In the midst of the COVID-19 pandemic: Perceived risks, management strategies and emerging opportunities for small and medium agri-food enterprises in a developing country

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ABSTRACT

The Covid-19 pandemic has posed unprecedented challenges to small- and medium-sized agri-food enterprises (SMAEs) in developing countries. However, research investigating what risks Covid-19 posed to these firms, how they responded, and what business opportunities emerged to SMAEs from the pandemic remains scanty. Drawing on a sample of 166 specialist SMAEs in Egypt, this study addressed these entwined questions by using multiple indicators and multiple causes (MIMIC) and mediation analysis. Our results point out that the Covid-19 pandemic exposed Egyptian SMAEs to complex and multidimensional risks, and caused profound effects on both upstream and downstream stages of their supply chains. In general, Egyptian SMAEs adopted a 'wait-and-see' approach to cope with such Covid-19 risks and impacts, which was attributed to their lack of sufficient financial resources to develop risk management strategies and formalize structures to deal with unexpected events. Interestingly, the results showed that several business opportunities emerged from pandemic; but SMAEs' resource disadvantages constrained their capacity to seize and exploit these opportunities. Moreover, we found that mitigation strategies adopted by SMAEs present a mediating factor between perceived Covid-19 risks and perceived business opportunities. Overall, our findings call for a paradigm shift in relation to enterprise risk management in developing countries' SMAEs toward more holistic frameworks to enhance their preparedness to future shocks, make mature operational and strategic management decisions, and exploit strategic opportunities.

1. Introduction

Like many other developing countries, the outbreak of the Covid-19 pandemic posed unprecedented risks to food supply chains (FSCs) in Egypt from production to consumption [1,2]. However, downstream stages of FSCs including small- and medium-sized agri-food enterprises (SMAEs) have been affected the most by the pandemic [3]. This is attributive to their heavy reliance on labor rather

than machinery, which amplified the consequences of the Covid-19 mitigation measures on the continuity of their businesses [4]. In addition, SMAEs' low financial capacity constrained their ability to implement government measures to minimize the spread of the virus within workplaces, and the informal nature of their business activities led to their exclusion from support schemes offered to Egyptian enterprises [5]. Accordingly, one of the early surveys on the effects of Covid-19 on small- and medium-sized enterprises (SMEs) in Egypt, conducted in 2020, revealed that more than half of the SMEs surveyed (n = 283) closed temporarily and 3 % closed permanently, due to sluggish demand, increased cost of production and operation, as well as unforeseen sales and staffing problems [6].

The risks posed by the Covid-19 to small businesses in Egypt, particularly SMAEs, have received considerable attention by policymakers and private-sector actors due to their strategic importance to employment, livelihoods, economic growth and socioeconomic development. For instance, SMAEs represent at least 90 % of all enterprises within Egypt's food and agricultural sectors, contribute around 75 % to the total value of agricultural exports, and employ more than 90 % of the agricultural labor force [4]. Therefore, risks that the pandemic posed to SMAEs threatened to further undermine livelihoods and worsen food insecurity of the poor whom well-being principally depend on the functionality of SMAEs' FSCs. In this context [7], point out that assessing the risks that Covid-19 posed to the major players in developing countries' FSCs and understanding their coping strategies would determine the severity and impacts of these risks, and subsequently the capacity of these countries to achieve the Sustainable Development Goals (SDGs) by 2030, particularly those related to hunger and poverty (e.g. SDG #2) and the sustainability of food production systems (e.g. SDG #12).

With this background, the present study drew on a sample of 166 Egyptian SMAEs, conducted between May and June 2020, to empirically test the statistical support for that a pre-determined set of distal variables related to SMAE-specific and managerial characteristics is related to their risk perception, mitigation strategies, and perception of risk-based opportunities from the Covid-19 pandemic. More specifically, the empirical analysis in this study addressed the following four intertwined questions:

- How was SMAEs' perception of Covid-19 induced risks related to firm-specific and business management characteristics?
- How was SMAEs' choice and implementation of management strategies to cope with Covid-19 risks related to firm-specific and business management characteristics?
- Has the Covid-19 pandemic offered any business opportunities to SMAEs, and what influences their perception?
- Did mitigation strategies adopted by SMAEs mediate the relationship between perceived Covid-19 risks and business opportunities?

Answers to these questions are envisaged to contribute to the active research agenda on risks and impacts of Covid-19 on FSCs in developing countries by addressing two important gaps in the extant literature (see a summary of our review of the literature in Table 1 in the Supplementary Material). First, the existing literature is dominated by investigations of risks and impacts of the pandemic on actors at the two ends of the supply chains: the consumers and to a lesser extent the producers. Specifically, the literature tends to focus on changes in consumer demand and purchasing behavior, food security and nutrition outcomes, ignoring the widely perceived risks of the pandemic on SMAEs and actors in the intermediate and downstream stages of FSCs before consumption [3]. Second, the bulk of the literature focuses almost exclusively on the "negative" side of Covid-19 risks and their "adverse" effects on FSC actors (e.g. Refs. [8–10]). This presents another major shortcoming in these studies provided that the classical decision theory stipulates that the term 'risk' also embraces expected 'positive' effects and broadly views risk as a possibility of economic and/or financial losses or gains [11,12]. This implies that a comprehensive assessment of enterprise risk management should comprise both the adverse effects of unexpected events and the opportunities that may emerge to SMAEs and other FSC actors from such events.

In the present study, we address the abovementioned two gaps in the existing literature by providing empirical evidence on the pathways through which Covid-19 posed business risks to SMAEs, as well as their coping strategies and perceived business opportunities. We frame "risks" posed by the Covid-19 pandemic as having the potential to cause "adverse" impacts or generate "positive" spillovers to SMAEs. Unlike previous studies on risk perception in SMEs, which chiefly focus on risk avoidance [13], we engage with risk sources and investigate their perceived consequences on the SMAEs surveyed. Next, we examine the links between perceived risks and the subsequent coping strategies implemented by SMAEs and the perceived risk-based opportunities. In addition, our empirical analysis contributes to the literature on organizational resilience by focusing on an under-researched context of SMAEs in developing countries' contexts and by adopting a "resource-based" view to risk management and resilience that integrates SMAEs' physical, human, organizational, and financial assets in a framework to investigate the determinants of SMAEs' risk perception, mitigation strategies and capacity to take advantage of the underlying opportunities. According to Ref. [14]; such resource-based approach to the analysis of risk perception and management is useful because the organizational capacity of SMAEs to mobilize resources for a desired outcome, such as minimizing risks and exploiting opportunities, greatly depends on their resource-base that determines their capacity to implement proactive and effective response to risk and exploit emerging opportunities.

Therefore, we expect our results to encourage more research into more comprehensive approaches to SMAEs' risk management, which can inform the design of effectives strategies that enable SMAEs to coherently minimize the downside risks and exploit business opportunities. Furthermore, our empirical findings offer useful insights to SMAEs' operators and policymakers in Egypt to design relevant interventions that could build SMAEs' overall resilience and enhance their preparedness to future pandemics. While our results are context-specific, *i.e.*, Egyptian SMAEs, they are envisaged to be generalizable to similar contexts in other developing countries and to be used for comparative assessments against similar studies, which would contribute to developing evidence-based risk management strategies for SMAEs' resilience against economic and environmental shocks.

Table 1
Profile of the 166 surveyed SMAEs.

Characteristics	Categories	Frequency	Percentage
SMAEs location	NRLDA	69	41.6
	OLNDA	97	58.4
Ownership type	Local investment	141	84.9
	Foreign investment	3	1.8
	Joint investment	22	13.3
Years in business	<5	40	24.1
	5 - <10	41	24.7
	10-<15	53	31.9
	15 -< 20	14	8.4
	≥20	18	10.8
Number of branches	1	145	86.8
	2	5	3.0
	≥3	16	10.2
Number of employees	<10	24	14.5
	10 -<20	68	41.0
	20 -<50	67	40.5
	>50	7	4.2
Total assets in 2019 (EGP million[a])	<3	64	38.6
	3 -<5	59	35.5
	5 -<10	20	12.1
	≥10	23	13.9
Turnover in 2019 (EGP million)	<3	73	44.0
	3 -<5	40	24.1
	5 -<10	35	21.1
	≥10	18	10.8
Share of export in total sales	<30	42	25.31
	30 -<50	14	8.43
	50 -<70	10	6.02
	≥70	100	60.24
Standard certifications	No	23	13.9
	Yes	143	86.1
Risk management strategies	No	135	81.3
	Yes	31	18.7

[a] 1 US dollar = 16.814 Egyptian Pound (EGP) in 2019–2020. NRLDA = SMAEs located in the newly reclaimed lands and desert areas in the provinces of Giza and Behaira and Kafr Al-Shaikh. OLNDA = SMAEs located in the old lands in the Nile delta areas in the provinces of Fayoum, Cairo, and Beni Suief.

2. Conceptualization of the study

Uncertainty and risks are inherent in any supply chain [11]. Risk perception and management have always been frequent topics in the organizational theory and agribusiness literature (e.g. Refs. [15,16]. The existing literature suggests that small- and medium-sized enterprises including SMAEs are more exposed to greater risks than larger-sized enterprises from external shocks and unexpected events. This vulnerability is attributed to their size and structural characteristics, as well as their limited capability to predict external shocks and changes that can hinder their performance and survival (Baporikar et al. (2016; [3]).

According to the conceptualization portrayed in Fig. 1, risks posed by the Covid-19 pandemic to Egyptian SMAEs originated mainly from government measures, such as lockdowns and night curfews, which were implemented to contain the spread of the virus
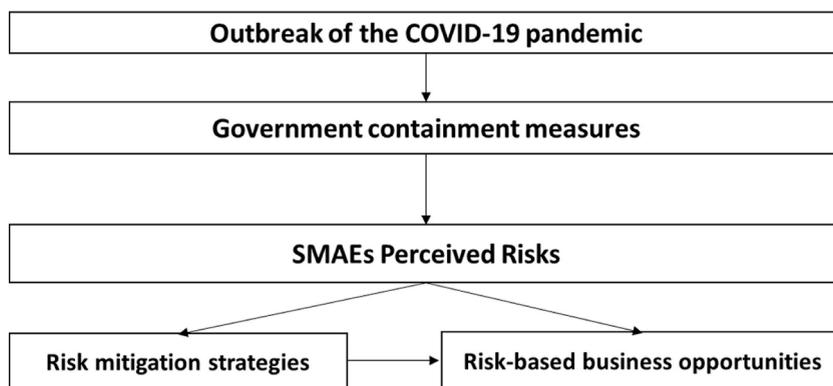

Fig. 1. Conceptual model linking Covid-19 impacts on SMAEs to their mitigation strategies and perceived business opportunities. Source: author conceptualization based on the literature reviewed

and protect public health (Zaazou and Salman, 2020). That is, after a rapid increase in the spread of the pandemic in Egypt during the first half of 2020, the government announced movement restrictions during the months of May and June 2020, which drastically disrupted SMAEs' supply chains by decreasing private consumption and subsequently their sales and revenues [3]. As such, the Covid-19 pandemic differs from other disease outbreaks that broke out in recent decades (e.g. the Middle East Respiratory Syndrome, and the High Pathogenic Avian Influenza) in the sense that it did not directly affect the upstream stages of the SMAEs' supply chain; but it rather disrupted logistics, labor markets as well as consumer demand and other downstream activities. However, these turbulences had effects on SMAEs' upstream activities, and thus put their whole supply chain under further risks of disruption.

The extant literature on the impacts of previous disease outbreaks and extreme events on SMEs reveals that business risks were traditionally channeled to SMAEs through effects on supply chain organization (e.g. Ref. [17], production and operation costs (e.g. Ref. [18], consumer demand and sales (e.g. Ref. [19], human resources (e.g. Ref. [20] and financial capacity (e.g., Ref. [21]. We contribute to existing research by examining how perceived consequences from the Covid-19 outbreak, contribute to explain the extent of SMAEs' perception of business risks related to various business dimensions, namely: human resources, cost of production, service delivery, supply chain, input and output prices, external financial environment, and internal firm finances. We then examine how firm-specific and management characteristics of SMAEs contribute to differentiate the extent of perceived risks across these business dimensions.

Furthermore, we posit that a range of risk mitigation strategies may be available to the SMAEs and that these strategies may be specific to areas of business operations (*i.e.* supply chain and logistics, financial, marketing, innovations, and contractual and sales). Existing research suggest that the management of supply chain risks is a complex task that depends on the sources and types of risk (e.g. Refs. [22,23]. That is, SMAEs' successful adoption of risk management strategies depends on a suite of organizational factors as well as on firm-specific characteristics that determine their post-crisis recovery (e.g. Refs. [24,25]. We contribute to this research by examining how the actions taken by SMAEs (adoption of mitigation strategies) to respond to business risks posed by the Covid-19 pandemic relate to specific areas of business operations. We then examine how firm-specific and management characteristics of SMAEs contribute to differentiate the adoption of mitigation strategies across the areas of business operations.

Risks originated from Covid-19 may not only have adverse effects on SMAEs but they could also generate positive spillover effects (business opportunities) on SMAEs' performance. Previous studies have revealed that such spillovers may originate directly from an unexpected event *per se* or indirectly from the mitigation strategies that SMAEs implement to cope with the event [26,27]. For example, there is evidence suggesting that the Covid-19 pandemic directly created opportunities in local markets for SMAEs by excluding competitors from other regions due to mobility restrictions, and by facilitating their access to government support schema (e.g. Refs. [28–30]. Other opportunities emerged indirectly from SMAEs' implementation of the mitigation strategies that led to organizational innovation and new competitive advantage including the adoption of new operational strategies to diversify products and penetrate new markets, which improve their short- and long-term profitability. We contribute to this line of research by investigating the business opportunities that the pandemic has offered to SMAEs and how firm-specific and management characteristics relate to the perception and potential exploitation of such opportunities.

Finally, the perceived risks, the risk mitigation strategies, and the risk-based business opportunities from the pandemic may be interlinked. In this context [31], view management strategies as a "mediator" between the perceived risks and the perceived opportunities [32]. point out that opportunities and threats have been separately treated in the literature, despite that they are seldom independent, and management actions should concentrate on reducing or neutralizing threats, and on simultaneously considering opportunities for positive improvements in performance. That is, the management strategies that SMAEs implemented to mitigate Covid-19 risks subsequently determine their perception and exploitation of emerging business opportunities. Therefore, we examine how the effect of perceived risks on risk-based business opportunities is influenced by the adoption of risk mitigation strategies.

3. Methods

3.1. Questionnaire and study participants

The empirical analysis in this paper relies on data collected through questionnaire-based interviews conducted during the period 25 May-21 June 2020 with a sample of 166 Egyptian SMAEs. The design of the questionnaire was informed by our review of the related literature (See Table S1 in the supplementary material). The survey content involved questions capturing various dimensions and sources of Covid-19 risk, mitigation strategies and emerging opportunities. More details regarding the survey design and pretesting, and the data collection process can be found elsewhere [3].

As portrayed in Fig S1 in the supplementary material, the 166 SMAEs surveyed were selected both from enterprises located in the newly reclaimed lands and desert areas (NRLDA) in the provinces of *Giza* and *Behaira* and *Kafr Al-Shaikh*, and from enterprises located in the old lands in the Nile delta areas (OLNDA) in the provinces of *Fayoum, Cairo*, and *Beni Suief*. These provinces represent major areas of agricultural production and export in Egypt. They also represent the conventional and the modern agricultural production systems in the country. That is, OLNDA are areas where traditional agricultural farming systems are practiced, and SMAFEs in these areas are often producing for local consumers and regional markets within the country. In contrast, NRLDA represent areas where modern and eco-friendly agricultural farming systems are practiced (e.g. mechanized production and postharvest operations, and organic farming), and enterprises within these areas are often producing for high-valued and export markets.

The sampled SMAFEs were randomly selected from enterprises officially registered and operating in the study areas, which are specialized in domestic and export sales of fresh fruit and vegetables. It is noteworthy that there is no official up-to-date information about the number of SMAFEs in each of the study areas. Thus, we based our sampling strategy on the widely accepted argument stating that nearly two-thirds of Egyptian agrifood enterprises are located in OLNDA, and the rest of the enterprises are located in

NRLDA. However, it was not possible to achieve such distribution in our sample due to the pandemic-related lockdown and other mobility restrictions during the data collection. Our final sample consisted of 97 SMAFEs located in OLNDA (58.4 % of the sample) and 69 enterprises located in NRLDA (41.6 %). Both the sample size (n = 166) and the response rate (70.9 %) of this study are the highest compared to recently conducted surveys with Egyptian agricultural enterprises [3]. Representatives of the sample SMAEs were owners, managers and key management members. They were informed prior to the face-to-face interviews about the purpose of the study and the confidentiality of the information provided, and they willingly consented to participating in the study. Within our sample, the majority of respondents were males (96 %), with close to 50 % of them belonging to the age group 25–44 years. Around 86 % of the respondents had post-secondary education including technical (28 %) or university (58 %) diplomas, whereas 8 % had completed secondary education, 2 % completed primary education and 3 % did not have any formal education. Further details about survey participants can be found elsewhere [3].

Table 1 show that close to 85 % of the enterprises were owned by domestic (Egyptian) investors, whilst 13 % were collectively owned by Egyptian and foreign investors and the rest (2 %) were owned by foreign investors. Fresh fruit and vegetables were the main two categories of firms' domestic sales (41 % and 26 % of domestic sales, respectively) and export sales (31 % and 17 %, respectively). Processed fruit and vegetables come next with 16 % and 21 % of firms' domestic and export sales, respectively. Other commodity groups such as dairy products and grains had relatively marginal shares in firms' total domestic and export sales. Other sales of the surveyed firms included farm inputs, medicinal and aromatic plants, and animal feed represented 13 % and 23 % of their domestic and export sales, respectively. Around one-fourth of the firms has been in the agrifood business for 15 years or more, close to one-third has been operating for periods ranging between 10 and less than 15 years, and around one-half of the firms were relatively younger with less than 10 years in operation.

With regard to the financial indicators of the SMAEs surveyed as per 2019, Table 1 shows that around two-thirds of the firms had total assets of less than EGP 5 million (1 US dollar = 16.8 Egyptian Pound (EGP) in 2019–2020), whilst the remaining third had total assets ranging between EGP 5 million and less than EGP 10 million (12 %) or more than EGP 10 million (14 %). The results related to the value of turnover in 2019 show a relatively similar distribution where about 68 % of the enterprises had annual turnover of less than EGP 5 million, 21 % had annual turnover ranging from EGP 5 million to less than EGP 10 million, and the remaining (11 %) had annual turnover of more than EGP 10 million. Selected performance indicators of the surveyed SMAEs are reported in Table S2 in the supplementary material.

In relation to the market specialization of the SMAEs surveyed, Table 1 indicates that export sales represented less than 30 % of the total sales of around one-fourth of the sample firms, and between 30 % and less than 70 % for 14 % of the firms. Other firms (60 % of the sample) were more export oriented with export sales accounting for more than 70 % of their total sales in 2019. The results in Table 1 show that 86 % of the SMAEs surveyed are certified with a certain quality scheme, where GLOBAL GAP and ISO 90001:2008 were the two main schemes for which the surveyed SMAEs were certified. Finally, the respondents were asked if their firms have internal guidelines for risk management and the results reveal that only 19 % of them had in place such guidelines for dealing with sudden shocks and unexpected events.

3.2. Measurements

Response options to the majority of the survey questions related to perception of Covid-19 risks, mitigation strategies and emerging opportunities were coded on a Likert scale with six responses from smaller to higher levels, including the option of "unable to judge". With regard to "risk perception", we adopted a multidimensional approach, suggested by Ref. [33] and implemented by Abu Hatab et al. (2020) to assess the perception of risk within and across multiple risk-source categories (see the attached questionnaire in the Supplementary Material). This approach measures the perceived risks among the surveyed SMAEs in three steps to generate a weighted subjective assessment of perceived risks based on three different dimensions of risk: severity, likelihood, and immediacy (See Abu Hatab et al., 2020).

Concerning strategies, the following question was asked "*The following table includes a list of potential actions that may be relevant for agrifood SMEs to adopt to respond to the impacts of the pandemic. To what extent are these relevant to your firm*?" The table contained 31 potential actions which were rated using a five-point Likert scale ranging from "completely disagree" to "completely agree". For the business opportunities, the question was phrased as follows: "*To what extent do you agree with the following statements regarding the positive changes and opportunities that the pandemic may have offered to your firm's business?*" A table including 13 possible opportunities was presented to the respondents who were asked to indicate the level of their agreement with each item on the table on a five-point Likert scale ranging from (1) "completely disagree" to (5) "completely agree".

Finally, variation in terms of Covid-19 risks, mitigation strategies and perceived opportunities was described according to key sociodemographic characteristics of the respondents (age, experience, highest level of education) as well as SMAEs characteristics and resource endowment (SMAEs location, ownership structure, number of branches, number of employees, certification status, value of total assets and value of total sales in the past year, 2019).

3.3. Data analysis

The multiple indicators and multiple causes model (MIMIC) was employed to measure the structural and measurement components of Covid-19 risks, mitigation strategies and emerging opportunities [34,35]. In addition, the MIMIC model allows us to combine indicators relating to perceived risks, mitigation strategies and emerging opportunities into their respective latent constructs. Furthermore, the MIMIC model permits us to specify the latent constructs relating to Covid-19 risks, mitigation strategies and emerging opportunities to be partly explained by sociodemographic and firms' characteristics and resource endowment. Practically, the MIMIC model follows two-step structural equation modelling process.

In the first step, a confirmatory factor analysis is performed to test the relationship (measurement model) between the latent Covid-19 risks, mitigation strategies and emerging opportunities constructs and their observed indicators (Tables S2, S3 and S4 in the Supplementary Material). Scores on Covid-19 risks, mitigation strategies and emerging opportunities constructs' indicators (γ_{kln}) for latent variables l are specified to capture the effects of scores on their resultant latent variable γ_{ln} and written as:

$$y_{k\ ln} = \hbar_{kl} \cdot \gamma_{ln} + \mu_{k\ ln} \tag{1}$$

$$\gamma_{k\ ln} = h_{kl} \times \gamma_{ln} + \mu_{k\ ln}$$

where γ_{kln} is the score for firm n on the kth indicator of latent variable γ_1, μ_{kln} denotes the measurement error in a given score. μ_{kln} is assumed to be uncorrelated across indicators that are independent and identically distributed (*i.i.d*), and $\hbar_{kl}$ are the factor loadings, which capture the effects of γ_1 on $\hbar_{kl}$. The fitness of equation (1) is tested using measures such as chi-square, root mean square error of approximation (RMSEA), comparative fit index (CFI) and standardized root mean square residual (SRMR) [36]. After testing for the model fitness and validity of equation (1), the structural model is estimated in the second stage. At this stage, the generated latent factors for Covid-19 risks, mitigation strategies and emerging opportunities are specified to be partly explained by the socioeconomic characteristics of firms and specified as:

$$\gamma_{ln} = \sum_{p} \lambda_{lp}.Z_{pn} + \nu_{ln} \tag{2}$$

where λ_{lp} are estimated coefficients that capture effects of the pth firms' social, economic and demographic characteristics denoted by z_{pn}. ν_{ln} denotes the error term with normally *i. i.d* assumption and permitted to correlate across latent variables. Equations (1) and (2) were jointly estimated as a MIMIC model [37]. indicated that when the socioeconomic characteristics of firms are specified to be free from error, then the error terms denote the effect of all remaining independent variables on the latent constructs. We incorporated all social, economic and demographic characteristics of the surveyed firms simultaneously in the structural component of the model to examine their influence on the latent constructs.

In accordance with our conceptual framework in Fig. 1, a mediation analysis was performed using ordinary least squares path analysis to examine how mitigation strategies adopted by SMAEs mediate the relationship between perceived Covid-19 risks and perceived business opportunities. Indirect effects were estimated using 10,000 bootstrap samples. Detailed theory and process for the mediation analysis is available in Ref. [38] and Cheng et al. (2016). It is worth mentioning that mitigation strategies, perceived Covid-19 risks and perceived business opportunities constructs were generated using their respective indicators. Thus, the generated constructs were used in the mediation analysis.

4. Empirical results

4.1. Effects of firm-specific and management characteristics on SMAEs' perception of Covid-19 risks

Table 2 displays the results of the MIMIC model concerning the risks perceived by the surveyed SMAEs due to the Covid-19 pandemic. The results identified seven categories through which the risks of the pandemic were transmitted to SMAEs: "human resources" (HR), "cost of production" (CP), "service delivery" (SD), "supply chain" (SC), "input and output prices" (IOP), "external financial environment" (EFE), and "internal firm finances" (IFF). Table S3 in the Supplementary Material presents the indicators defining each of the seven identified latent constructs. The validity of these constructs was assessed using composite reliability (CR) and average variance extracted (AVE). The CR values for the seven risk categories were 0.81, 0.78, 0.76, 0.71, 0.75, 0.70 and 0.74 respectively. The AVE values for the same set of constructs were 0.75, 0.72, 0.70, 0.70, 0.75, 0.70 and 0.71, respectively. For AVE and CR values [36], indicated that a value of at least 0.70 is satisfactory for confirmatory factor analysis. Regarding individual item reliability, standardized loadings of at least 0.70 is ideal, in order to obtain a reliability of at least 0.50, suggesting that we achieved about 50 % explained variance in the individual measure as a function of its factor (i.e. avoiding the inclusion of indicators with more than 50 % error) [39]. Based on these, we can see that all individual reliability values are ideal and acceptable. Moreover, we used root mean square error of approximation (RMSEA), comparative fit index (CFI) and standardized root mean square residual (SRMR) to further confirm the validity of the seven identified latent constructs and the fitness of the MIMIC model. The final MIMIC model had good fitness with RMSEA of 0.04, CFI of 0.98 and SRMR of 0.03. Comparing these values with the standards (RMSEA ≤0.06, CFI ≥0.95, and SRMR ≤0.08) recommended by Refs. [40,41]; it is clear that our latent construct and MIMIC model are valid. The estimates of the measurement (indicator) and structural (predictor) variables are presented in Tables 2–4. In terms of interpretation of coefficients, the measurement (indicator) estimates, one-unit change in the latent construct is associated with the corresponding coefficient change for the indicator variable. For the structural (predictor) variables, a unit change in a given variable is associated with the corresponding coefficient change in the latent construct [42]. For instance, the estimates in Table 2 show that a unit increase in experience is associated with 0.02 reduction in the perceived Covid-19 risk related to HR. The results reported in Table 2 also reveal that relative to SMAEs collectively owned by Egyptian and foreign entrepreneurs, SMAEs owned by Egyptians only perceived significantly lower Covid-19 risks related to PC, SC, EFE and IFF. In terms of magnitude, SMAEs owned by Egyptians lower their perceived Covid-19 risks related to PC, SC, EFE and IFF by 0.31, 0.14, 0.15 and 0.17 respectively. Generally, the variables related to SMAEs size (numbers of branches and employees, and values of total assets and sales) tend to suggest that the probability of perceiving Covid-19 risks decreases with SAME size.

Table 2

MIMIC model estimates for risk perceived from Covid-19 pandemic by the SMAEs surveyed.

Variable	Covid-19 risks						
	HR	CP	SD	SC	IOP	EFE	IFF
Structural model							
Gender	0.21(0.11)	0.16*(0.22)	0.89**(0.43)	0.01(0.12)	0.19(0.33)	−0.03(0.13)	0.15(0.09)
Age							
25-34	−0.13(0.93)	−0.08(0.16)	0.69**(0.28)	−0.11(0.08)	−0.15(0.22)	−0.08(0.09)	0.03(0.05)
35-44	−0.15(0.10)	0.03(0.17)	0.42(0.10)	−0.14(0.09)	0.02(0.23)	−0.04(0.09)	0.04(0.06)
45-54	−0.08(0.12)	0.06(0.19)	0.74**(0.33)	−0.07(0.10)	−0.38(0.25)	−0.07(0.10)	0.02(0.06)
Experience	−0.02***(0.01)	−0.01(0.01)	0.03(0.02)	−0.01(0.01)	−0.02(0.01)	−0.00 (0.00)	−0.00(0.00)
Education							
Secondary	0.36**(0.14)	0.39(0.28)	0.06(0.45)	−0.14(0.13)	0.40(0.35)	0.023 (0.16)	0.37***(0.14)
Technical	0.37**(0.01)	0.03(0.20)	−0.17(0.38)	−0.25**(0.12)	0.18(0.23)	−0.17(0.12)	0.18**(0.09)
University	0.29***(0.08)	0.08(0.20)	0.03(0.37)	−0.07(0.11)	0.15(0.28)	−0.14(0.12)	0.17**(0.09)
SAME location (OLNDA)	−0.14(0.09)	0.02(0.11)	0.383(0.23)	−0.16**(0.07)	−0.28(0.16)	0.03(0.06)	−0.14**(0.06)
Domestic investment	0.08(0.10)	−0.31*(0.17)	−0.27(0.25)	−0.14*(0.08)	0.07(0.32)	−0.15*(0.08)	−0.17**(0.07)
Branches	−0.07(0.05)	0.08(0.07)	−0.34**(0.11)	0.04(0.03)	−0.17**(0.08)	0.04(0.04)	0.04(0.02)
Employees	0.01(0.00)	−0.01(0.00)	−0.01(0.01)	0.00(0.00)	0.01(0.01)	−0.00**(0.00)	−0.00**(0.00)
Total assets (million EGP)							
<3	−0.26(0.17)	0.01(0.24)	0.40(0.39)	−0.57**(0.17)	0.10(0.31)	0.07(0.14)	−0.01 (0.07)
3- <5	−0.01(0.15)	0.04(0.21)	0.28(0.34)	−0.48**(0.15)	−0.03(0.27)	−0.00(0.11)	0.08(0.07)
5-<10	−0.27*(0.13)	0.16 (0.23)	0.02(0.34)	−0.29*(0.13)	0.28(0.27)	0.01(0.11)	−0.18**(0.08)
Total sales (million EGP)							
1-<3	−0.10(0.11)	0.06(0.13)	−0.12(0.25)	0.072(0.07)	−0.11(0.197)	0.05(0.08)	−0.04(0.05)
3- <5	−0.49***(0.14)	−0.18(0.26)	0.59(0.36)	0.04(0.05)	−0.37(0.25)	0.05(0.01)	−0.17**(0.08)
5-<10	−0.29**(0.13)	−0.23(0.22)	0.32(0.35)	0.18(0.11)	−0.29(0.27)	−0.04(0.11)	−0.06(0.07)
>10	−0.05(0.19)	−0.63*(0.38)	0.86(0.53)	0.12(0.14)	−0.05(0.37)	−0.27***(0.10)	−0.09(0.05)
Strategy	−0.03(0.08)	−0.20(0.13)	−0.73**(0.22)	0.07(0.06)	−0.42**(0.17)	−0.11(0.08)	−0.11**(0.05)
Certification	0.31**(0.10)	0.22(0.14)	−0.62**(0.28)	0.09(0.08)	2.67*** (0.25)	0.14(0.12)	0.08(0.05)
Explained variance (R²)	*0.67*	*0.49*	*0.63*	*0.49*	*0.90*	*0.33*	*0.41*
Measurement model							
Plummet productivity	2.06***(0.33)						
Loss skilled labor	0.75***(0.15)						
Reduced working days	1.81*** (0.21)						
High absenteeism	1.38*** (0.19)						
Preventive measure cost		2.57***(0.42)					
Central bank rate		1.89***(0.46)					
High loan interest		1.49*** (0.35)					
Transport restriction			0.89***(0.11)				
Reduced service delivery			−0.24**(0.09)				
Delayed port operations				2.27***(0.25)			
Produce shortage				2.59***(0.56)			
Reduced quality				2.85***(0.70)			
High commodity cost					0.37***(0.06)		
High input cost					0.38***(0.06)		
Uncertain corporate tax						2.63***(0.30)	
Uncertain salary cuts						1.42***(0.33)	
Uncertain policy rate						3.37**(0.20)	
Reduced receivables							2.89***(0.16)
Reduced bank credit							4.97**(1.57)
Increased credit default							4.60**(1.33)

Note: Standard errors are reported (in parentheses). ***, ** and * indicate significance at 1 %, 5 % &10 % levels, respectively. The latent constructs were labelled as follows: human resources (**HR**), cost of production (**CP**), service delivery (**SD**), supply chain (**SC**), input and output prices (**IOP**), external financial environment (**EFE**), and internal firm finances (**IFF**).

For instance, SMAEs with more branches were less likely to perceive SD and IOP risks, and those with larger number of employees were less likely to perceive EFE or IFF risks. Likewise, the results indicate that SMAEs with larger value of total assets are significantly less likely to perceive Covid-19 risks on SC in particular, as well as on IFF and HR. The value of SMAEs total sales was significantly associated with less probability of perceiving risks related to HR, and to a lesser extent to EFE and IFF. Interestingly, the results indicate that SMAEs that had internal guidelines (strategies) in place for risk management were less likely to perceive Covid-19 risks related to SD, IOP and IFF. Moreover, the results demonstrate that quality standard certification has a mixed effect on SMAEs perception of Covid-19 impact. That is, establishing a quality system decreases SMAEs' perception of SD risks; but it increases the probability of perceiving HR and IOP issues.

Concerning the influence of the personal characteristics of SMAEs operators, the results in Table 2 reveal that age of SMAEs' operators generally has a statistically insignificant influence of SMAEs' perception of Covid-19 risks, with the exception of SD where the estimates for the age groups 25–34 and 45–54 were statistically significant at 5 % level. In connection with this, the estimates related to the experience of SMAEs operators (proxied by the number of years in business) show a statistically weak effect on SMAEs perception

Table 3

MIMIC estimates for the mitigation strategies adopted by SMAEs to cope with Covid-19 risks.

Variable	Mitigation strategies				
	Supply chain	Financial	Marketing	Innovation	Contractual
Structural model					
Gender	0.05(0.06)	0.42*(0.23)	−0.29(0.37)	0.11(0.21)	0.21(0.42)
Age					
25-34	0.03(0.04)	0.05(0.15)	0.43(0.28)	0.27(0.17)	0.07(0.28)
35-44	0.02(0.04)	0.04(0.16)	0.42(0.28)	0.25(0.16)	−0.02(0.10)
45-54	0.00(0.04)	0.20(0.19)	0.54(0.32)	0.30(0.18)	−0.19(0.33)
Experience	−0.00(0.00)	−0.01(0.01)	−0.01(0.02)	0.01(0.01)	0.02(0.02)
Education					
Secondary	0.04(0.06)	0.34(0.26)	0.82**(0.40)	0.05(0.21)	0.04(0.46)
Technical	0.01(0.05)	−0.04(0.21)	0.57*(0.33)	−0.04(0.18)	−0.15(0.38)
University	−0.03(0.05)	−0.00(0.20)	0.54*(0.32)	−0.03(0.17)	−0.04(0.36)
SAME location (OLNDA)	−0.04(0.03)	−0.11***(0.00)	0.01(0.18)	0.26*(0.11)	0.01(0.21)
Domestic investment	0.10**(0.05)	−0.41**(0.15)	−0.47**(0.23)	−0.24*(0.12)	0.08(0.26)
Branches	−0.04(0.02)	0.21***(0.06)	0.25***(0.09)	0.07(0.06)	−0.04(0.11)
Employees	−0.00(0.00)	0.01**(0.00)	0.01**(0.01)	−0.01**(0.00)	−0.01(0.01)
Total assets (million EGP)					
<3	−0.11*(0.06)	−0.29(0.18)	−0.67**(0.29)	0.58**(0.25)	0.76**(0.35)
3- <5	−0.11*(0.06)	−0.11(0.19)	−0.93***(0.30)	0.44*(0.24)	0.41(0.34)
5-<10	−0.08(0.07)	−0.59** (0.28)	−1.32***(0.42)	0.31(0.30)	0.62(0.48)
Total sales (million EGP)					
1-<3	0.12(0.07)	0.09(0.21)	−1.21**(0.36)	0.31(0.20)	1.60***(0.39)
3- <5	−0.10(0.06)	0.14(0.19)	−1.05** (0.32)	0.22(0.18)	1.09***(0.34)
5-<10	−0.01(0.05)	0.35(0.19)	−0.72**(0.31)	−0.02(0.16)	0.33(0.34)
>10	−0.05(0.04)	−0.06(0.13)	−0.48**(0.22)	0.51**(0.23)	0.20(0.25)
Strategy	−0.09*(0.05)	−0.21(0.12)	−0.45**(0.19)	0.24(0.13)	−0.04(0.25)
Certification	0.20**(0.09)	0.07(0.16)	0.24(0.25)	−0.05(0.13)	0.40(0.28)
Explained variance (R^2)	*0.85*	*0.58*	*0.94*	*0.83*	*0.50*
Measurement model					
Procure local inputs	3.56***(0.12)				
Firm networking	3.56**(1.46)				
New market channels	3.97**(1.64)				
Preventive measures	3.92**(1.65)				
Commercial bank loans		3.98***(0.45)			
Government assistance		1.92***(0.41)			
Microfinance loans		0.99***(0.21)			
Bank negotiations		0.10***(0.24)			
Identify new business			−0.40**(0.13)		
Product new products			−0.65**(0.20)		
Innovative services				0.69***(0.24)	
New customers				−0.85***(0.31)	
Improve quality				−1.31***(0.37)	
Outsourcing					0.82***(0.07)
Local market					0.24**(0.11)

Note: Standard errors are reported (in parentheses). RMSEA = 0.04, CFI = 0.97, SRMR = 0.04. ***, ** and * indicate significance at 1 %, 5 % &10 % levels, respectively.

of Covid-19 risks, with HR dimension being the only statistically significant coefficient. That is, the longer the experience of a SMAE operator in the agrifood business, the lower the probability that the SAME would perceive Covid-19 risks related to labor and human resources. The level of educational attainment of SMAEs operators showed a mixed effect on the perception of Covid-19 risks. On the one hand, education was found to be associated with a higher probability of perceiving HR and IFF risks for the three comparison categories of the variable. On the other, SMAEs ran by operators with technical education significantly perceived less SC effects relative to those ran by illiterates. Finally, the insignificant influence of gender on SMAEs' perception of various Covid-19 risks may be explained by the low share of female-led enterprises in our sample, which represent only 4 % of the SMAEs surveyed.

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4.2. Effects of firm-specific and management characteristics on SMAEs' adoption of risk mitigation strategies

Table 3 presents the results of the estimated MIMIC model for determinants of SMAEs' adoption of mitigation strategies to cope with risks posed by the pandemic. Five mitigation strategies were identified and labelled as "supply chain strategies", "financial strategies", "marketing strategies", "innovation-based strategies", and "contractual strategies". In the interest of brevity, details of

Table 4
MIMIC model estimates for perceived opportunities emanating from Covid-19 pandemic.

Variable	Efficiency Improvement	New Markets	Access to Financial Services	New Products & Services
Structural model				
Gender	0.03(0.30)	−0.20(0.37)	−0.30(0.40)	0.304 (0.414)
Age				
25-34	0.30(0.20)	0.36(0.24)	0.41(0.27)	0.15(0.27)
35-44	0.42**(0.21)	0.37(0.25)	0.10(0.28)	−0.22(0.29)
45-54	0.60**(0.23)	0.49**(0.23)	0.41(0.31)	0.61**(0.32)
Experience	0.02**(0.01)	0.01(0.01)	−0.01(0.02)	0.00(0.02)
Education				
Secondary	−0.03(0.31)	0.16(0.39)	0.18(0.42)	−0.59(0.43)
Technical	−0.04(0.27)	0.19(0.32)	−0.06(0.35)	−0.56(0.37)
University	−0.23(0.25)	0.16(0.32)	0.14***(0.04)	−0.26(0.36)
Firm location (OLNDA)	0.16(0.15)	0.16(0.18)	−0.10(0.20)	0.19(0.32)
Domestic investment	0.29(0.18)	−0.08(0.22)	−0.46*(0.24)	−0.40(0.25)
Branches	0.07(0.07)	0.10(0.09)	0.10(0.10)	0.21**(0.10)
Employees	−0.00(0.01)	−0.01(0.01)	−0.01(0.01)	0.00(0.01)
Total assets (million EGP)				
<3	−2.14***(0.29)	−0.51(0.34)	0.58(0.39)	0.83(0.34)
3- <5	−1.42***(0.25)	−0.38(0.30)	0.62*(0.35)	0.34(0.36)
5-<10	−0.61**(0.25)	−0.30(0.30)	0.56(0.34)	−0.51(0.37)
Total sales (million EGP)				
1-<3	−0.47*** (0.12)	0.01(0.22)	−0.03(0.23)	0.81**(0.24)
3- <5	−1.08*** (0.23)	0.06(0.27)	0.01(0.30)	1.34*** (0.31)
5-<10	−1.30***(0.25)	−0.09(0.29)	0.29(0.32)	1.46***(0.33)
>10	1.16** (0.34)	0.08(0.41)	−0.14(0.45)	0.93**(0.47)
Strategy	0.516** (0.16)	−0.26(0.19)	−0.31(0.20)	0.75*** (0.21)
Certification	0.72*** (0.20)	0.85***(0.27)	0.14(0.26)	−0.29(0.28)
Explained variance (R^2)	*0.65*	*0.20*	*0.29*	*0.47*
<u>Measurement model</u>				
Improved efficiency	5.22***(0.58)			
New customer services	0.88***(0.13)			
Enhanced risk preparedness	0.50***(0.09)			
Improved returns	0.51***(0.11)			
New local opportunities		2.63***(0.716)		
New regional markets		1.04***(0.18)		
Export opportunity		0.64***(0.15)		
Access government programs			3.50***(0.76)	
Access bank services			1.06***(0.18)	
High market prices			0.65***(0.13)	
New product identification				1.26***(0.28)
New operational strategies Innovative new services				0.24*** (0.10)
				0.15***(0.08)

Note: RMSEA = 0.05, CFI = 0.96, SRMR = 0.04; ***, **, * show significance at 1 %, 5 % &10 % levels respectively.

the indicators defining these constructs are reported in Table S4 in the Supplementary Material. However, as shown in the measurement component of Table 3, all the indicators significantly explain their respective constructs.

By and large, results related to SMAEs size support our results discussed in the previous section, and confirm that SMAEs size and financial capacity significantly determine the adoption of Covid-19 mitigation strategies. Specifically, SMAEs with more branches and employees were more likely to adopt financial and marketing strategies. In addition, SMAEs size was positively and significantly associated with adoption of innovation-based strategies. In contrast, SMAEs with larger number of employees were significantly less likely to adopt innovation-based strategies, and those with larger values of total assets and annual sales were less likely to adopt marketing, financial and supply chain strategies, but they are more likely to adopt innovation-based strategies. Among the five clusters of mitigation strategies, the results show that the pre-existence of internal guidelines for risk management at SMAEs significantly influences the adoption of supply chain and marketing strategies.

The overall weak influence of this variable and its negative effect on the adoption of these two strategies could be explained by the results in the previous section, which showed that SMAEs with internal guidelines for risk management are generally less likely to perceive Covid-19 risks, and therefore, they may have only to adjust, upgrade or broaden the scope of their existing guidelines instead of designing and implementing new strategies for coping with Covid-19 risks. Lastly, and in line with our findings discussed in previous section, the results reveal that certified SMAEs are more likely to adopt and focus on supply chain strategies.

Concerning operators' characteristics, the results in Table 3 indicate that SMAEs operators with higher levels of education were more likely to implement marketing strategies, including for example, shifting products towards other markets rather than traditional markets or shifting to activities to specialize in other products rather than firm's traditional products. Furthermore, the ownership structure of the surveyed SMAEs was found to be a significant determinant of the adopted mitigation strategies, where domestically-

owned firms were significantly less likely than firms with foreign or joint foreign-domestic ownership to implement financial, marketing and innovation-based strategies.

4.3. Effects of firm-specific and management characteristics on SMAEs' perception of risk-based opportunities emanating from the Covid-19 pandemic

The estimated MIMIC model in Table 4 regarding SMAEs perception of business opportunities that emerged from the Covid-19 pandemic identified four clusters of opportunities that were denoted "efficiency improvement", "new markets", "access to financial services", and "new products & services". The results of the measurement model in Table 4 reveal that all the indicators defining each of the constructs are significantly explaining their respective constructs.

The results related to the value of SMAEs' total assets and sales indicate that enterprises with total assets up to 10 million EGP are significantly less likely to perceive opportunities related to efficiency improvement. However, SMAEs with larger total sales (more than EGP 10 million) are more likely to perceive opportunities from the pandemic that can enable them to improve efficiency of their operations. Likewise, SMAEs with larger values of total sales (all sub-categories) were significantly more likely to take advantage from the pandemic to introduce new products and services.

In addition, the results indicate that SMAEs that hold quality certifications and guidelines for risk management were more likely to benefit from the pandemic by improving the efficiency of their business operations, entering into new markets, and introducing new products and services. Furthermore, the probability of introducing new products and services was positively correlated with the number of SMAEs branches, where enterprises with more branches were found to be more likely to introduce new customer services and delivery options within the domestic markets, and exploit emerging opportunities in the international markets. Finally, the probability of perceiving business opportunities related to efficiency improvement and new products and services was found to increase with the existence of risk management strategies at the SMAEs surveyed. A look at the sociodemographic characteristics of SMAEs operators reveals that the age of firm operators significantly explains SMAEs' perceived opportunities from the pandemic in relation to efficiency spillovers, accessibility to new consumer markets and the development of new services and products. In particular, the results show that SMAEs operators who belong to the age group 45–54 years and who have more experience in the agrifood business are more likely to perceive efficiency spillovers from the pandemic. Surprisingly, the level of formal education of SMAEs operators had weaker association with firms' perception of business opportunities induced by the Covid-19 pandemic, while it was found to only influence perception of firm operators with university level education of improved access to financial services.

4.4. Mediation analysis of relationship between SMAEs' perceived risks, adopted mitigation strategies and perceived business opportunities

The results presented in Table 5 show that perceived Covid-19 risks by SMAEs' had a *direct* association emerging business opportunities, as indicated by the significantly positive path coefficient of 1.183 at 1 % level. In addition, the results reveal that perceived risks by the SMAEs due to the Covid-19 pandemic also had a positive and significantly *direct* association with the adoption of mitigation strategies. Likewise, risk mitigation strategies adopted by SMAEs had *direct* and significant association with perceived business opportunities.

Concerning the *indirect* effects, the results reveal that the perceived Covid-19 risks significantly linked to the adoption of specific risk mitigation strategies, and subsequently, risk mitigation strategies directed SMAEs' perception of emerging business opportunities (path coefficient of 0.586 and significant at 1 % level). With respect to the *total* effects, the significant and positive total effect of perceived Covid-19 risks on risk mitigation strategies suggests that Covid-19 risks significantly predicted the mitigation strategies adopted by SMAEs. Furthermore, Covid-19 risks significantly predicted the emerging opportunities through the risk mitigation strategies. Thus, risk mitigation strategies adopted by SMAEs present "mediators" that explain the fundamental relationship between Covid-19 risks and perceived emerging opportunities to the SMAEs surveyed.

5. Discussion

In developing countries, SMAEs operate in increasingly dynamic and unpredictable environments, and thus understanding and managing related risks arising from extreme events and shocks are a prerequisite for their survival and growth. This is because SMAES

Table 5
Mediation analysis of the relationship between SMAEs' perceived Covid-19 risks, mitigation strategies and emerging business opportunities.

Effects		Path coefficient	T-statistic	95 % Conf. Interval Lower Upper
Total effects				
Perceived opportunities →	Perceived risks	1.183***(0.039)	30.69	1.107 1.258
Perceived opportunities →	Mitigation strategies	0.495***(0.053)	9.40	0.392 0.598
Mitigation strategies →	Perceived risks	1.057***(0.041)	25.52	0.975 1.137
Direct effects				
Perceived opportunities →	Perceived risks	1.183***(0.039)	30.69	1.107 1.258
Perceived opportunities →	Mitigation strategies	0.495***(0.053)	9.40	0.392 0.598
Mitigation strategies →	Perceived risks	0.471***(0.062)	7.62	0.350 0.592
Indirect effects				
Perceived opportunities →	Mitigation strategies	0.586***(0.063)	9.36	0.463 0.708

Overall R^2 = 0.95. The mediation analysis was conducted bias-corrected bootstrapping approach [38] and corrected for potential heteroscedasticity using heteroscedasticity standard errors with HC4.

are particularly vulnerable and more easily threatened by extreme events and natural disasters due to financial and non-financial resource characteristics. Despite the major contributions that SMAEs make to economic growth and sustainable development in developing countries, few studies have been undertaken to investigate how they perceive and deal with uncertainties originating from extreme events and natural disasters that may jeopardize their success and threaten their existence [43]. With the Covid-19 pandemic being an example of a recent shock that presented unprecedented uncertainties to SAMEs, the present study surveyed a sample of 166 Egyptian SMAEs to examine the determinants of their perception of Covid-19 risks, the determinants of their adoption of mitigation strategies to cope with these risks, and the determinants of their perception of risk-based business opportunities from the pandemic. In addition, the study examined the links between perceived risks, mitigation strategies, and perceived business opportunities. In the following sub-sections, we discuss the main empirical findings and their policy implications.

5.1. Identified risks, mitigation strategies and business opportunities

With regard to SMAEs' perceived risks, the results lend support to the recent studies on the profound effects that Covid-19 had on small- and medium-sized businesses in developing countries (e.g. Ref. [44]; Abuhussein et al., 2020; Zazzou & Abdou, 2021). Especially, the seven risk groups that were identified by the MIMIC model confirm the Covid-19 pandemic has posed multiple and significant risks to SMAEs and caused profound effects on both their upstream and downstream activities. This finding underscores the need for more integrative approaches to address the multifaceted effects of unexpected events on the performance of developing countries' SMAEs, and allow for deeper understanding of the pathways through which risks are transmitted across various upstream and downstream stages of their activities.

In relation to Covid-19 mitigation strategies, the results identified five key strategies that SMAEs implemented to cope with risks posed by the Covid-19 pandemic, which consisted of strategies focusing on management and marketing, contractual relationships, and enterprise finances and innovation. Surprisingly, the results revealed an insignificant association of the pre-existence of internal guidelines for risk management on SMAEs' adoption of Covid-19 coping strategies. This finding may be explained by the 'wait-and-see' approach that SMAEs in developing countries adopt to cope with uncertainties and external shocks because they lack sufficient financial resources to develop risk management strategies and formalize structures to deal with unexpected events. In particular, many SMAEs managers think that preventive measures, such as risk management guidelines, require financial expenditures that have nothing to do with the enterprise's production objectives [45]; Falker & Hiebl, 2015).

Concerning the perceived business opportunities, the results generally confirmed that risk-based opportunities that may be created by SMAEs' exposure to unexpected events. Specifically, we found that the Covid-19 pandemic has offered business opportunities to SMAEs represented by a facilitated access to government support schemes, an improved resource-use and supply chain efficiency, and an enhanced preparedness for future risks through the implementation of innovation-based transformation in business and marketing strategies. Particularly noteworthy are the insights derived from our interviews with the surveyed enterprises, indicating that the Covid-19 pandemic has prompted a shift toward digitization and innovation, providing SMAEs with opportunities to explore novel avenues for enhancing customer services and adapting to evolving market dynamics. These prospects encompass the embrace of e-commerce platforms and the establishment of online marketplaces and digital payment systems, facilitating contactless transactions. Furthermore, the pandemic has enabled SMAEs to leverage social media as a means to cultivate their brand, exhibit their products, and establish connections with a broader customer base. Moreover, the pandemic-induced environment has incentivized SMAEs to collaborate with other stakeholders within the supply chain, such as logistics companies and input suppliers, to optimize operations and offer comprehensive services to their clientele. Additionally, the proliferation of mobile applications and SMS services during the pandemic has empowered SMAEs to access real-time updates on pricing and market trends, endowing them with valuable insights for comprehending consumer preferences, market shifts, and demand patterns, allowing them to tailor their offerings accordingly. These findings align with the findings of de Araújo Lima et al. (2020) and [46]; which point out that investigations of SMEs' risk perception and management should account for the adverse effects and the emerging opportunities from unexpected events.

5.2. Effects of firm-specific and management characteristics of risk perception, mitigation strategies and business opportunities

A close look at the influence of SMAEs' characteristics and resource endowment on their risk perception, adoption of mitigation strategies, and perception of risk-based opportunities, reveals that the probability of perceiving Covid-19 risks decreases with SMAE size, whereas the probability of adopting a coping strategy and perceiving risk-based opportunities increases with firm size. For instance, the results suggested that the number of employees and branches of SMAEs together with the values of their total assets sales are associated with lower perception of Covid-19 risks. In contrary, the results showed that the values of SMAEs' total assets and sales are associated with a higher probability of perceiving risk-based opportunities from the pandemic. These findings are in line with previous studies on developing countries' SMEs, which indicate that firm smallness is associated with higher risk exposure and perception during unexpected events because of their lower productivity, weaker financial structure, limited financing options and lack of diversity in their business activities (e.g. Refs. [47,48]. In particular, the results related to the influence of the value of total assets and total sales on the probability of perceiving Covid-19 risks are in consent with those reported by Refs. [49,50] who find that, for small businesses, the greater the value of a firm's total assets, the less the probability that it would experience financial distress during extreme events and market shocks because these assets function as a buffer that enable firms to maintain cash flow to cover recurrent expenses during extreme events. In addition, the results comport with the findings of [51,52]; which indicate that smaller-sized enterprises have resource disadvantages and are more risk averse than large enterprises, and they may therefore be unable to seize emerging business opportunities to the same extent.

The risk perception results showed that the existence of internal guidelines for risk management reduces the likelihood of SMAEs' perception of Covid-19 risks, particularly in relation to input and output prices, service delivery and internal SMAE finances. In addi-

tion, the existence of risk management guidelines is significantly associated with the likelihood of perceiving business opportunities from the pandemic in relation to improving supply chain efficiency and introducing new products and services. These findings are in accord with previous studies on managerial practice and SMEs' performance, which show that performance management process begins with the development of effective strategies to adapt to the changing business environment and emergent needs (e.g. Ref. [53]). While our MIMIC model results revealed a weak influence of the pre-existence of internal guidelines for risk management on SMAEs' adoption of coping strategies, it is crucial for government initiatives geared toward supporting SMAEs to include components focusing on building capacity of these enterprises to better predict supply chain risks and respond timely and effectively to their anticipated impacts.

Another important finding was related to the role of quality standard certification, which had a mixed effect on SMAEs' perception of Covid-19. In particular, establishing a quality system was found to reduce SMAEs' perception of risks related to product delivery; whereas it was associated with increased perception of risks related to human resources and input and output prices. This might be attributive to the reliance of certified SMAEs on highly skilled labor, usage of higher quality inputs to meet food safety and quality standards in local and export markets, and the higher prices of their products than those produced by non-certified firms [54]. In the wake of the outbreak of the Covid-19 pandemic, many of SMAEs encountered profound financial and non-financial challenges including disruptions in the functionality of agrifood markets, decreased purchasing power of the consumers, shortage in skilled labor, and many of them had to layoff skilled workers to reduce financial stress. However, the results showed that certified SMAEs are more likely to adopt management strategies to enhance supply chain resilience, and are also more likely to take advantage from the pandemic to improve the efficiency of their business operations, enter into new markets, and introduce new products and services. These findings accord with the findings of Abu Hatab et al. (2019) and [55]; which demonstrate that SMAEs' certification for food safety and quality standards enhances their organizational performance, improves their profitability and competitiveness, and reduces their vulnerability to business shocks and risk exposure.

Another notable finding was related to the influence of ownership structure, where SMAEs with 100 % foreign ownership or joint foreign-domestic ownership, often engaged in exporting and/or domestic market operations, were more likely than domestically-owned enterprises to perceive Covid-19 risks. In this respect [56], illustrates that doing business internationally is often much costlier and more difficult for foreign-owned SMEs because of costs related, for example, to access to information and border regulations and standards. Another explanation is that SMAEs, which are fully or partially owned by non-Egyptians, were excluded fully or partially from stimulus plans that the government of Egypt introduced to help SMAEs cope with the adverse consequences of the pandemic. In addition, the results revealed that SMAEs with 100 % domestic ownership were significantly less likely than firms with foreign or joint foreign-domestic ownership to implement financial, marketing and innovation-based strategies or take advantages of business opportunities emerging from the pandemic. These findings are consistent with the literature on the effect of ownership structure SMAEs' performance during economic uncertainty (e.g. Refs. [43,46,57]. Elements in this literature suggest that a foreign or joint foreign-domestic ownership structure may decrease developing countries' SAMEs risk exposure, reduce the negative effects of economic uncertainty, and enable them exploit emerging business opportunities. Therefore, there is a good case for incentives to encourage foreign ownership and joint ventures between domestic and foreign entities in the Egyptian SMAEs' sector through providing various forms of fiscal, financial and technical support, streamlining regulatory processes and simplifying administrative procedures for foreign investors, and ensuring transparent and predictable business environments.

Besides SMAEs characteristics, the results showed that the experience and educational level of SMAEs' operators are associated with their risk perception, adoption of mitigation strategies, and perception of risk-based opportunities. For instance, although the effect is generally subtle, the results showed that the longer the experience of a SMAE operator in the agrifood business, the lower the probability that the enterprise would perceive Covid-19 risks related to labor and human resources. Similarly, the level of educational attainment of SMAEs' operators was associated with a higher probability of perceiving risks related to human resources and internal firm finances, which may be attributed to the fact that SMAEs operated by highly educated entrepreneurs are more engaged in export-oriented businesses where human resources and internal firm finances play a major role in their business operations, sales and competitiveness [54]. SMAEs' operators with higher levels of education were also more likely to implement marketing strategies, including for example, shifting products towards other markets rather than traditional markets or shifting to activities to specialize in other products rather than firm's traditional products.

Despite that the level of education of SMAEs' operators had a weak effect on firms' perception of business opportunities induced by the Covid-19 pandemic, the results revealed that SMAEs operators with university level education were more likely to access to financial support and services. This finding aligns with the findings of [58] showing that higher levels of education are expected to enhance the ability of firm operators to cope with problems and seize opportunities. However, previous research on Egyptian SMAEs revealed the insignificant influence of education level of SMAEs' managers on enterprises' business performance (e.g. Ref. [54] and revealed that obtaining an educational degree does not necessarily mean that the holder possesses the relevant entrepreneurial skills and training to manage SMAEs and seize business opportunities. Therefore, these findings should be interpreted with caution, because the actual and perceived risk theory posits that the characteristics of SMAEs' operators do not necessary mean that SMAEs would perceive lower risk or higher business opportunities, since more knowledgeable and experienced individuals are more likely to understate or overstate the level of actual risk due to familiarity and control they perceive to have over risk [59].

5.3. The mediating role of mitigation strategies between perceived Covid-19 risks and perceived business opportunities

The results of the mediation analysis indicated that perceived Covid-19 risks directly motivated SMAEs' to adopt mitigation strategies and influenced their perception of emerging business opportunities. Furthermore, perceived Covid-19 risks were found to significantly influence the adoption of mitigation strategies, which subsequently influenced SMAEs' perception of risk-based opportunities.

Overall, these results confirmed that mitigation strategies adopted by SMAEs present a mediating factor between perceived Covid-19 risks and perceived opportunities. The findings are in keeping with the recent literature on enterprise risk management in SMEs (e.g. Refs. [47,60], which point out that risk management not only has considerable implications for reducing enterprises' vulnerability to unexpected events and business risks, but it also enables the design of coping strategies to minimize the likely losses and exploit emerging business opportunity. This implies that building up capacities of SMAEs to develop and implement proper mitigation strategies can enable them to address adverse effects arising from business risks and exploit business opportunities offered by various risks. It is worth mentioning that, our findings do not unpack mechanisms through which SMAEs take up business opportunities, rather the findings point out relevant factors that are associated with SMAEs' perceived business opportunities arising from the perceived Covid-19 risks. Future research should unpack whether and how the SMAEs take up these opportunities.

5.4. Conclusion

In conclusion, our empirical results offer relevant insights that should help SMAEs' operators and concerned Egyptian policymakers implement effective strategies to enable SMAEs mitigate Covid-19 risks, exploit emerging business opportunities, and enhance their overall resilience to future pandemics. Especially, the findings underscore the need for a paradigm shift in relation to risk management in developing countries' SMAEs toward more holistic frameworks that identify, assess, and monitor different risks, promote enhanced risk awareness and preparedness, and enable risk-based opportunities to be exploited. Although our findings are specific to the Egyptian SMAE landscape, they are anticipated to be relevant to similar contexts in other developing countries and be useful for the development of evidence-based risk management strategies to build resilience of SMAEs against economic and environmental disruptions.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijdrr.2023.104045.

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