	0.159***
	(0.062)	(0.071)	(0.056)
Gender of the owner (1 = male, 0 = female)			
Gender is male	0.037	-0.003	-0.0139
	(0.029)	(0.068)	(0.050)
Age (1 = below 40 y, 0=above 40 y)			
Age is below 40 years	0.036	-0.117	0.092
	(0.035)	(0.077)	(0.062)
Education dummies (base: primary or no education)			
Higher education	-0.063	-0.380***	-0.462***
	(0.043)	(0.099)	(0.081)
Secondary education	-0.023	0.031	0.007
	(0.024)	(0.065)	(0.033)
Commercial behavior indicators			
% procured from own county in 2019	0.0003	-0.002	0.001
	(0.001)	(0.0016)	(0.0007)
% sold within own county in 2019	-0.001***	0.003**	0.001
	(0.0004)	(0.0016)	(0.001)
Constant	0.816***	0.503***	0.572***
	(0.067)	(0.180)	(0.136)
R-squared	0.249	0.551	0.712

[1] Heteroscedasticity robust standard errors are in parentheses. *** $P<0.01$, ** $P<0.05$, * $P<0.1$ indicate statistical significance at 1, 5, and 10%, respectively. Other product forms include washed and peeled whole potatoes, washed and peeled chopped/sliced potatoes, washed potatoes, and fried chips (what US calls French fries).

Potato processors were disaggregated into industrial operators (defined as those whose main product sold was crisps or ready-cut chips – either chilled of frozen), and traditional processors (focusing mainly on fried chips and other lower added-value product forms). Among industrial processors, being in rural areas of a producing county or in Mombasa (instead of Nairobi) and having a high share of local sales contributed to higher losses, probably due to the challenges to reach the major markets where demand is concentrated. For traditional potato processors, the largest businesses were less affected and, again the ones based in rural

Table 9. Ordinary Least Squares regressions of relative change in fish gross turnover 2020 vs 2019 (absolute values).[1]

Variables	Fish traders	Fish processors
Firm size (gross turnover 2019, tons/week)	0.066***	0.072
	(0.023)	(0.060)
Firm size squared	-0.004**	-0.007
	(0.001)	(0.008)
County dummies (base: Nairobi)		
Producing county	0.111**	-0.135**
	(0.052)	(0.052)
Mombasa	-0.061	-0.208***
	(0.061)	(0.071)
Location dummies (base: Urban)		
Peri urban	-0.026	0.028
	(0.046)	(0.060)
Rural	-0.233**	0.009
	(0.106)	(0.133)
Gender of the owner (1 = male, 0 = female)		
Gender is male	-0.048	0.009
	(0.042)	(0.050)
Age (1 = below 40 y, 0 = above 40 y)		
Age is below 40 years	-0.0018	-0.021
	(0.035)	(0.047)
Education dummies (base: primary or no education)		
Higher education	-0.054	0.018
	(0.056)	(0.079)
Secondary education	-0.025	-0.060
	(0.042)	(0.050)
Commercial behavior indicators		
% procured from own county in 2019	1.86e-05	-0.0008
	(0.0005)	(0.0005)
% sold within own county in 2019	0.002***	-0.0008
	(0.0008)	(0.0009)
Constant	0.331***	0.777***
	(0.097)	(0.096)
R-squared	0.193	0.181

[1] Heteroscedasticity robust standard errors are in parentheses. *** $P<0.01$, ** $P<0.05$, * $P<0.1$ indicate statistical significance at 1, 5, and 10%, respectively.

areas were more likely to be hurt. For both types of potato processors, having higher education mitigated the impact. For fish processors, being based in a producing county or Mombasa (also an important fish landing site) mitigated the loss in turnover as compared to being based in Nairobi.

We also conducted OLS regressions to identify the factors that helped potato and fish actors' operations recover in 2021. In the case of fish traders and processors, the largely uneven recovery across businesses in 2021 (with both 'winners' and 'losers', see Table 7), suggests that a Probit model might provide a better fit.[8] The Probit results are highly consistent with the findings presented in Table 8 and 9. With few exceptions,

[8] These models are presented in the Appendix.

in all models, variables that (partially) explain the dramatic drop in turnover in 2020 contributed to the recovery a year later. This can be explained by the firms most affected by the shock in 2020 being able to regain most of their lost turnover and market share in 2021.

Interestingly, the results for potato traders and fish processors are in line with the expectations that firms located nearby production areas and selling primarily within their own county, experience less variability in business operations, both in terms of negative shocks in 2020 and positive recovery in 2021. However, the opposite holds for fish traders and 'industrial' potato processors.

For fish traders, this result might be explained by the perishability of fresh fish. The challenge of timely sales and transport of fish in fresh form might have led to increased processing of products preserved by drying and smoking close to production sites. This might have resulted in a saturation of local markets for these products, creating opportunities for those traders with the capacities, networks, and experience to transport and sell these processed products in distant locations. Industrial potato processors may have benefitted from the proximity to the destination market for their products, coupled with the ability to distribute them over longer distances and the capacity to procure less perishable forms of raw material and sell their processed products by by-passing traders (see Section 3.1.1).

4. Conclusions

This study assessed the impact of the COVID-19 on the midstream of the fish and potato value chains in Kenya and investigated short- and longer-term responses and pivoting strategies deployed by actors in these chains in face of the restrictions introduced by the government of Kenya to contain the pandemic.

Most businesses survived the disruptions caused by these restrictions. There was no significant change in the number of operational fish businesses over the period 2019-2021, while in the case of potato, the relatively few traders and processors that stopped operations in 2020 were back in business in 2021. However, in 2020 both the number of days per week in which the businesses operated and the average volume handled daily declined dramatically in both value chains. The resulting drop in average volumes traded weekly compared to 2019 was 85 and 62% for potato traders and processors, respectively, and about 50% for fish traders and processors.

In 2021, weekly volumes handled by potato businesses recovered significantly, though remaining 69 and 42% lower than during the pre-pandemic period for traders and processors, respectively. Unlike for potatoes, sales volumes for fish traders and processors declined further in 2021, indicating a prolonged deterioration in business conditions. Volumes handled by fish traders and processors were 57 and 63% lower, respectively, in 2021 than 2019. Three quarters of surveyed firms indicated that COVID-19 was the main reason for these changes in business operations.

Purchase prices for potatoes fell sharply in 2020 relative to 2019 and recovered in 2021, although still remaining significantly below 2019 levels. Fish prices increased sharply and significantly in 2020 and even further in 2021. The divergent pattern in prices for the two sets of commodities may be explained by differences in seasonality, and by differences in COVID-19 containment measures affecting their respective value chains. The sharp drop in potato prices in 2020 is likely linked to the coincidence of a seasonal peak in supply that occurs around July (time of the survey), coupled with a combination of more limited market access due to transport and mobility restrictions, and lower consumer demand linked to these restrictions and their income effects. In contrast, disruption of fishing activities and, to a lesser extent fish imports, likely contributed to constrained supply, even relative to lower demand, thereby pushing up average fish prices.

A trend toward greater market concentration in the wake of COVID-19 could be observed in all segments of both value chains, starting from 2020, probably reflecting the greater resilience of largest businesses in

possession of capital, connections, networks, and access to transport and ICT that allowed them to capture a growing share of the market, even if the total volume of sales made by each business declined.

How have the businesses pivoted in terms of geography of procurement and distribution, industrial organization (e.g. type of and relations with business partners), transport and logistics, and increased adoption of ICT? Overall, surveyed firms shifted toward more localized procurement and sales, and shorter supply chains.

In 2020, fish traders and processors significantly increased the share of fish purchased from the county where their business was located and, for fish processors, the share of local sales also increased. Furthermore, both fish traders and processors significantly increased the share of direct sales to consumers, at the expense of traders.

In the same year, a similar drastic drop in the proportion of purchases from intermediaries was observed in the potato value chain. The operations of traders, often based in the largest urban centers, were likely particularly affected by transport restrictions, thus resulting in an increase in procurement from more distant production areas by the largest traders and processors with the ability to facilitate or coordinate long distance transportation.

In terms of product distribution, both potato traders and processors had a significantly higher share of local sales in 2021, compared to the pre-pandemic situation and their direct sales to consumers also increased, again mainly at the expense of traders.

Since the emergence of COVID-19, many actors, especially in the fish value chain, have pivoted towards increased use of formal and informal contractual arrangements with suppliers and customers to secure their business transactions.

During the pandemic, value chain actors consistently shifted toward the use of smaller vehicles, consistent with the lower volumes of goods traded, more localized sales, the reduced role of intermediaries, the increased difficulty in accessing transport, and higher transport costs.

Use of ICT tools and social media platforms for searching and engaging with business partners and for making payments increased significantly between 2019 and 2021. The pandemic seems to have driven an increase in the breadth and depth of ICT adoption, either by triggering the decision to start (particularly among potato actors), or increase (particularly among fish actors) the use of these tools. Few respondents expected to cease or reduce the use of ICT once the pandemic ends, suggesting that these changes are here to stay.

Our findings confirm the hypothesis that, within the same business category, smaller firms would be more resilient and subject to smaller fluctuations in business operations as consequence of shocks: the larger the firm, the larger the relative reduction in turnover in 2020 (and, unsurprisingly, the larger the recovery in 2021). However, the very largest businesses were less affected, suggesting an inverted U-shape relationship between firm size and impact of COVID-19 related restrictions.

Finally, the hypothesis that firms located close to production areas and selling primarily within their own county would face less variability in business operations was confirmed for potato traders and fish processors. Conversely, in the case of fish traders and potato processors, it appears that firms with capacities, networks and experience allowing them to procure (in case of potato processors) or sell (in case of fish traders) goods in distant locations might have been able to respond opportunistically to emerging opportunities and challenges, which were disproportionally faced by less well resource endowed players and intermediaries.

Some recommendations for increasing businesses' resilience to shocks can be drawn from the findings presented above. First, managers of agri-food businesses should be cognizant that smaller firms and very large firms may be less vulnerable to most shocks, due to the adaptive capacities of the former and the larger

capital and assets of the latter. Mid-size firms may be least resilient. Second, participation in shorter supply chains, characterized by more localized procurement and sales, and lower dependance on intermediaries and third-party logistics, is a safer option in case of shocks, unless the firm is sufficiently large to by-pass intermediaries and, possibly, own or secure timely and reliable access to transport and logistics. Third, in line with the findings of Yuan *et al.* (2022), and Grau and Reig (2019), informal agreements and formal contracts with suppliers and customers may contribute to stabilizing the procurement and distribution of the goods when normal market functions are affected. Finally, the adoption of ICT, besides reducing transaction costs, can contribute to mitigating challenges posed by restrictions on mobility, as experienced during the COVID-19 pandemic.

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