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Innovation, digital technologies, and sales growth during exogenous shocks

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ABSTRACT

We investigate how the introduction of different types of innovation and the adoption of various digital technologies during exogenous shocks, influence firms' sales growth. By drawing from a sample of 1979 firms from the Caribbean small island developing states (SIDS) during the COVID-19 pandemic, we show that although some innovation types enhance sales growth, others are not as important and can even reduce revenue over time. Moreover, by examining the interrelationship between innovation and digital technologies we unveil situations where the simultaneous introduction of certain types of innovations with specific digital tools further enhances sales growth and other instances where rigidities arise that impair sales growth. This study furthers our understanding of whether and how innovation, digital technologies, and their interaction, enable firms to positively respond to the challenges of exogenous shocks.

1. Introduction

Despite the negative impact exogenous shocks have on firm performance, the extant literature has only partially explored how firms can respond (Davidsson and Gordon, 2016; Doern et al., 2019; Morgan et al., 2020; Saridakis, 2012; Smallbone et al., 2012) and what strategies they can develop to maintain their competitiveness under such conditions (Krammer, 2021). For example, innovative solutions can potentially help firms survive by enhancing their competitiveness and performance during an exogenous shock (Dewald and Bowen, 2010; Krammer, 2021). The introduction of innovations can assist firms in becoming more agile, allowing them to quickly adapt their business models and respond to the newly arising needs of their customers (Hamel and Valikangas, 2003; Ibidunni et al., 2022; Khurana et al., 2022).

Additionally, scholars and practitioners have also emphasised that a firm's innovation activity can benefit from the adoption of digital technologies (see for example, Ardito et al., 2018; Bresciani et al., 2018; Westerman and Bonnet, 2015). Indeed, digital transformation can create opportunities for innovation and entrepreneurship by altering the mechanisms of value creation and value capture (Scuotto et al., 2017; Nambisan et al., 2017). This brings us to a second strategy that firms can employ during exogenous shocks as a means to maintain their competitiveness–the one pertaining to the adoption of digital technologies (Usai et al., 2021; Mikalef and Pateli, 2017).

In this study we investigate two strategies that firms can employ during external shocks (in this case the COVID-19 pandemic) to retain their customers and maintain or improve their level of sales. These strategies refer to a) the implementation of different types of innovation (i.e., good, service, process, organisational, and marketing) (Kim and Lui, 2015; OECD/Eurostat, Oslo Manual, 2005[1]; Tavassoli and Karlsson, 2015), and b) the adoption of certain forms of digital technologies (i.e., digital technologies for social media, and digital technologies for assisting external collaborations) (Han and Trimi, 2022; Mikalef et al., 2021; Tajvidi and Karami, 2021). More importantly, we also examine the interplay between innovation types and digital technologies–an issue which, to the best of our knowledge, is examined for the first time in the context of exogenous shocks. In effect, our study is a response to the recent calls for further research that illuminates the intricate

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[1] We adopt the Oslo (2005) definition with the 4 sub-categories of innovation, as this is the one employed by the Compete Caribbean (2021) IFPG survey that was used in this study.

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interrelationship between digital transformation and innovation processes (see e.g., Appio et al., 2021) — a topic that is also of incredibly high practical relevance in today's business world (Arbabi, 2022).

Our work contributes to prior literature that investigates the role of innovation during major exogenous shocks (Konara and Ganotakis, 2020; Krammer, 2021; Paunov, 2012a, 2012b). Extant literature agrees that innovation is a critical strategy that firms can deploy during abrupt, extreme events (Krammer, 2021; Paunov, 2012a, 2012b; Roper and Turner, 2020). However, we lack a detailed understanding of the influence that different types of innovations have on firm performance, during an exogenous shock. Specifically, most of the literature has so far concentrated on examining how external crises affect a firm's innovative activities (e.g., Paunov, 2012a, 2012b), while there is a limited understanding of whether firms that do innovate can better respond to such events by achieving higher levels of performance (Krammer, 2022). The very few studies (Castillejo et al., 2019; Flammer and Ioannou, 2015a, 2015b; Krammer, 2022) that have actually investigated this relationship, have considered innovation inputs (internal, external R&D), rather than innovation outputs (e.g., product, process, organisational, marketing), and/or have only considered certain types of innovation, i.e., product or patent (Amore, 2015; Jung et al., 2018a, 2018b; Spescha and Woerter, 2019). In order to move toward a conceptually richer domain of innovation management, however, we need to further investigate the different types and thus, the variations of innovation outputs as these determine whether firms are able to compete successfully in highly uncertain environments (Ganotakis and Love, 2011). While broadly speaking innovating may be increasingly valuable, strong emphasis on novelty in some domains can be very hazardous or inefficient when environmental conditions (i.e., competitive and economic) are becoming more taxing; this is especially true in times of crisis (Miller and Friesen, 1983). In fact, the very occurrence of a crisis is thought to expose firms to uncertainty. Such uncertainty, coupled with the fact that some types of innovation can be extremely disruptive during periods of crisis, suggests that any performance benefits that stem from these innovations will likely be cancelled out or even negative consequences may arise. To tackle this issue, we investigate which types of innovation outputs are important for firms' sales growth during exogenous shocks and which ones can deter growth. By doing so, our study also enriches prior limited literature that has so far considered the overall effect of innovation on firm performance—without hypothesizing specific differences across alternative innovation types (e.g., Devece et al., 2016; Jung et al., 2018a, 2018b; Krammer, 2022).

We also contribute to the fast-growing research stream that considers the overall value of digital technologies (e.g., Berger et al., 2021; Boeker et al., 2021; Iacobucci and Perugini, 2021). It is recognized that digital transformation can offer important advantages to firms, such as allowing them to adapt their strategy to better capture opportunities (Furr and Shipilov, 2019), helping create products and services that better suit customer needs, improving collaboration efficiency, and reducing information processing costs. However, the adoption of digital technologies also involves challenges, and therefore arguments regarding their "dark side" also exist in prior literature (e.g., Correani et al., 2020). Potential negative outcomes include employees not being able to cope with the changing workflows, increased technology-related anxiety and work overload, as well as interruptions and distraction from main duties (Tarafdar et al., 2015). All these challenges can jeopardise problem solving ability and firm level performance. By empirically examining the sales growth effects of digital technologies during an exogenous crisis we build on the aforementioned ongoing debate about the real impact of digital technology tools on firms' performance (e.g., Signh and Hess, 2017; Usai et al., 2021) in two important ways: First, by investigating how different digital technologies directly influence firms' sales growth, and second, by examining the symbiotic (or hindering) relationship between digital technologies and different types of innovation for sales growth during an exogenous shock. By doing so, our empirical investigation unveils for the first time in the literature situations where the simultaneous introduction of certain types of innovations and digital technologies creates rigidities that can negatively impact a firm's sales growth, and situations where other types of innovations can further enhance sales growth if combined with the adoption of certain digital technology tools.

From a practical perspective, by disaggregating the "all inclusive" concept of innovation into five distinct types, our study draws the attention of managers to the facilitating or hindering role of each of these types in periods of exogenous shocks. We therefore provide managers with a clear roadmap on the innovation strategies that should be avoided during exogenous crises and the ones that should be employed as a means to improve competitiveness and boost sales growth. Further, while acknowledging the opportunities that digital transformation offers to firms in periods of major exogenous shocks, we instruct managers on how to better optimize the adoption of relevant digital technologies, both as stand-alone and as complementary-to-innovation tools.

To test our set of hypotheses, we present quantitative evidence on how firms have responded to the COVID-19 pandemic, by utilizing a survey dataset, specifically designed to capture the effects of the pandemic on a sample of 1979 firms across the thirteen Caribbean small island developing states (SIDS). The survey was conducted by the Inter-American Development Bank (IDB) (2021) and the Compete Caribbean Partnership Facility. Firms in developing countries such as those located in the Latin America and Caribbean, LAC, region recorded significant income deficits and experienced make-or-break challenges in meeting their financial obligations, with approximately 31 % of firms projected to default because of the COVID-19 crisis (Economic Commission for Latin America and the Caribbean, ECLAC, 2020). Our empirical findings allow us to, not only draw the aforementioned contributions to the existing literature, but also propose some practical implications for managers and policy makers of firms for SIDS.

The remainder of the paper is organized as follows: In the following section, we theorize around the two strategies that firms in SIDS employed during the COVID-19 pandemic—namely innovation and digital technologies–as well as their interplay, in an attempt to examine whether, and if so, how they assist (or hinder) sales growth in comparison to the pre-crisis period. Next, we present our data and methods, with a particular emphasis on the explanation of our empirical setting. Further, we present our empirical results and supplemental analyses. Last, we summarize our conclusions, implications, and future research directions.

2. Hypotheses development

Exogenous shocks can become a fertile ground for innovative opportunities that arise due to environmental and industry changes that take place (Roper and Turner, 2020; Wenzel et al., 2020; Dewald and Bowen, 2010; Hamel and Valikangas, 2003). This notion is in line with Schumpeterian's view of "creative destruction" according to which some firms respond to those changes by reallocating resources that allow them to develop innovative solutions and consequently exploit new avenues (Flammer and Ioannou, 2015a, 2015b; Morgan et al., 2020). Indeed, literature suggests that strategic renewal and the introduction of innovations can be an efficient way to respond to an external shock (Wenzel et al., 2020; Roper and Turner, 2020), while existing evidence shows that by maintaining their innovation activity in times of exogenous shocks, firms are able to sustain their competitiveness and performance (Flammer and Ioannou, 2015a, 2015b; Jung et al., 2018a, 2018b; Krammer, 2022). For instance, results from a recently published multi-country survey of 11,000 firms between May–June 2020 (first COVID-19 wave) show that innovative firms were better able to adapt to the COVID-19 crisis (Krammer, 2021).

At the same time, recent empirical evidence suggests that although 52 % of firms reduced their investments due to COVID-19, these reductions did not influence the uptake of digital technologies and the implementation of digital transformation projects (Appio et al., 2021). The adoption of digital technologies can reshape the business models and operations of companies, and therefore enhance their performance (Ceipek et al., 2021; Madolla et al., 2019). This is even more critical in periods of exogenous shocks, as new digital technologies can allow firms to increase the flexibility of their products and services, facilitate connections among firms, and lower the barriers across industries (Correani et al., 2020). More importantly, digital technologies increase access to timely data, which, in turn, can provide firms with the opportunity to perform dynamic data analysis and take informed decisions more quickly than ever before (Del Vecchio et al., 2018).

In the following sections we theorize around these two important strategies that firms may employ during an exogenous shock—namely innovation and digital technologies–as well as their interplay, and provide insights into whether, and if so, how they facilitate (or hamper) sales growth, in comparison to the period prior to the exogenous shock.

2.1. Innovation types and sales growth

Although as described above there is increased evidence that innovative firms can enhance their performance during exogenous shocks (Jung et al., 2018a, 2018b; Krammer, 2021; Roper and Turner, 2020), we nevertheless posit that not all innovation activities/types matter the same for sales growth during a crisis. Specifically, we propose that although good, service, and process innovations are important for enhancing sales growth, organisational and marketing innovations will matter less.

During an exogenous shock, firms that develop good, service or process innovations are more efficient and align better with the shifting demands of their customers and other stakeholders (Roper and Turner, 2020). Good and service innovations (e.g., market introduction of new or significantly improved goods or services with respect to their capabilities, user friendliness, components, and/or sub-systems) allow firms to gain, at least temporarily, a monopoly over rivals, by meeting their customers' new expectations and needs that arise due to the external crisis. This, in turn, increases customers' willingness to pay a premium price for certain goods or services (Tavassoli and Karlsson, 2015). Goods innovation can also enhance a firm's efficiency by reducing the cost of inputs (e.g., materials) needed for manufacturing. This may result in significant savings that, if passed to customers, may further improve sales volume (Damanpour et al., 2009). Indeed, increased competitiveness derived from goods innovation has been associated with higher levels of growth, particularly during periods of economic recession (Devece et al., 2016).

Similarly, the introduction of a process innovation (e.g., implementation of a new or significantly improved production process, distribution method, and/or support activity for goods or services) can also lead to efficiency gains (e.g., operational flexibility, cost saving, and time reduction in the manufacturing of goods or delivery of services) throughout the supply chain. Cost savings can allow firms to reduce good or service prices, if deemed necessary to attract more customers, which, in turn, can enhance sales. Supply chain improvements, such as faster time from design to production, and then to distribution/delivery (lead-times) can also improve customer satisfaction (Un and Asakawa, 2015). Evidently, process innovations can make goods and services more appealing in the eyes of consumers, and hence lead to increased sales (Tavassoli and Karlsson, 2015).

In contrast, we assert that during an exogenous shock, organisational and marketing innovations might not lead to sales growth. On the one hand, organisational innovations (e.g., new or improved practices for organizing procedures or external relations, methods for organizing work, and human resource management) can potentially assist firms' overall performance by improving their efficiency, flexibility, and creativity (Tavassoli and Karlsson, 2015; Damanpour et al., 2009), as they can enhance internal and external coordination and information sharing (Azara and Ciabuschi, 2017). On the other hand, because their implementation requires changes to a firm's organisational routines and management practices, they are more complex to implement than good and service innovations, and their introduction creates disruption that takes time for employees to adapt to (Hashi and Stojcic, 2013). During that readjustment period, employees' productivity can be adversely affected, not only because they must learn to carry out their duties in new ways, but also because they might resist such changes (Birkinshaw et al., 2008). This seems to be particularly true in times of crisis where uncertainty and time constraints prevail. In fact, organisational innovations seem to add another layer of complication through their disruptive nature and complexity, which can, in turn, erode their ability to positively influence firm performance (Angelidou et al., 2022; Birkinshaw et al., 2008).

Marketing innovations (e.g., implementation of new marketing strategies that require significant changes in product design, packaging, product placement, product promotion, and/or pricing) enable firms to adopt new marketing strategies that are well-suited to the characteristics of selected market segments and implemented in ways that enhance customers' perceptions, and therefore purchase intentions (Konara and Ganotakis, 2020). However, under conditions of severe external uncertainty, managers often react by combining simultaneously different marketing strategies that are less well-suited and easier to implement (e.g., matching competitive actions and engaging in promotional wars). During exogenous shocks managers may decide to offer their products at discount prices, while simultaneously attempting to differentiate and target various market segments. Such strategies ultimately reduce the benefits of marketing innovations and even distract managers from monitoring customers' emerging needs, which are rather dynamic in times of crisis (Anning-Dorson, 2017; Damanpour et al., 2009). Moreover, a marketing strategy can be more easily copied by competitors, which means that its effect on sales growth can be temporary or even difficult to materialize in periods of crisis when the market demand is significantly ceased (Konara and Ganotakis, 2020; Tavassoli and Karlsson, 2015). Accordingly, we propose that:

Hypothesis 1. During an exogenous shock, good, service, and process innovations will positively affect firms' sales growth, whereas organisational and marketing innovations will not.

2.2. Digital technologies and sales growth

We posit that digital technologies will enable firms to better and quicker respond to demand fluctuations and supply interruptions during crises, and therefore their use will lead to sales growth. The use of digital tools enables firms to pivot their business models, marketing plans, and operations, and persevere during a crisis (Digitally Driven, 2021).

The usage of social media allows firms to better manage some of the complexities triggered by the pandemic, including the disruption in the traditional marketing and communication channels, and the reduced product demand. Indeed, under such conditions of exogenous shocks, social media technologies can become important tools for communication and information search purposes. For example, a strong presence on social media allows firms to directly interact with potential customers in a timely and less costly manner. Also, by enabling firms to gather current data on the changes that occur in the external environment or collect customer feedback on their own and competitive offerings, social media can reduce the cost of market research. Such customer-related information allows managers to regularly update their promotions and/or offered services (Hudson and Thal, 2013) as a means to meet the emerging needs and desires. Continuous interaction with customers may also result in better understanding of their needs, stronger relationships, more customized offerings (Alarcón-del-Amo et al., 2018; Foltean et al., 2019), and tailor-made after sales support. Ultimately, such interactions on social media can enhance customer satisfaction and retention levels, and in turn, increase sales.

Social media can also support firms' selling effort, and hence, assist them in tackling reduced product demand caused by external shocks. For instance, social media can improve brand awareness, and also generate electronic word-of-mouth by allowing customers to share their consumption experiences with their fellow counterparts across the world. This can give firms direct and cost-free access to potential new customers in domestic and international markets (Tajvidi and Karami, 2021).

Furthermore, the usage of digital technologies for collaboration improves information exchange and enhances coordination, connectivity, and integration with external partners, such as customers, manufacturers, and logistics providers (Han and Trimi, 2022). This allows access to more accurate and timely data that speeds up reaction to environmental and market changes. For example, when firms experience a disruption in their supply chain, such technologies can allow managers to quickly reconfigure their supply chain process and re-arrange their internal and external resources in order to better respond to the changes caused by these disruptions – e.g., changes in demands or inventory levels. This increased agility and responsiveness can, in turn, improve cost control, make product pricing more competitive, enhance customer effectiveness and value creation, and lead to higher levels of financial performance. We therefore hypothesise that:

Hypothesis 2. During an exogenous shock, digital technologies for social media, and those for assisting external collaborations will positively affect firms' sales growth.

2.3. The interplay between innovation and digital technologies

Although extant research has widely recognized that digital technologies can stimulate and foster innovation activities and processes (Berger et al., 2021; Urbinati et al., 2020), it has yet to examine how digital technologies can alter the effect that different types of innovations have on firm performance. Central to our argumentation is that although certain digital technologies can have a symbiotic relationship with particular types of innovation and can hence (further) enhance the effect of those innovations on sales growth, the same digital technologies might not have an amplifying effect on other innovation types, or that their simultaneous adaptation can impair sales growth.

Once a firm has introduced an innovative good or service to the market in order for sales to grow, marketers will have to inform potential customers about the new features and benefits of the good or service, convince them about its quality, persuade them to purchase it, and collect relevant feedback (Hinterhuber, 2004). Social media can be particularly helpful throughout this process, especially in testing innovative goods and services by collecting early feedback for their improvement from early adopters or by checking the importance of certain attributes through customer reviews and customer feedback ratings (Moe and Schweidel 2017; Roberts and Piller 2016).

Regarding marketing innovations, social media can highlight the improvements that firms introduce in the promotion, pricing, packaging of products, and also enhance their "soft" attributes. Additionally, the customer-related information derived from social media channels allows firms to configure different versions of products (in terms of attributes and price). Such product configurations can be promoted and targeted more effectively to relevant market segments, enhancing in this way overall firm sales (Moe and Schweidel 2017; Netzer et al., 2012). Indeed, social media are viewed as a way to augment the efficiency of other marketing activities (and not to substitute them) in better understanding purchasing behaviour. In this regard, some evidence exists (Roberts and Piller 2016) that social media adoption in the absence of a clear marketing strategy does not achieve the anticipated results (Moe and Schweidel 2017). Finally, social media are often used to support packaging improvements. This was the case with Nestle's launch of a new KitKat where new packaging was combined with promotional hashtags, adding to the product's novelty and visibility (Roberts and Piller 2016). We, therefore, propose that:

Hypothesis 3a. During an exogenous shock, digital technologies for social media will positively interact with good, service, and marketing innovations leading to increased sales growth.

As discussed in hypothesis 2, digital technologies for collaboration allow for more efficient communication between the focal firms and their value chain partners. The deeper the communication between the partners is, the higher the agility and responsiveness of the firms to the external disruption will be and thus, their ability to adapt their innovation portfolios (Sambamurthy et al., 2003). In fact, deep communication enables firms to receive from their partnerships better and more reliable information about potential changes in the business environment, and specifically, insights into market demand and customer preferences about new goods and services, which are often in flux during periods of exogenous crisis (Kwon et al., 2018). Beyond that, the adoption of collaboration technologies can also assist firms in accommodating potential changes in the business environment. This is because such an adoption allows firms to more effectively collaborate with other partners and thus, to respond in a better and more timely manner to a variety of client needs and situations; something which is necessary for designing successful good and service innovation in times of crisis (Fjeldstad et al., 2012). Meanwhile, because digital technologies for collaboration permit closer integration and more efficient management of virtual collaboration among the new product (i.e., good or service) development teams (NPD) of different partners (e.g., customers, suppliers), it can also help firms to improve, optimize, and redesign existing goods and services (Nambisan, 2003). In fact, the NPD teams of various partners can more easily coordinate in order to gather and share design information and then work together to improve product (i.e., good or service) features, through carrying out design iterations and testing suggested improvements (Edmondson and Nembhard, 2009). This cannot only help firms address unmet and changing customer needs in periods of exogenous crisis, but it can also shrink the lead times of the improved goods and services, as well as the costs involved in the innovation process. Digital technologies for collaboration, therefore, can assist good and service innovation and their mutual adoption may provide a competitive advantage over rivals, which leads to increased sales.

In contrast, we expect that the simultaneous adoption of digital technologies for collaboration and organisational innovation might impair sales growth. This is because digital technologies for collaboration may add an additional layer to the complexities that occur due to the introduction of organisational innovations (Birkinshaw et al., 2008; Hashi and Stojcic, 2013). In fact, they may further intensify the disruption caused to employees' routines and sense of uncertainty, which accompanies organisational innovation in times of crisis (Birkinshaw et al., 2008). For instance, in order to better align digital technologies for collaboration with a firm's organisational structure and business systems, additional changes to a firm's organisational practices and routines have to occur that adds to the disruption introduced by an organisational innovation as well as by the external crisis (Miri-Lavassani et al., 2010; Munkvold, 2005). Employees will need to develop new digital skills for collaboration with external partners and learn how to meet the expectations of the "new" digitally organized interorganizational environment (Kelly and Moen, 2020). This not only takes considerable time (something which is not ideal in times of crisis since there are considerable time constraints), but can also lead to informational and managerial overload, and therefore limit employees' and managers' cognitive capacities and attention (Boudreau and Robey, 2005; Ocasio, 1997). It may also exacerbate the same symptoms (resistance to change, complexity, time to adapt) that arise from an introduction of an organisational innovation during periods of crisis. We therefore propose that:

Hypothesis 3b. During an exogenous shock, digital technologies for collaborations will positively interact with good and service innovations leading to increased sales growth, and negatively interact with organisational innovation impairing sales growth.

3. Methodology

3.1. Empirical setting, sample, and data

We selected the Caribbean region as our empirical setting because several of its structural characteristics make it particularly suitable for our research. First, the pursuit of growth has been a major strategic objective for firms originating from this region (Broome et al., 2018). Compared with their counterparts in developed economies, firms in this region face greater challenges of growth because of the turbulent market conditions driven by low levels of economic structure (Peng, 2003) and lack of market-supporting institutions (Hoskisson et al., 2000). Second, innovation has played a predominant role and became a real engine of technological progress in the region since the late 19th century (Olavarrieta and Villena, 2014). Meanwhile, the use and penetration of digital technologies in the region has enjoyed enormous growth over the last decade (Robinson et al., 2020). Indeed, both innovation and digital technologies have a high profile within the space of exogenous shock response (i.e., response to natural disasters frequently encountered in the region) and are recognized as factors for sustainability, and consequently, growth in the region (Fontes de Meira and Bello, 2020). Thus, Caribbean firms are likely to consider innovation and digital technologies as key vehicles for their exogenous shock aid. Third, Caribbean has been one of the most affected regions by the COVID-19 pandemic in the world, with 2.7 million formal enterprises closures and a loss of 8.5 million jobs, mainly in small- and medium-sized enterprises (ECLAC, 2020). In light of this situation, it is reasonable to expect that becoming apt to achieve higher growth should be a top priority for increasing numbers of firms in the region. Last, countries in the region share many commonalities in culture and political dynamism (Bruton et al., 2004), which can offer control for latent influences (Khoury and Peng, 2011a, 2011b).

The data used in this study was collected by the IDB group through the Innovation, Firm Performance, and Gender (IFPG) survey. The sample captures data from 1979 SMEs across 13 Caribbean SIDS during 2020–2021. Eight firms were dropped from the analysis due to missing data, rendering the final dataset of 1968 Caribbean firms. To generate a representative country- and sector-level sample, firm selection was determined through stratified random sampling. Table 1 provides a breakdown of the sample per each of the 13 SIDS. The period for data collection covers 2020 and 2021 and has collected information for this period, as well as for the firms' 2019 fiscal year (for sales, and human resources), and the three-year period 2017–2019 for (past) innovation activities and digital technologies.

Table 1
Country breakdown of sample.

Country	Firms sampled
Jamaica	172
Antigua and Barbuda	150
Barbados	170
Dominica	137
Grenada	124
Guyana	155
St. Kitts and Nevis	130
St. Lucia	152
St. Vincent	133
Suriname	162
Belize	157
The Bahamas	157
Trinidad and Tobago	169
Total	1968

3.2. Measures

3.2.1. Dependent variable

We use *sales growth* as our main dependent variable, which we measure as the expected percentage change in a firm's value of total sales (Batt, 2002; Uhlaner et al., 2013) due to the COVID-19 crisis. For instance, a figure of 100 % reflects the situation where a firm has maintained at time t + 1 the same level (100 %) of sales volume achieved just before the onset of the pandemic (i.e., at time t). A figure above or below 100 % (e.g., 120 % or 80 %) provides the percentage that sales grew or reduced at time t + 1 (i.e., by 20 % in either case) relative to the level of sales achieved just before the onset of the pandemic (i.e., at time t), respectively. Measuring sales growth this way can help us achieve temporal order of the independent variables (preceding in time since they are all measured at time t) to the dependent variables to enhance causal inference (Biddle et al., 1985). It can also reduce the threat of common method bias that could have been present if the independent and dependent variables were measured simultaneously (Podsakoff and Organ, 1986; Schilke, 2014).

3.2.2. Independent variables

To test Hypothesis 1, we consider five innovation types: (1) *good,* (2) *service*, (3) *process*, (4) *organisational*, and (5) *marketing.* To measure good, service, and marketing innovation, we use three dummy variables (0,1) for whether, since the advent of the COVID-19 crisis, the firm attempted to develop or introduce new or improved goods, new or improved services, and new marketing methods for promotion, packaging, pricing, and product, respectively (Konara and Ganotakis, 2020; Tavassoli and Karlsson, 2015). Process and organisational innovation were both operationalized as count variables that indicate the number of processes and organisational improvements a firm engaged in, respectively (Kim and Lui, 2015). In terms of process innovation, the Caribbean dataset includes information on whether firms introduced a set of new processes, such as new methods for producing goods or providing services (including methods for developing goods or services), as well as new logistics, delivery, or distribution methods. Regarding organisational innovation, responding firms were asked to indicate if they introduced new methods for information processing and communication; new methods for accounting and other administrative operations; new business practices for organizing procedures for external relations; and new methods for organizing work responsibility, decision making, and human resource management. Both variables take the value 0 for no innovation activity at all, with 1 added for each type of process and organisational innovation the firm engaged in, respectively.

To test Hypothesis 2, we further employed metrics for digital technologies, which focus on two areas: (1) *social media*, (2) *digital technologies for collaboration*. We measure social media adoption by using a dummy variable (0, 1), which indicates whether a firm uses social media (Facebook, Instagram, etc.) or not (Cassetta et al., 2020). The adoption of digital technologies for collaboration is operationalized as a count variable, which considers the number of different realms where digital technologies are used to assist business collaboration. More specifically, respondents were asked to evaluate whether firms use digital technologies to connect to the business world (e.g., CRM, ERP), or for collaborative processes (e.g., software and platforms to communicate, share files and concurrently work with partners, etc.) (Ganotakis et al., 2013).

Last, to test Hypothesis 3a and Hypothesis 3b, we introduced interaction terms between the two types of digital technologies and each of the five innovation activities, based on the measures described earlier. Specifically, for Hypothesis 3a we included cross-product terms *by multiplying the measure for social media* by each one of the measures used for the five types of innovation. Similarly, for Hypothesis 3b we included cross-product terms *by multiplying the measure for digital technologies for collaboration* by each one of the measures used for the five innovation types.

3.2.3. Control variables

We also consider several control variables that prior studies have identified as important for achieving sales growth and for navigating exogenous shocks like the COVID-19 pandemic. First, we control for *firm size* measured as the total number of full-time employees (Akgün and Keskin, 2014). In doing so, we account for the possibility that relatively bigger firms are less susceptible than smaller firms to exogenous shocks, since they possess and have access to more resources (Sørensen and Stuart, 2000). Second, we control for *firm age* calculated as years since founding (Akgün and Keskin, 2014). In turbulent environments, older firms may exhibit higher rates of growth, which reflect their prior experience and greater access to information (Dimov, 2010). Third, we control for *top management experience* measured as the years that top management is working in the industry where the focal firm operates. Fourth, we control for *export intensity* measured as the percentage of firm sales that are accounted for by exports (D'Angelo et al., 2020). We expect exporting firms to achieve higher sales growth for two reasons: a) because they are characterised by higher levels of productivity (Ganotakis and Love, 2012), and b) because they will have the opportunity to substitute part of the loss, due to the pandemic sales, with additional sales from foreign markets (Love and Ganotakis, 2013). Fifth, we account for *foreign* participation in both public-owned and privately-owned enterprises. To measure the variable, we use a dummy variable that takes the value of 1 if the firm has a majority foreign ownership (>50 %), and 0 otherwise (Krammer, 2022). Last, we employed country and industry dummies as additional control variables in our models. This approach allows us to account for inherent differences, and therefore control for unobserved cross-country and cross-industry heterogeneity. It also enables us to capture unobserved common characteristics across different industries and countries in the Caribbean region. All our independent and control variables are measured at the onset of the pandemic (i.e., at time t); therefore, by construction, these variables are lagged by one year with respect to the dependent variable. Table 2 provides a summary of the variables and relevant descriptive statistics.

3.3. Estimation method

We implement a Tobit model since firm growth data is always nonnegative. This procedure takes account of the nature of the dependent variable, which is left-censored at zero. Using the maximum likelihood principle, it results in parameter estimates that are consistent and asymptotically efficient. The basic model to be tested in this study is:

$$y_i^* = x_i\beta + \varepsilon_i$$

where the dependent variable, y_i (which is equal to y_i^*) is generated if $x_i\beta + \varepsilon_i > 0$ and is otherwise equal to zero. X_i is a vector of explanatory variables that are hypothesized to influence sales growth.

Table 2 presents the descriptive statistics and correlations among our variables. Before conducting the Tobit regression analysis, we performed multicollinearity diagnostics by calculating the variance inflation factors (VIFs) for each predictor variable. Our results indicated a maximum VIF value of 2.26 across the regression models, well below the suggested threshold of 10 for the risk of multicollinearity (Neter et al., 1996).

3.4. Results

Table 3 presents the Tobit regression results. Model 1 examines the impact of different types of innovation on sales growth during an exogenous shock. Good and process innovations have a positive and significant effect on sales growth (goods innovation, $\beta = 7.771$, $p < .01$; process innovation, $\beta = 2.156$, $p < .10$). Contrary, service and

Table 2
Descriptive statistics and correlations.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1) Sales growth												
(2) Goods innovation	0.072***											
(3) Service innovation	0.035	0.151***										
(4) Process innovation	0.057**	0.205***	0.427***									
(5) Organisational innovation	0.013	0.171***	0.240***	0.505***								
(6) Marketing innovation	−0.032	0.129***	0.174***	0.212***	0.192***							
(7) Social Media	0.063***	0.002	0.026	0.058**	0.014	0.025						
(8) Digital technologies for collaboration	0.105***	0.059***	0.114***	0.181***	0.085***	0.090***	0.110***					
(9) Firm size	0.084***	0.046**	0.020	0.014	0.053**	0.022	0.068***	0.159***				
(10) Firm age	−0.006	0.021	−0.012	0.003	−0.010	0.032	−0.005	0.034	0.099***			
(11) Export intensity	−0.050**	0.019	−0.034	−0.033	−0.015	−0.013	−0.005	−0.036*	0.088***	−0.010		
(12) Top management experience	−0.005	0.022	0.026	−0.008	0.024	−0.023	−0.002	0.016	0.034	0.008	0.009	
(13) Foreign	0.038*	−0.029	−0.048**	−0.048**	−0.024	−0.008	0.031	−0.011	0.019	0.011	−0.024	−0.038*

*** $p < .01$.
** $p < .05$.
* $p < .1$.

Table 3
Tobit regressions: sales growth.

	Model (1)	Model (2)	Model (3)
Goods innovation	7.771***	1.637	1.837
	(2.778)	(4.611)	(3.426)
Service innovation	1.051	1.636	0.566
	(2.181)	(3.622)	(2.606)
Process innovation	2.156*	2.107	3.016*
	(1.144)	(2.265)	(1.575)
Organisational innovation	−2.703	−4.703	0.527
	(2.21)	(3.75)	(2.84)
Marketing innovation	−6.36**	−10.52**	−9.055***
	(2.552)	(4.596)	(3.289)
Social media	1.543**	1.218	1.598**
	(0.762)	(0.787)	(0.759)
Digital technologies for collaboration	2.062***	2.069***	1.851***
	(0.574)	(0.574)	(0.603)
Firm size	0.015***	0.015***	0.015***
	(0.004)	(0.004)	(0.004)
Firm age	−0.01	−0.008	−0.01
	(0.018)	(0.018)	(0.018)
Export intensity	−0.072**	−0.072**	−0.07**
	(0.034)	(0.034)	(0.034)
Top management experience	−0.01	−0.009	−0.007
	(0.028)	(0.028)	(0.028)
Foreign	2.063	2.005	2.004
	(1.335)	(1.334)	(1.331)
Social media × good innovation		9.958*	
		(5.801)	
Social media × service innovation		−1.147	
		(4.54)	
Social media × process innovation		0.087	
		(2.635)	
Social media × organisational innovation		2.515	
		(4.642)	
Social media × marketing innovation		5.362	
		(5.564)	
Digital technologies for collaboration × goods innovation			9.346***
			(3.154)
Digital technologies for collaboration × service innovation			1.91
			(2.544)
Digital technologies for collaboration × process innovation			−0.996
			(1.265)
Digital technologies for collaboration × organisational innovation			−4.325*
			(2.386)
Digital technologies for collaboration × marketing innovation			3.498
			(2.888)
Industry dummies	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes
Constant	73.523***	73.734***	73.538***
	(1.327)	(1.332)	(1.324)
No. of observations	1968	1968	1968
Log likelihood	−8261.7	−8259.1	−8254.4
Chi-square	108.08***	113.25***	122.80***
Pseudo R^2	0.006	0.007	0.007

Standard errors are in parentheses.
*** p < .01.
** p < .05.
* p < .1.

organisational innovations have no significant effect (service innovation, β = 1.051, p > .10; organisational innovation, β = −2.703, p > .10), while the impact of marketing innovation was found to be negative and significant (β = −6.36, p < .05). These results provide partial support for H1. We explicitly tested this using a series of Wald tests of equality of coefficients (Luo and Homburg, 2008). The Wald tests showed that the coefficient for goods innovation is indeed significantly different from the coefficient for organisational innovation (F = 7.85, p < .01) and the coefficient for marketing innovation (F = 11.73, p < .01). Similarly, a Wald test revealed a significant difference between process innovation and marketing innovation (F = 6.87, p < .01), as well as a significant difference between process innovation and organisational innovation (F = 2.29, p < .05).

Regarding H2, model 1 shows that the coefficients for social media and digital technologies for collaboration were both positive and significant (social media, β = 1.543, p < .05; digital technologies for collaboration, 2.062, p < .01). These results suggest that H2 is strongly supported.

In model 2 and 3, we test whether different innovation types interact with digital technologies to increase sales growth. We, therefore, create interaction terms between the two types of digital technologies and each of the five innovation activities. In model 2, we introduce interactions between social media and the five types of innovation. We find that only the interaction between social media and goods innovation is positive and significant (β = 9.958, p < .10). This indicates that the effect that social media technologies have on sales growth is further enhanced if firms have at the same time introduced goods innovation. This finding partially supports H3a. Finally, model 3 includes the interaction terms between digital technologies for collaboration and the five innovation types. Consistent with our expectations, we find that the interaction between digital technologies for collaboration and goods innovation is positive and significant (β = 9.346, p < .01) and the interaction between digital technologies for collaboration and organisational innovation is negative and significant (β = −4.325, p < .1). These results partially support H3b.

To further assess the significant interaction effects in our models, we conducted additional analysis. Unlike OLS, the marginal effect of an interaction between the independent and the moderator in a Tobit model is not simply the coefficient for their interaction. The magnitude, sign, and significance of the interaction effect must be calculated for given values of the estimated coefficients and all independent variables in the models. Calculating the total marginal effect at different values of the moderator indicates how the relationship between the independent and the dependent variable changes with the value of the moderator (Bowen and Wiersema, 2005). In Fig. 1, we evaluated the interactions introduced in our models by graphing the total marginal effects at the two different levels of goods and organisational innovation (dummy variable) (Aiken et al., 1991). Overall, the plots in Fig. 1 confirm our Tobit regression results.

3.5. Supplemental analysis

We conducted several supplemental analyses to assess the robustness of our findings. First, we examined the possibility of reverse causality influencing our main findings (Granger, 1969). For example, some innovation types might be the result of sales growth, not their cause. This might be the case if firms devote resources, which are generated through prior growth, to innovation projects. In order to test for this scenario, we created dummy variables for each one of the innovation types (i.e., *good, service, process, organisational and marketing innovations*) and used logit regression models to estimate whether innovation is influenced by prior sales growth (*prior sales growth* refers to the year preceding the COVID-19 crisis). We also used the same vector of control variables as in the main models. The results of this analysis are shown in Table 4. In all models, the coefficient of prior sales growth is not statistically significant. We find one exception to this pattern: for model 8, the coefficient of prior sales growth is significant (β = 2.221, p < .05). We tested the significance of our logit models with the model log likelihood chi-square, which is analogous to the multivariate F-test in linear regression. Since the overall fit in model 8 is not significant, the result cannot be considered meaningful.

Second, a potential problem relates to the possibility that there is an imbalance between older and younger firms in our sample. For example, older firms may have more resources to invest in innovation and digital technologies (George, 2005; Senyard et al., 2014) and might have experienced more adversities in the past and thus, be more capable of

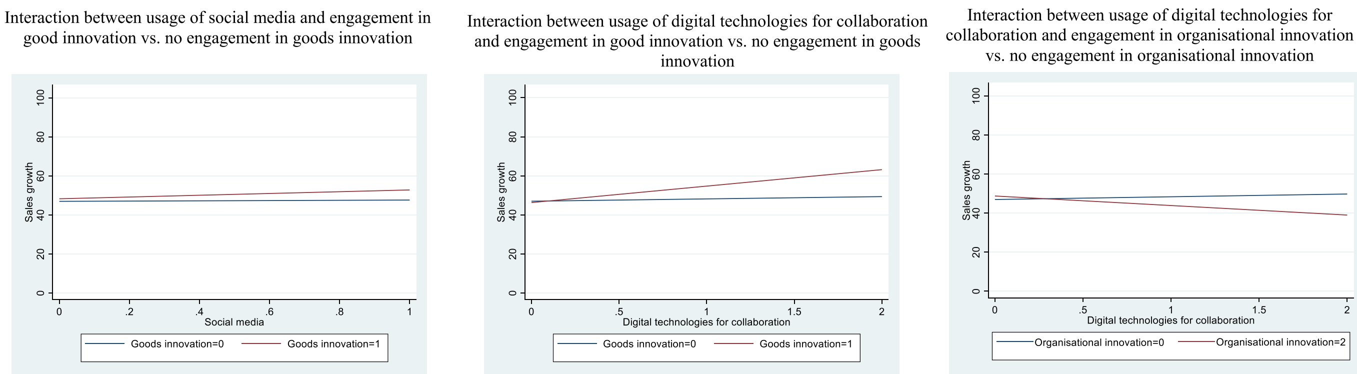

Fig. 1. Estimated marginal effects.

Table 4
Supplemental analysis: results of reverse causality logit regression models.

	Model (4)	Model (5)	Model (6)	Model (7)	Model (8)
	Dependent variable: goods innovation	Dependent variable: service innovation	Dependent variable: process innovation	Dependent variable: organisational innovation	Dependent variable: marketing innovation
Prior sales growth	−0.883	0.86	0.809	0.701	2.221**
	(1.08)	(1.055)	(0.795)	(1.19)	(1.041)
Firm size	0.002	0.001	0	0.002**	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Firm age	0.003	−0.006	0	−0.007	0.008
	(0.008)	(0.007)	(0.005)	(0.008)	(0.007)
Export intensity	0.011	−0.024	−0.009	−0.016	−0.012
	(0.015)	(0.015)	(0.01)	(0.018)	(0.017)
Top management experience	0.01	0.011	−0.008	0.009	−0.013
	(0.012)	(0.009)	(0.007)	(0.011)	(0.012)
Foreign	−1.193	−1.764*	−1.332**	−0.709	−0.28
	(1.025)	(1.014)	(0.595)	(0.738)	(0.614)
Industry dummies	Yes	Yes	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes	Yes	Yes
Constant	−1.07	−8.931*	−8.154**	−7.999	−14.379***
	(4.972)	(4.967)	(3.751)	(5.566)	(4.914)
Observations	1660	1968	1968	1844	1968
Log likelihood	−166.4	−278.8	−422.4	−133.2	−201.6
Model log likelihood chi-square	29.30**	40.41***	69.92***	36.50***	18.28

Standard errors are in parentheses.
*** $p < .01$.
** $p < .05$.
* $p < .1$.

managing adversity over time (DesJardine et al., 2019). To account for differences between old and young firms, we apply a non-parametric matching technique, namely entropy balancing (Hainmueller, 2012; Hainmueller and Xu, 2013). This method allows to directly impose the first and second moments (i.e., means and variances) of a predefined set of covariates to be perfectly balanced among both groups. In our case, entropy balancing allows us to compare young and old firms with the same preconditions in the beginning of the pandemic, so that diverging trajectories in sales growth during and after the pandemic can be more credibly ascribed to their innovation activities and their digital infrastructure. We categorise firms as young if they are at least one year old, but not >20 years old. All firms that are >20 years old are categorised as old (Yli-Renko et al., 2001). To achieve balance between old and young firms, we include as covariates in the entropy balancing step the control variables described in our main analysis. This makes the estimator double robust and also increases the precision of the estimates, as the control variables reduce the unexplained variance in the outcome (Bang and Robins, 2005). Table 5 compares treatment and control observations before and after entropy balancing. We observe that after entropy balancing, there are no significant differences between the groups. Following, the entropy-balancing weights are included in the main Tobit regression model (see Table 6, model 9). We found the results are consistent with our primary analysis, but the influence of marketing innovation on sales growth was insignificant. This might be the case because new or significantly improved marketing methods may require more time to materialize especially in the presence of demand uncertainty, which is inherent during the course of major exogenous crises such as COVID-19.

The third issue concerns the possibility that some of our main independent variables seem to hinge upon others and thus, are not sufficiently distinct. For instance, the use of social media may be an important part of the firm's marketing innovation activities (Obstfeld, 2005), while digital technologies for collaboration might be an integral part of organisational innovation (Trantopoulos et al., 2017; Za et al., 2014). To examine whether this issue affects our main findings, we rerun our analysis by excluding the interactions between these variables, as well as the variable measuring the respective type of innovation which is related to the digital technology in each model. The results of this analysis can be found in Table 6 (see models 10 and 11) and appear to be consistent with our main findings.

Table 5
Descriptive statistics by firm age classification with and without entropy balanced matching.

Before entropy balanced matching	Treatment Group			Control Group		
	Mean	Variance	Skewness	Mean	Variance	Skewness
Firm size	41.830	7340	8.446	29.410	9313	20.160
Export intensity	5.245	106.300	2.676	5.722	121.400	2.907
Top management experience	21.530	178.100	0.490	20.990	167.900	0.526
Foreign	0.076	0.070	3.212	0.090	0.082	2.857
Industry dummies	Yes			Yes		
Country dummies	Yes			Yes		

After entropy balanced matching	Treatment Group			Control Group		
	Mean	Variance	Skewness	Mean	Variance	Skewness
Firm size	41.830	7340	8.446	41.830	7340	6.562
Export intensity	5.245	106.300	2.676	5.245	106.300	2.595
Top management experience	21.530	178.100	0.490	21.530	178.100	0.478
Foreign	0.076	0.070	3.212	0.076	0.070	3.212
Industry dummies	Yes			Yes		
Country dummies	Yes			Yes		

Fourth, we examine whether our results hold using an alternative estimator. Specifically, we ran OLS regressions by using the absolute value of sales growth during the pandemic as our main dependent variable, rather than a percentage. The results of this analysis are presented in Table 6 (see models, 12, 13, and 14) and are similar to those for the Tobit regressions reported in Table 3.

Finally, we employ a difference-in-differences (DID) research design to further assess whether exogenous shocks, like the COVID-19 pandemic, drive the differences in the influence of innovation and digital technologies on the firms' sales growth that we observe. More specifically, the DID design enables us to estimate the causal effects of innovation and digital technologies on sales growth during the pandemic relative to when the pandemic was not present. We implement the method for all the independent variables and interaction terms which we found significant in our main analysis. As our main dependent variable, we use sales growth measured one year before and one year after the onset of the pandemic. All the independent and control variables are lagged one time period with respect to the dependent variable (t - 1) in our models. Here, our key explanatory variables are the interactions between the *Covid19* dummy (equal to one for the year during the pandemic, and zero pre-pandemic) and the type of innovation or the type of digital technology, accordingly (equal to one for firms that engage in this type of innovation or digital technology, and zero for firms that do not engage in this type of innovation or digital technology). To test our interaction effects, we include the *Covid19* dummy x innovation digital technologies interactions. The results for the DID models are provided in Table 7, models 15–22. Since we specify directionality in our hypotheses, one-tailed tests were used to determine significance (Cohen, 1977). As shown, the coefficients of the interaction terms *Goods innovation X Covid19* (see model 15), *Process innovation X Covid19* (see model 16) and *Digital technologies for collaboration X Covid19* (see model 19) are all positive and statistically different from zero. In contrast, the coefficient of the interaction term *Marketing innovation X Covid19* (see model 17) is negative and significant. In other words, firms that adopt goods innovation, process innovation, and digital technologies for collaboration during the COVID-19 pandemic perform significantly better than those that do not, while firms that adopt marketing innovation during the COVID-19 pandemic perform significantly worse than those that do not. Further, the coefficient of the interaction term *Social Media X Covid19* (see model 18) is positive but insignificant, indicating that the influence of social media on sales growth is not more pronounced during the pandemic relative to that before the pandemic. One possible explanation for this result could be that social media are not a viable solution on a stand-alone basis during an exogenous shock. Instead, what may be more beneficial during this period is to use social media as a vehicle for promoting innovation.

Turning to our main interaction terms, the coefficients of *Goods innovation X Social Media X Covid19* (see model 20) and *Goods innovation X Digital technologies for collaboration X Covid19* (see model 21) are positive and significant, which as expected indicates a positive interaction effect. Meanwhile, the interaction term of *Organisational innovation X Digital technologies for collaboration X Covid19* receives a negative but statistically insignificant result, suggesting that the synergistic effect of organisational innovation and digital technologies for collaboration is not more pronounced during the pandemic relative to that before the pandemic. A possible explanation for this finding is that during exogenous shocks, organisational innovation may offer a similar means of establishing successful collaborations with other entities to the one offered by digital technologies for collaboration. Overall, most supplemental checks are qualitatively similar to our main results.

4. Discussion and conclusions

In this study we examine how innovations and digital technologies can individually and in combination affect sales growth during an exogenous shock. In doing so, we improve our understanding of how firms can maintain their competitiveness and performance during a crisis. Our findings have several implications for theory. We contribute to the scant literature that has examined firm-level innovation in the context of exogenous crisis events (Krammer, 2021; Paunov, 2012a, 2012b; Roper and Turner, 2020). Our results confirm past research findings that innovation is an important strategy during a crisis (e.g., Krammer, 2021; Paunov, 2012a, 2012b), but also suggest that not all innovation types matter the same. Specifically, we provide evidence that although good and process innovations are effective in boosting sales growth, service and organisational innovations do not seem to matter. Further, marketing innovations may even have a detrimental effect on firms' sales growth during periods of exogenous shocks. Distinguishing between different innovation types reveals important asymmetries in their effect on firm performance and thereby contributes to existing innovation literature.

Even more novel is our finding that service innovation has a non-significant effect on sales growth. One possible explanation for this finding is that governmental measures taken to reduce the spread of

Table 6
Additional supplemental analysis.

	Model (9)	Model (10)	Model (11)	Model (12)	Model (13)	Model (14)
	Main model with E-balance	Partially specified model with interaction effects	Partially specified model with interaction effects	Ordinary least squares regression	Ordinary least squares regression	Ordinary least squares regression
Goods innovation	7.157*	1.16	1.836	10.623***	1.148	6.27
	(4.244)	(4.615)	(3.425)	(3.15)	(5.308)	(3.866)
Service innovation	2.053	0.33	0.461	0.426	1.906	−0.057
	(2.371)	(3.586)	(2.609)	(2.508)	(4.17)	(3.004)
Process innovation	2.547**	2.058	3.054**	2.661**	2.369	3.941**
	(1.296)	(2.269)	(1.476)	(1.312)	(2.607)	(1.808)
Organisational innovation	−2.813	−4.297		−3.518	−4.889	−0.684
	(3.084)	(3.754)		(2.54)	(4.317)	(3.274)
Marketing innovation	−5.493		−9.054***	−7.11**	−10.606**	−10.323***
	(3.722)		(3.285)	(2.935)	(5.291)	(3.793)
Social media	2.084**	1.308*	1.6**	2.224**	1.854**	2.26***
	(0.901)	(0.785)	(0.76)	(0.874)	(0.905)	(0.875)
Digital technologies for collaboration	1.561*	2.012***	1.872***	2.001***	2.027***	1.882***
	(0.878)	(0.575)	(0.603)	(0.659)	(0.66)	(0.694)
Firm size	0.026**	0.015***	0.015***	0.015***	0.015***	0.015***
	(0.011)	(0.004)	(0.004)	(0.005)	(0.005)	(0.005)
Firm age	−0.009	−0.011	−0.008	−0.01	−0.008	−0.01
	(0.019)	(0.018)	(0.018)	(0.021)	(0.021)	(0.021)
Export intensity	−0.088*	−0.072**	−0.071**	−0.061	−0.061	−0.059
	(0.045)	(0.035)	(0.034)	(0.04)	(0.04)	(0.04)
Top management experience	0.006	−0.007	−0.009	0.006	0.008	0.009
	(0.032)	(0.028)	(0.028)	(0.032)	(0.032)	(0.032)
Foreign	2.104	2.014	2.02	2.884*	2.826*	2.812*
	(1.351)	(1.337)	(1.333)	(1.527)	(1.527)	(1.526)
Social media × good innovation		9.826*			15.218**	
		(5.795)			(6.621)	
Social media × service innovation		−0.012			−2.8	
		(4.514)			(5.225)	
Social media × process innovation		−0.074			0.645	
		(2.637)			(3.031)	
Social media × organisational innovation		1.394			1.504	
		(4.629)			(5.342)	
Social media × marketing innovation					4.222	
					(6.404)	
Digital technologies for collaboration × goods innovation			9.043***			6.987*
			(3.154)			(3.612)
Digital technologies for collaboration × service innovation			2.158			1.909
			(2.544)			(2.934)
Digital technologies for collaboration × process innovation			−2.000*			−1.43
			(1.152)			(1.456)
Digital technologies for collaboration × organisational innovation						−3.75
						(2.751)
Digital technologies for collaboration × marketing innovation			2.96			4.18
			(2.88)			(3.33)
Industry dummies						
Country dummies						
Constant	73.598***	73.573***	73.569***	−23.592***	−23.378***	−23.577***
	(1.577)	(1.333)	(1.325)	(1.518)	(1.525)	(1.519)
No. of observations	1968	1968	1968	1979	1979	1979
Log likelihood	−8975.2	−8263.1	−8256.8			
Chi-square	4.51***	105.26***	117.99***			
Pseudo R2	0.0066	0.0063	0.0071			
R-squared				0.065	0.068	0.069

Standard errors are in parentheses.
*** $p < .01$.
** $p < .05$.

* p < .1.

Table 7
Difference-in-differences design.

	Model (15)	Model (16)	Model (17)	Model (18)	Model (19)	Model (20)	Model (21)	Model (22)
	Change	Change	Change	Change	Change	Change	Change	Change
Goods innovation	0.153	1.501	1.308	1.372	1.346	0.569	0.157	1.289
	(1.189)	(1.106)	(1.103)	(1.103)	(1.103)	(2.033)	(1.257)	(1.104)
Service innovation	−0.444	−0.406	−0.177	−0.306	−0.351	−0.509	−0.485	−0.232
	(1.222)	(1.223)	(1.224)	(1.222)	(1.222)	(1.222)	(1.221)	(1.233)
Process innovation	0.134	−0.937	−0.059	0.077	0.062	0.194	0.092	0.117
	(0.98)	(1.185)	(0.984)	(0.981)	(0.981)	(0.981)	(0.98)	(0.983)
Organisational innovation	−0.524	−0.471	−0.604	−0.477	−0.372	−0.534	−0.632	0.485
	(1.442)	(1.443)	(1.445)	(1.444)	(1.445)	(1.442)	(1.446)	(1.863)
Marketing innovation	−0.627	−0.412	0.12	−0.742	−0.745	−0.678	−0.617	−0.953
	(1.144)	(1.164)	(1.26)	(1.145)	(1.144)	(1.145)	(1.142)	(1.156)
Social media	1.749***	1.71***	1.749***	1.631*	1.702***	1.759*	1.753***	1.704***
	(0.582)	(0.583)	(0.582)	(0.907)	(0.583)	(0.99)	(0.581)	(0.583)
Digital technologies for collaboration	1.18	1.171	1.328*	1.251*	−0.395	1.195	−0.428	−0.598
	(0.733)	(0.736)	(0.735)	(0.735)	(1.263)	(0.734)	(1.369)	(1.346)
Firm size	0.007**	0.007**	0.007**	0.007**	0.007**	0.007**	0.007**	0.007**
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Firm age	−0.04***	−0.04***	−0.04***	−0.04***	−0.04***	−0.039***	−0.038***	−0.04***
	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)
Export intensity	−0.018	−0.017	−0.017	−0.017	−0.017	−0.018	−0.017	−0.017
	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)
Top management experience	0.005	0.006	0.006	0.006	0.006	0.006	0.005	0.007
	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)
Foreign	1.559	1.571	1.49	1.503	1.527	1.541	1.602	1.492
	(1.02)	(1.021)	(1.02)	(1.02)	(1.02)	(1.019)	(1.017)	(1.021)
Covid19	−35.599***	−35.551***	−35.094***	−35.399***	−35.687***	−35.534***	−35.878***	−35.619***
	(0.641)	(0.654)	(0.642)	(0.987)	(0.678)	(1.027)	(0.69)	(0.686)
Goods innovation dummy × Covid19	7.957***					1.991	0.532	
	(2.913)					(4.803)	(3.592)	
Process innovation dummy × Covid19		2.854*						
		(1.871)						
Organisational innovation × Covid19								−2.377
								(3.571)
Marketing innovation dummy × Covid19			−4.44*					
			(2.732)					
Social Media dummy × Covid19				0.173		−0.118		
				(1.176)		(1.245)		
Digital technologies for collaboration × Covid19					2.475*		1.905	2.805*
					(1.542)		(1.636)	(1.618)
Goods innovation × Social Media						−0.605		
						(2.441)		
Goods innovation × Social Media × Covid19						9.533*		
						(6.039)		
Goods innovation × Digital technologies for collaboration							0.192	
							(3.483)	
Goods innovation × Digital technologies for collaboration × Covid19							19.463***	
							(6.526)	
Organisational innovation × Digital technologies for collaboration								1.258
								(3.942)
Organisational innovation × Digital technologies for collaboration × Covid19								−4.03
								(6.426)
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	108.796***	108.767***	108.479***	108.664***	108.836***	108.779***	109.004***	108.783***
	(1.106)	(1.11)	(1.106)	(1.199)	(1.114)	(1.234)	(1.115)	(1.117)
Observations	3407	3407	3407	3407	3407	3407	3407	3407
Log likelihood	−14,297.2	−14,299.8	−14,299.6	−14,300.9	−14,299.6	−14,295.9	−14,289.7	−14,298.7
Chi-square	2668.56***	2663.43***	2663.74***	2661.12***	2663.68***	2671.24***	2683.60***	2665.63***
Pseudo R^2	0.085	0.085	0.085	0.085	0.085	0.085	0.086	0.085

Standard errors are in parentheses.
*** p < .01.
** p < .05.
* p < .1.

COVID-19 could have affected the provision of services more than the development and selling of goods (Xiang et al., 2021). It is, therefore, possible that service innovations implemented during the COVID-19 pandemic could not reach customers on time or in a manner that managers have expected. Take for example groceries, coffee bars, and restaurants, which have routinely introduced takeaway services or home delivery (sometimes in collaboration with local taxis) in response to the crisis. While these actions can be fundamentally advantageous, if COVID-19 restrictions force a limited radius within which the businesses can receive and execute orders, the usefulness of service innovation can be impeded. It can therefore exert no impact on sales.

The results also suggest that organisational and marketing innovations cannot lead to increased sales growth. We have argued that the introduction of organisational innovation creates an additional layer of disruption because employees need considerable time to adapt to the new organisational changes (Hashi and Stojcic, 2013; Birkinshaw et al., 2008). The effect can also be attributed to the managerial overload that such changes create particularly during exogenous shocks (Ocasio, 1997). Meanwhile, because marketing innovations can be easily copied by rivals, their benefits may diminish and their implementation may lead to inefficiencies, especially if different marketing approaches are followed simultaneously, without considering their suitability for different market segments (Anning-Dorson, 2017; Konara and Ganotakis, 2020).

We further advance extant literature by confirming empirically that digital technologies help firms achieve higher growth in periods of crisis. Recent work calls for the identification of digital technologies that firms can use to alleviate detrimental performance effects (Berger et al., 2021; Boeker et al., 2021; Iacobucci and Perugini, 2021; Usai et al., 2021). We propose that certain types of digital technologies may not only directly affect sales growth, but they must also work together with different innovation types to affect the overall growth of the firms in periods of crisis. Consistent with our expectations, we also find that other digital technologies when deployed in combination with some innovation types may deteriorate sales growth. That is, digital technologies do not always make the influence of firm level innovation stronger and thus, do not enable firms to achieve consistently the potential of all their innovation activities during exogenous shocks.

Finally, as a corollary to our main findings, we also provide some tentative explanations for the digital technologies - innovation interactions that did not perform according to our predictions. Although we hypothesized that social media technologies will have a symbiotic relationship with service and marketing innovations, the empirical findings did not support our expectations. One possible explanation for this finding is that it may be difficult to align social media strategies to fit contextual requirements of marketing and service innovations during periods of crisis (Muninger et al., 2019). For example, social media strategies cannot be simply determined by evaluating traditional marketing and service requirements, but need to be adapted according to the changing needs of the different market segments (Killian and McManus, 2015). When crisis, however, occurs, firm resources and time which are limited may not be allocated to "master" this digital marketing tool in ways that are advantageous to service and marketing innovation (Acar et al., 2019). Instead, firms may shift their focus of attention to goods innovation whose contribution to sales growth can be more easily quantified (McEvily and Chakravarthy, 2002). Such a shift can destruct value and may result in consumer complaints and negative electronic word-of-mouth. In addition, we found that digital technologies for collaboration do not seem to interact with service innovation to increase sales growth. This might be the case because in periods of crisis firms may be forced to outsource most of the provision of their services to external patterns (Ciravegna and Maielli, 2011). When the delivery of the firm's services is so dependent on the performance of suppliers or other actors, the ability to managerially control these services can diminish (especially given the time constraints during periods of crisis), eroding simultaneously their effectiveness (Aundhe and Mathew, 2009).

4.1. Implications for practice

Although in theory, the range of innovations firms can pursue may be limited only by the imagination and creativity of their employees, the reality is that the availability of resources and the external environmental conditions (like the unprecedented scale of the COVID-19 pandemic) can force firms to think strategically and become very selective when considering alternative options. The findings of this study provide practical insights to managers by disaggregating the "all inclusive" concept of innovation into five distinct types and demonstrating that each of these types performs differently in the face of exogenous shocks. In other words, our empirical findings help guide firms on which innovation activities they should employ and which they should avoid to improve their competitiveness and boost their sales growth during a crisis event.

Second, our study draws managers' attention to the need of using more effectively the different types of digital technologies, both as stand-alone tools and as complementary-to-innovation tools. While firms in some industries, like retail, were already utilizing digital tools well before this exogenous shock (e.g., digital payments and social media to engage with customers and conduct sales), firms in several other industries (re)discovered the benefits of using digital technologies. For example, many firms perceived digital technologies as the "only way" to keep their supply chains operating and serve their customers during lockdowns (Digitally Driven, 2020). Digital technologies need to be embraced as part of the firm's innovation strategy and not as a separate "IT or ecommerce" function (Bharadwaj et al., 2013). Digital tools and infrastructures work best when they are embedded into the organization, its goods and services, as well as its innovation outputs. This is the best way forward and, indeed, the only way that digital tools can lead to a transformation of the organisational culture and processes (Yoo et al., 2012). Achieving this kind of digital transformation opens opportunities for firms by changing how value is created and captured and by providing them with a digital safety net during major exogenous shocks (Usai et al., 2021).

Our findings are also useful for broader policy making in different spheres. Because value chains are more globalized, SIDS become increasingly interconnected, and are thus more susceptible to exogenous shocks. Through government-led initiatives (e.g., training and education programmes, infrastructural support, tax allowances, grants, and subsidies), policy makers in SIDS can stimulate and incentivize firms' pursuit of (1) innovation types that offer the greatest benefit, as reflected in performance; (2) digital technologies that allow them to better deliver their value proposition and to better serve their customer needs.

4.2. Limitations and future research

Our study has a few limitations that also open up avenues for further research. Through our analysis, we were able to compare the effects that different types of innovation and digital technologies have on sales growth before and during the exogenous shock. This comparison allowed us to identify their "added value" and therefore their real usefulness during the shock. However, we lack detailed data regarding the longer-term effects of our main independent variables. In this regard it would be interesting to see whether managerial decisions taken as a response to an external shock maintain their value once the shock has ended. Indeed, it is possible that the experience gained in adjusting to an external shock and the reputation that a firm has gained in doing so, can be beneficial when regressing back to more "normal" external conditions.

Last, we documented the effects of two different strategies, namely, innovation and digital technologies (as well as their interplay) across all 13 Caribbean SIDS, during a global exogenous shock. Future research should explore the generalizability of our findings to different geographies, beyond SIDS, including other developing and developed countries.

CRediT authorship contribution statement

Panagiotis Ganotakis: Conceptualization, Investigation, Data Analysis, Methodology, Software, Investigation, Writing-original draft, Writing- review & editing.

Sofia Angelidou: Investigation, Data Analysis, Methodology, Software, Investigation, Writing-original draft, Writing- review & editing.

Charalampos Saridakis: Conceptualization, Validation, Data Curation, Methodology, Software, Investigation, Writing- review & editing.

Panagiotis Piperopoulos: Conceptualization, Investigation, Writing-original draft preparation, Writing- Reviewing & Editing.

Miguel Dindial: Data Curation, Methodology.

Data availability

The datasets and information for this survey can be found here: https://www.competecaribbean.org/proteqin-ifpg-datasets/

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