

Are Caribbean Firms Willing to Innovate in the COVID-19 Era?

The Effect of Managers' Perceptions and External Factors on Firm Innovation.

Taryn De Mendonca*; Togba Massaquoi.

*corresponding author. Email: tdemendonca19@gmail.com

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Abstract

We investigate the indirect innovation response of firms in thirteen Caribbean states to the COVID-19 crisis that unfolded in the region from 2020. With the use of probit regressions covering two time periods (2014—the pre-COVID-19 period, and 2020—the COVID-19 year), we found little evidence of an innovation (product and process) intent by firms in response to the COVID-19 crisis. This cyclical response is somewhat weakened where Managers perceive that there will be the resumption of business operations. In that circumstance, the country-level investment climate (infrastructure quality) featured less as an obstacle to firms' process innovation intent. The results imply that firms in the Region have unexploited opportunities for implementing innovation in business processes that are profitable even at current costs the investment climate may impose. They further imply that firms in the Region do not detect profitable opportunities for introducing new or significantly-improved products to the market. Because innovation is a key driver of economic growth, governments in the Region may, therefore, wish to prioritize continued improvement in consumer demand to stimulate firms' deduction of economic rent and to pursue product innovation even in the crisis period, and industrial policies that stimulate firms in pursuing operational efficiencies by the deployment of process innovation.

Keywords: Caribbean firms, COVID-19 crisis, institutional environment, firm innovation, Managers' perceptions.

1. Introduction

Environmental shocks—unanticipated and disruptive changes in firms' operational environment (Chakrabarty, 2015)—emerge periodically, disrupting the internal efficiency of firms and/or their competitive position. A firm's internal efficiency can decline if an environmental shock increases its cost structure or reduces the demand for its goods and services (Chakrabarty, 2015). If a shock reduces its core business, limits its access to resources or new growth opportunities—also available to competing firms—the competitive position of a firm can be interrupted (Chakrabarty, 2015). Environmental shocks, therefore, potentially affect firm performance. The debate on the appropriate response for firms to environmental shocks is unsettled. Some scholars indicate that an environmental shock provides the impetus for greater risk-taking and adaptation (Bromily, 1991), and increases the likelihood of radical firm response (Romanelli and Tushman, 1994). Firms that innovate stand a better chance of adapting to shocks and the crises that ensue and are more likely to cope better than their non-innovating counterparts (Krammer, 2021), as the engagement in formal research and development (R&D) activities leads to the acquisition of know-how that can be easily deployed to deal with crises. Other scholars have cautioned that by attempting to reconfigure, firms could increase their vulnerability to an environmental shock (March, 1981), and this could lead them to remain controlled by routines appropriate to past environmental states (Nystrom and Starbuck, 1984; Starbuck, Greve and Hedberg, 1978). Zouaghi et al. (2018) made the observation that the financial crisis of 2007-2009 made business opportunities less certain and was associated with an overall reduction in innovation activity in that period, though some firms had continued to deploy innovation strategies to force their competitiveness in the crisis period. Notwithstanding this, there is a growing consensus that firms that reimagine their operations will perform best in the next normal (Helfat and Winter, 2011; Liguori and Pittz, 2020) and are more likely to adapt to the COVID-19 crisis (Krammer, 2021).

Caribbean firms have repeatedly experienced disruptions to their input supply and consumer demand, due to the naturally-occurring exogenous events including, natural disasters, variability in and the reduced prices for commodities with the closing of preferential access to markets, and discrete non-tariff barriers to trade. From 2020, a new challenge emerged. The COVID-19 crisis led to *inter alia* rising costs in sourcing supplies, reduced hours of business operation, disrupted supply chains, and lowered consumer demand. It is expected that because the value of economic rents decreases in times of economic crisis, firms will be inclined to introduce

new products or processes (Filippetti & Archibugi, 2010). Yet, the evidence reveals that Caribbean firms generally did not attempt innovation. This can be explained by several possibilities. We expect that firms with the capacity to innovate will respond to environmental shocks faster than non-innovating firms (Saeed et al., 2017), and put forward the argument that Caribbean firms experienced stickiness to their status quo institutional environments (the investment climate). Institutions may have an impact on the monetary and non-monetary costs associated with launching innovations, or they can expand or restrict the opportunities available for innovation whereby, for instance, support policies by the government can encourage firms to undertake risky but profitable opportunities, or institutions can exacerbate or alleviate the risks (including regulatory burden) that firms may encounter while innovating (Chadee & Roxas, 2013).

It is suggested that the quality of the investment climate is more relevant in the period of a crisis when there is an expectation of both foreign and domestic investments to revive economic growth, given that the investment climate positively affects economic growth. Innovation by firms is here considered consequential to their competitiveness, sustainability, and productivity growth (Manez, et al., 2015), and offers the potential to improve the performance of an affected firm (Divisekera and Nguyen, 2018). It is one of the important strategies of competition for firms. It is furthermore widely acknowledged that innovation also has national level impacts as a major stimulant to economic growth, and economic development (Fagerberg & Srholec, 2008), and therefore is very desirable. Innovation is herein defined as “the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organisation or external relations” (OECD, 2005, p. 46).

To fill the above-indicated gap in our knowledge this paper sets out to answer the following research questions (i) given the effect of COVID-19, what aspects of the firms' investment climate affect their innovation intent? Innovation will be identified in two parts—product innovation and process innovation, and (ii) what role do Managers' perceptions of COVID-19 play in driving an effect of the investment climate on firms' innovation intent? The paper therefore considers the indirect effect of the COVID-19 crisis on firm innovation. The research proposed will indicate to governments which of the constraints that existed before COVID-19 need urgent attention if the innovation performance of firms should be improved in the current COVID-19 era to drive the recovery of the Caribbean economies.

This paper is organized in the following way. In the next section, Section 2, the conceptual framework and the specification of the model is presented, and is concluded with the specification of hypotheses. In Section 3, the data and methodology used are detailed. Section 4 presents the findings of regression analyses, and Section 5 presents a discussion on research findings.

2. Conceptual Framework and Hypotheses

Table 1—constructed with the use of data from the Innovation-Firm Performance-Gender (IFPG) dataset—shows that 2% of the Caribbean firms surveyed in the 2020 period indicated attempting to pursue innovation since the advent of the COVID-19 crisis. Where innovation was attempted, firms were less focused on product innovation and more so on pursuing innovation in processes. Whether or not firms innovate in a crisis is a difficult prediction, as firms may choose a cyclical response in reducing their innovation activity where there is a downsizing of an economy, or a countercyclical response in recognizing that crises and recessions are fertile periods for firm innovation, as the demand volumes and preferences change. While a great number of factors and explanations could be put forward to explain firms' responses, the literature establishes that the national institutional setting plays a role in how firms behave and carry out their innovation activities (Archibugi & Filippetti, 2011). We build on this literature by examining the differential effect of national-level institutional factors (the investment climate) and managers' perceptions of the severity of the crisis, on firms' innovation intent.

Table 1: Breakdown of firm attempts at innovation since the start of COVID-19

Item	Attempted Innovation	Frequency	Not Attempted Innovation	Frequency
New or improved goods	38	1.9	1,941	98
New or improved services	71	3.6	1,908	96.4
Methods for producing goods and services	40	2.0	1,939	97.9
Logistics, delivery and distribution methods	52	2.6	1,929	97.3
Methods for Information Processing and Communication	62	3.1	1,917	96.8
Methods for Accounting and Admin	23	1.2	1,956	98.8
Practices for organizing procedures and external relations	26	1.3	1,953	98.7
Methods for organizing work	29	1.5	1,950	98.5
Marketing methods	44	2.2	1,935	97.7
TOTAL	385		17,428	

Authors' elaboration based on an analysis of the IFPG dataset.

Institutional theory (Meyer and Rowan, 1977) establishes that formal and informal institutions influence the behavior of firms. For this study, institutions are defined as “rules of a game played in a society or restrictions imposed by people to shape their relationships and create a framework for their interactions” (North, 1990). Institutions tend to impose the rules for legitimacy, as well as allocate incentives and resources for innovation (Lu et al., 2008), and limit the set of choices that individuals and organizations have (North, 1990). Properly designed institutions provide a sound business environment that can stimulate productive behavior (Dollar and Kraay, 2003) and innovation (Baris, 2019) at the firm level. Where high-quality institutions exist, the uncertainty typically associated with launching innovation activities is reduced (Voeten and Basara, 2015), as strong institutions tend to reduce transaction costs and ease coordination between economic agents by enforcing contractual obligations and mediating intellectual property rights and patent laws (Oyelaran-Oyeyinka, 2004).

On the other hand, weak institutions often lead to unproductive behaviors, can lower the returns to innovation (Nguyen and Jaramillo, 2014), and therefore serve as disincentives to firms undertaking innovation. Firms operating where the institutional quality is low have a lower likelihood of conducting and benefitting from research and development (Voeten and Basara, 2015), for the cost of introducing new products and uncertainties on deriving benefits from those introductions are increased when corruption becomes widespread, rules of law are weakened and bureaucratic transactions are intensive and troublesome (Silve & Plekhanov, 2015). Institutional voids also tend to undermine the workings of the market and increase transaction costs (Saka-Helmout et al., 2020).

Dollar et al. (2003) indicated that the concept of the investment climate is closely related to high-quality institutions, and is therefore used as synonymous to the institutional context in this paper. The investment climate is herein considered the environment where governance and institutions support entrepreneurship (Hall-Driemeier et al., 2003). In this study we follow Kinda et al. (2015) and identify the following categories of the investment climate operating around firms: (i) quality of infrastructure; (ii) the experience and education of the labour force, (iii) cost of and access to financing, and (iv) Government-business relations. It is widely accepted that innovations are based on strong institutions (Baris, 2019), and that a poor environment for doing business disincentivizes firms from bringing ideas to the market.

Infrastructure and firm innovation

Firms rely on infrastructure (for example, IT, roads, electricity) to transform inputs into outputs that are accessible by buyers. The public good nature of physical infrastructure suggests underinvestment of these goods by the private sector, and the reliance on the state sector for their supply. The economic growth literature has put forward the argument that especially in developing countries where access to infrastructure serves as a bottleneck to economic growth, investments in infrastructure to reduce such constraints and can stimulate economic growth (Timilsina et al., 2020). It is expected that where the quality of (and access to) infrastructure is low, logistical and transactions costs will be higher leading to a limited supply of otherwise competitive products (Escribano et al., 2010). Furthermore, the lack of access to transportation infrastructure, for instance, is likely to reduce the flow of knowledge among innovators (Agrawal et al., 2016), leading to a less than desirable level of replication of innovation activity. It can be concluded, therefore, that low-quality or impaired access to physical infrastructure will result in reduced marginal returns on innovations, and will serve as a disincentive to innovation activity. Based on these, it is hypothesized that:

Hypothesis 1 (H1): A Low quality of infrastructure negatively influences innovation.

Business-government relations and firm innovation

The political environment of a firm is material to encouraging or constraining managers' incentives to take risks (Boubakri et al., 2013). Where weak political rights exist, for instance, firms will also tend to have a higher cost of debt financing (Qi et al., 2010). Governments tend to allocate resources through fiscal measures and industrial policies in order to stimulate firm innovation, and they can affect firm operations through measures including over-regulation, solicitation of bribes, confiscatory taxation, and the expropriation of firm assets. The literature shows that smaller firms may be disproportionately affected by weak political environments as smaller firms can be more targeted for bribery, and the distraction of continuous bribery requests can be costlier for this group of firms. Larger firms could suffer smaller distortionary effects as they are more in a position to benefit from regulatory capture. There is also a fairly large body of literature which shows that politically-connected firms tend to have higher leverage and lower taxes. Yang (2017) found that in the Latin America and the Caribbean region innovative SMEs

encountered lower sales and profits than non-innovative counterparts, when the governance environment (percentage of firms expected to make informal payments) operated in was poor. Therefore, it is expected that where the political environment is poor, an otherwise profitable investment could become unprofitable, and this will serve as a disincentive for innovation. Based on these, it is hypothesized that:

Hypothesis 2 (H2): A low quality of business-government relations negatively influences innovation.

Human capital and firm innovation

The literature concludes that the ability of a firm to innovate is closely linked to its ability to use its knowledge resources (Andries and Czarnotzki, 2014). The upper echelons hypothesis suggests that highly educated and more experienced owners/managers are expected to be more skillful in opportunity recognition. But also, the literature confirms that non-managerial employees' human capital has a positive effect on the firms' knowledge creating capability. A highly skilled and educated workforce can assimilate and integrate external knowledge into internal innovation processes (Khadan, 2012; Zouaghi et al., 2018). Having highly-educated managers and a greater portion of workers who have completed university education are associated with greater firm innovation (Ayyagari et al., 2011), because highly-educated individuals tend to adopt and implement innovations sooner than their less-educated counterparts (Khadan, 2012). Research set among thirteen Caribbean states found that innovation—including for future technological and non-technological decisions—at the firm-level is less likely to be pursued where firms have constraints on their access to new skilled employees (Khadan, 2018). Based on these, it is hypothesized that:

Hypothesis 3 (H3): Constrained access to appropriately-trained employees negatively influences innovation.

Financing and firm innovation

The literature makes the general conclusion that financial frictions will tend to cause firms to underinvest in research and development, and innovation (Hall, 2002; Ayyagari et. al. 2011); good access to finance is associated with greater innovation at the firm level—particularly among non-state-owned firms (Girma, S. Y. Gong, & H, Görg, 2008). The literature has considered a distinction between external financing and internal (firm-generated) financing for innovation. There is the conclusion that existence of the potential for free-riding associated with new innovations, makes internal financing a less attractive option for firms and if used, can lead to the delaying of innovation activities. External financing, therefore, becomes an incentive for removing delays in investments and the waiting for first-movers' actions (Yung, 2016). There is also the evidence that public firms that depend on external financing generate more and higher quality patents than their private counterparts, but this does not hold where firms rely on internal finances (Achara and Xu, 2016). Even though, it is optimal to go private when exploring new ideas, and public when exploiting existing ideas (Ferreira et al., 2012). State grants were found to have strong effects on patenting, especially among financially constrained firms (Howell, 2017), and the externally-financed portion of firms' investment expenditures was found related to firm innovation after controlling for investment opportunities (Ayyagari et. al. 2011). Based on these, it is hypothesized that:

Hypothesis 4 (H4): Financing constraints have a negative effect on firm innovation.

The moderating effect of Managers' perceptions of the COVID-19 crisis

The existing literature has generally treated Managers as homogenous in analyses. However, Schumpeter (1934) indicated that it is the entrepreneur who implements changes in an organization by innovating. The importance of the entrepreneur—both skills and attitudes—in the innovation process has been confirmed (de Mel et al., 2009), leading to the conclusion that innovative firms are those with innovative owners. In a review of the literature based on innovation surveys, it has been confirmed that factors hampering innovation tend to be positively correlated with the resources invested in innovation—an indication that innovation is a matter of capabilities (Bogliacino et al., 2010), and the result of entrepreneurs appreciating the possibilities of innovation (Alonzo, 2017).

The strategic issues interpretation literature indicates that Managers apply categorizations to new issues in their operating environment, and this shapes their motivations and actions (Haney, 2017). Managers' strategic response to unfamiliar events is dependent on Managers' interpretation of the event (Barr, 1998), and specifically on their belief on whether the affected firm can survive in the prevailing circumstance (Daft and Weick, 1984). Such beliefs are directed to an event itself and to the actions required to compete in that environment. Literature also indicates that a failure on the part of Managers to update beliefs about a changing environment can lead to delays in changes in strategy with consequences of decreased performance or firm failure. Hence, the subjective view of Managers concerning their operating environment can affect their decision to innovate or not.

There exists the view that the motivation that incites a Manager to engage in an innovative process varies by factors including the perceived benefits of obtaining temporary monopoly positions that could engender additional profits, and the perceived possibility of obtaining long-term property rights that will offer protection against potential imitators (Radu, 2014). In line with this, we argue that a reduction in business returns, coupled with the uncertainty surrounding the crisis, will cause firms would be more inclined to pursue new opportunities. In pursuing new opportunities, the costs of an unfriendly investment climate will be less likely to feature as a deterrent because individuals are more likely to respond in risk-seeking ways to potential losses than to potential gain (Kahneman and Tversky, 1979). Based on these it is hypothesized that:

Hypothesis 5 (H5): The expectation of firms not resuming normal business activity weakens the effect of a poor investment climate on innovation.

Hypothesis 6 (H6): The expectation of an effect on capacity utilization weakens the effect of a poor investment climate on innovation.

3. Data and Methodology

The empirical tests of hypotheses rely on the construction of a balanced panel dataset. They utilized the Productivity, Technology and Innovation in the Caribbean 2014 Survey (PROTEqIN) and the Innovation-Firm Performance-Gender (IFPG) datasets—financed by the Compete Caribbean Partnership Facility and its donors the Inter-American Development Bank, the United Kingdom's Foreign and Commonwealth Development Office, the Caribbean Development Bank

and the Government of Canada. The data were generated from interviews conducted in thirteen Caribbean territories among manufacturing and service firms. Table 1 shows that responses were almost equally represented across sample countries. The panel construction allows the identification of the differential impact on firm innovation before (2013/2014) and during the COVID-19 crisis (2019/2020). Having removed observations for missing datapoints and outliers, the dataset utilized amounted to 698 firm-year observations (349 firms x 2 time periods).

Table 1: Frequency distribution of responses across sample countries.

Country	Frequency	Percent
Jamaica	30	4.3
Antigua and Barbuda	68	9.7
Barbados	88	12.6
Dominica	52	7.4
Grenada	54	7.7
Guyana	32	4.6
St. Kitts and Nevis	24	3.4
Saint Lucia	52	7.4
St. Vincent and the Grenadines	74	10.6
Suriname	42	6.0
Belize	64	9.1
The Bahamas	58	8.3
Trinidad and Tobago	62	8.9
Total	700	100.0

Table 2 shows that within the sample, male-dominated enterprises accounted for 47.4% while female-dominate enterprises accounted for just 11.2%. A 64% representation of the services sector is generally consistent with what obtains in the sample countries.

Dependent Variables

This study is concerned with the indirect effect of Managers' perceptions on the severity of the COVID-19 crisis on firm innovation. A model is developed that identifies firm innovation in two ways. According to the OECD OSLO Manual (2005) firm innovation can be in the form of (i) *product innovation*, which accounts for entirely new goods and/or services as well as significant improvements to existing goods and services; and (ii) *process innovation*, which accounts for

significant changes in production and delivery methods. Each provides a useful understanding and has been identified across the PROTEqIN and the IFPG datasets. The IFPG survey asked respondents whether in the next two years “do you plan to pursue innovations in your establishment?”. The PROTEqIN survey similarly asked respondents whether in the next two years they plan to pursue an innovation type. The respondent was required to respond with a “yes” coded as “1” or a “no” coded as “2”. These were recoded so that each dependent variable takes the value of “1” if the firm indicated innovation intent, and “0” if not.

Table 2: Frequency distribution of ownership by Gender and Economic Sector

	Gender	Frequency	Percent	Cumulative Percent
	All men	492	70.2	70.2
	Equally men and women	90	12.9	83.1
	All women	118	16.9	100.0
	Total	700	100.0	
Economic Sector				
	Manufacturing	248	35.4	35.4
	Services	452	64.5	100.0
	Total	700	100.0	

Explanatory Variables

As in Barasa et al. (2017) this study adopts the belief that a single measure of the quality of institutions may not be best as institutions are latent factors. More so, both the PROTEqIN and the IFPG datasets present multiple indicators of the vast concept of a firm’s investment climate. The researcher faces the dilemma of (i) working with all indicators as would be preferred, but they are known to be highly correlated and would present a disruption in the econometric analysis, or (ii) choosing the indicators most representative of the investment climate in the econometric analysis, discarding the others and accepting the omitted variable bias. A series of composite measures is constructed by combining various measures of institutions, according to the classifications provided by Kinda et al. (2015). To measure *financial constraints*, a composite variable derived as the arithmetic mean of firms’ ranking of their access to finance and their cost of finance is used. In both surveys, respondents were asked to rank each of these as constraints to their current operations. To measure *infrastructure quality*, a composite variable derived as the arithmetic mean of firm’s ranking of (i) telecommunications, (ii) electricity, and (iii) access to

land. This choice of variables was guided by the highest cronbach's alpha attainable for this cohort. The average firm ranked infrastructure as a minor tending towards a moderate factor affecting the operation of the firm. To measure *business-government relations*, a composite variable derived as the arithmetic mean of tax rates, tax administration, customs, land regulations, business licensing, political, corruption, and theft. A cronbach's alpha of 0.648 indicates that this scale is reliable. The average firm considered business-government relations as a minor to moderate obstacle to firm operation. *Human Capital* is measured by the variable "inadequately educated workforce".

Where composites of variables were constructed, the results were rounded to the nearest whole number so that the vectors of responses used in the analysis matched the original 0 – 4 scale. For all explanatory variables, respondents ranked each as an obstacle affecting the current operations of the firm.

Control Variables

An array of control variables is included in the model. First, *firm size* measured as the natural log of the number of employees, as is common in the literature, to account for the potential of scale and scope economies that larger firms in their innovation process (Andries and Czarnitzki, 2014). On average, firms in the sample employ 24 persons. We include a measure of *firm age*. As in Barasa et al. (2017) we believe that younger firms are more likely to introduce innovation. The average firm in the sample had attained 29 years. Following Ayyagari et al. (2012) and Barasa et al. (2017) we include the *legal status* of the firm and similar to the authors, we expect that firms organized as corporations will register greater innovation than those with other legal statuses. As in Barasa (2010) we construct a dichotomous variable which takes the value of "1" if the firm is organized as a corporation (that is, a shareholding company with shares trade in the stock market, or a shareholding company with non-traded shares or shares traded privately), and "0" otherwise (sole proprietorship, partnership, limited partnership, or any other form). As in Girma et al. (2008) we include the *percentage of firm output that is exported* to account for the evidence that firms that are more active on the export market are more likely to innovate. We also control the effect of the presence of a dedicated research and development (*R&D department*) at the firm as a dichotomous variable, as having an in-house R&D department indicates a greater capacity and willingness to undertake innovation. An indicator of the *gender* of the owners/shareholders is included to account for the differential impact of gender on the propensity to innovate.

The sample includes firms located in 18 sectors across manufacturing and services. Since sector-specific factors may influence firms into innovation, dichotomous variables coded “1” and “0” are included. Similarly, given that country-specific factors may influence firms into innovation, a dichotomous variable coded “1” and “0” indicates the country effects.

Moderate Variables

We model the boundary conditions under which the country-level institutional environment may have affected the innovative ability of Caribbean firms. The IFPG survey asked firm respondents about their outlook on the COVID-19 crisis and its expected impact on their operations. We alternatively use the responses of the following three questions to identify this: ‘Do you expect that the COVID-19 crisis will impact the capacity utilization of your establishment?’, and “Do you think that your establishment is likely to resume the normal course of its operations?”. The answers to these questions, we believe, provide insights on firms’ expectations of the costs to them of the COVID-19 crisis. These help an identification of Managers’ assessment of the severity of the COVID-19 crisis and its impact on firm innovation, as it is hypothesized that Managers’ interpretation of a crisis is instrumental to their decision-making.

Empirical Model

We use random effects probit models to test our hypotheses by use of STATA. A probit estimation is used to recognize that the dependent variables are both dichotomous variables. Stepwise analysis is used.

The model is specified as follows:

$$Y_{it+2} = X_{it}\beta + \alpha_{it} + \varepsilon_{it} \dots (1)$$

We make the assumption that α_{it} and ε_{it} are independent and identically distributed of X_{i1}, \dots, X_{in} , with zero means and variances σ_{α}^2 and σ_{ε}^2 , respectively. By specifying the explanatory variables as factors that can affect the current operation of firms and firms’ innovation intent two years into the future, the specification of the model avoids the possibility of endogeneity (reverse causality) bias.

4. Results

Table 3 reports the descriptive statistics. Tables 4a and 4b report the collinearity diagnostics for the variables used in the study. The correlation values are generally not high (that is, not generally above 0.75), indicating a low possibility of collinearity issues in the model. An analysis of variance inflation values confirms that there are no serious collinearity issues, except when the dichotomous variable indicating a COVID-19 crisis is included. An average VIF of 3.20 is generally attained, by a VIF of 15.58 is associated with the variable 'COVID-19'.

Table 3: Summary of variables used

Variable	Mean	Standard Deviation
Product Innovation	0.72	0.45
Process Innovation	0.74	0.44
Legal Status	0.34	0.47
Gender	2.04	1.40
Firm Age (years)	29.09	22.41
Exports (%)	11.51	24.89
Firm Size (Ln)	1.79	1.50
R&D Department	1.92	0.27
Infrastructure Quality	1.53	0.94
Business-Government Relations	1.64	0.71
Human Capital	2.24	1.27
Financing	2.31	1.05
COVID-19 crisis	0.50	0.50
Resume Normal Operations (when?)	0.62	0.69
Capacity utilization (impact)	0.57	0.62
Observations = 698		

Table 4a: Correlation among variables – Production Innovation (dependent variable)

	Product Innovation	Legal Status	Gender	Firm Age	Exports	Firm Size	R&D Department	COVID-19 crisis	Infrastructure Quality	Business-Government Relations	Human Capital	Financing	Resume Normal Operations	Capacity utilization
Product Innovation	1.00													
Legal Status	-0.09*	1.00												
Gender	-0.09*	0.01	1.00											
Firm Age	0.04	0.09*	0.02	1.00										
Exports	0.04	0.03	0.10*	-0.09*	1.00									
Firm Size	-0.05	-0.02	-0.03	0.15*	0.01	1.00								
R&D Department	0.26*	-0.13*	-0.03	-0.15*	-0.05	0.07	1.00							
COVID-19 crisis	-0.08*	-0.07	0.00	0.10*	0.03	0.85*	0.12*	1.00						
Infrastructure Quality	-0.17*	-0.05	0.03	0.07	-0.01	0.24*	0.00	0.27*	1.00					
Business-Government Relations	-0.07	0.01	0.01	-0.02	0.02	0.21*	0.07	0.26*	0.27*	1.00				
Human Capital	0.06	-0.07	-0.04	0.11*	0.05	0.25*	0.04	0.25*	0.04	0.24*	1.00			
Financing	0.03	-0.03	0.01	-0.01	0.05	0.19*	0.16*	0.28*	0.15*	0.22*	0.11*	1.00		
Resume Normal Operations	-0.06	-0.07	-0.03	0.12*	0.04	0.76*	0.09*	0.89*	0.23*	0.20*	0.24*	0.25*	1.00	
Capacity utilization	-0.08*	-0.07	0.01	0.10*	0.01	0.80*	0.09*	0.92*	0.23*	0.25*	0.22*	0.23*	0.79*	1.00

*p < 0.05

Table 4b: Correlation among variables – Process Innovation (dependent variable)

	Process Innovation	Legal Status	Gender	Firm Age	Exports	Firm Size	R&D Department	COVID-19 crisis	Infrastructure Quality	Business-Government Relations	Human Capital	Financing	Resume Normal Operations	Capacity utilization
Process Innovation	1.00													
Legal Status	-0.12*	1.00												
Gender	-0.05	0.01	1.00											
Firm Age	-0.01	0.09*	0.02	1.00										
Exports	0.04	0.03	0.10*	-0.09*	1.00									
Firm Size	-0.26*	-0.02	-0.03	0.15*	0.01	1.00								
R&D Department	0.15*	-0.13*	-0.03	-0.15*	-0.05	0.07	1.00							
COVID-19 crisis	-0.22*	-0.07	0.00	0.10*	0.03	0.85*	0.12*	1.00						
Infrastructure Quality	-0.18*	-0.05	0.03	0.07	-0.01	0.24*	0.00	0.27*	1.00					
Business-Government Relations	-0.09*	0.01	0.01	-0.02	0.02	0.21*	0.07	0.26*	0.27*	1.00				
Human Capital	0.02	-0.07	-0.04	0.11*	0.05	0.25*	0.04	0.25*	0.04	0.24*	1.00			
Financing	0.02	-0.03	0.01	-0.01	0.05	0.19*	0.16*	0.28*	0.15*	0.22*	0.11*	1.00		
Resume Normal Operations	-0.16*	-0.07	-0.03	0.12*	0.04	0.76*	0.09*	0.89*	0.23*	0.20*	0.24*	0.25*	1.00	
Capacity utilization	-0.23*	-0.07	0.01	0.09*	0.01	0.80*	0.09*	0.92*	0.23*	0.25*	0.22*	0.23*	0.79*	1.00

*= p < 0.05

Control Variables

Table 5 presents the probit estimations indicating the factors influencing the probability of Caribbean firms undertaking product and process innovations. It shows that corporations are less likely to pursue innovations. This possibly reflects a greater bureaucracy in decision making in corporations vis-à-vis sole proprietorships, for instance. It shows no differential effect of gender on product innovation, but that women are less likely to be innovative. The model also shows that older firms in the Caribbean region are more likely than their younger counterparts to pursue product innovation. This finding generally holds across all models, and contributes the distinction to the literature that perhaps older firms would have had the opportunity to take existing products and processes through their lifecycle and therefore are more willing and ready to explore additions. Contrary to expectation, Model 1 shows that whether a firm predominantly exports or not, it is not more likely to pursue innovation. The model also reveals that larger firms are more likely to undertake process innovations, but not product innovations. As expected, the results show that firms a dedicated research and development department will be more likely to show innovation intent.

Direct Effects

Model 1 indicates some support for the view that the country-level investment climate features in firms' decision to pursue process innovation. We found, as expected, that where there exists poor access to and quality of infrastructure (electricity, telecommunications, access to land), firms will be less likely to pursue process innovation ($\beta=-0.018$; $p=0.01$). A similar result was found in the relationship between the quality of infrastructure and firms' product innovation intent ($\beta=-0.026$; $p=0.00$). Therefore, Hypothesis 1 is supported.

Contrary to expectation, we found that a financial constraint enhances the likelihood of process innovation ($\beta=0.11$; $p=0.06$), but has no effect on product innovation. Therefore, our hypothesis 2 is partially supported. We did not find significant relationship between business-government relations and human capital for either type of innovation. Therefore hypotheses 3 and 4 were not supported. Owing to a failure to arrive at significant results indicating business-

government relations and human capital as factors influencing innovation in the region, a consideration of these variables is excluded from the analysis from this point.

Model 1 also shows that the COVID-19 crisis reduced the likelihood of process innovation ($\beta=-0.57$; $p=0.01$), but had no significant effect on the likelihood of product innovation in the region.

Interaction effects

Models 2 to 7 shows the results of the moderation effects. This research is concerned with the indirect effect of the COVID-19 crisis on firms' innovation intent. It is focused on how the COVID-19 crisis facilitated the investment climate in driving an impact on firms' innovation intent. Model 2 shows that the COVID-19 crisis weakened infrastructure quality as an obstacle to process innovation ($\beta=-0.33$, $p=0.02$), but had no effect on the effect of infrastructure quality on product innovation.

As is evident in Model 4, we found that where there was the expectation of a resumption of the normal course of operations, the quality of infrastructure was registered as less an obstacle for process innovation ($\beta=-0.24$; $p=0.07$), but no effect was found on product innovation. The expectation of the resumption of normal business operation did not have an effect on financing driving process innovation, as is evident in Model 5. Therefore, we find partial support for Hypothesis 5.

As Model 6 and 7 show that when firms registered an effect on their capacity utilization, infrastructure quality did not feature as a factor in neither product nor process innovation. Therefore, hypothesis 6 was not supported.

Table 5: Results of Probit regressions

	Process Innovation							Product Innovation			
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[1]	[2]	[6]	[4]
<i>Control Variables:</i>											
Legal Status	-0.28 (0.03)	-0.28 (0.03)	-0.28 (0.04)	-0.28 (0.03)	-0.27 (0.04)	-0.28 (0.03)	-0.28 (0.03)	-0.23 (0.07)	-0.23 (0.07)	-0.23 (0.07)	-0.23 (0.07)
Gender	-0.05 (0.24)	-0.06 (0.21)	-0.05 (0.25)	-0.05 (0.25)	-0.05 (0.29)	-0.05 (0.22)	-0.05 (0.22)	-0.09 (0.04)	-0.09 (0.04)	-0.09 (0.04)	-0.09 (0.04)
Firm Age	0.01 (0.07)	0.01 (0.08)	0.01 (0.07)	0.01 (0.09)	0.01 (0.08)	0.01 (0.08)	0.01 (0.08)	0.01 (0.01)	0.01 (0.01)	0.01 (0.01)	0.01 (0.01)
Exports (%)	0.00 (0.52)	0.00 (0.54)	0.00 (0.50)	0.00 (0.62)	0.00 (0.56)	0.00 (0.57)	0.00 (0.58)	0.00 (0.53)	0.00 (0.54)	0.00 (0.53)	0.00 (0.57)
Firm Size (Ln)	-0.24 (0.00)	-0.23 (0.00)	-0.24 (0.00)	-0.23 (0.00)	-0.24 (0.00)	-0.23 (0.00)	-0.24 (0.00)	0.10 (0.20)	0.10 (0.18)	0.10 (0.18)	0.10 (0.18)
Research and Development Department	0.87 (0.00)	0.89 (0.00)	0.86 (0.00)	0.88 (0.00)	0.89 (0.00)	0.88 (0.00)	0.90 (0.00)	1.37 (0.00)	1.38 (0.00)	1.38 (0.00)	1.37 (0.00)
COVID-19 crisis	-0.21 (0.37)	0.26 (0.40)	0.07 (0.86)	-0.08 (0.77)	-0.06 (0.82)	-0.43 (0.18)	-0.39 (0.23)	-0.57 (0.01)	-0.34 (0.27)	-0.55 (0.09)	-0.53 (0.05)
<i>Direct Effects:</i>											
Infrastructure Quality	-0.18 (0.01)	0.01 (0.96)	-0.18 (0.01)	-0.08 (0.41)	-0.18 (0.01)	-0.14 (0.16)	-0.20 (0.01)	-0.26 (0.00)	-0.18 (0.07)	-0.21 (0.03)	-0.21 (0.02)
Business-Government Relations	0.00 (0.97)	0.00 (0.97)	0.01 (0.94)	0.01 (0.90)	0.01 (0.91)	0.00 (0.97)	0.00 (0.97)	-0.05 (0.64)	-0.05 (0.64)	-0.05 (0.64)	-0.04 (0.68)
Human Capital	0.05 (0.29)	0.04 (0.40)	0.05 (0.32)	0.04 (0.40)	0.05 (0.36)	0.05 (0.35)	0.05 (0.29)	0.07 (0.17)	0.07 (0.19)	0.07 (0.18)	0.07 (0.19)
Financing	0.11 (0.08)	0.12 (0.06)	0.19 (0.06)	0.12 (0.07)	0.18 (0.05)	0.11 (0.08)	0.05 (0.52)	0.06 (0.33)	0.06 (0.30)	0.06 (0.29)	0.06 (0.30)
Resume Normal Operations				0.19 (0.54)	0.08 (0.83)					0.16 (0.66)	
Capacity Utilization						0.41 (0.24)	-0.04 (0.92)				0.11 (0.72)

	Process Innovation							Product Innovation			
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[1]	[2]	[6]	[4]
<i>Interaction Effects:</i>											
COVID-19 crisis * Infrastructure Quality		-0.33 (0.02)							-0.15 (0.28)		
COVID-19 crisis * Financing			-0.12 (0.32)								-0.11 (0.42)
Resume Normal * Infrastructure Quality				-0.24 (0.07)						-0.12 (0.39)	
Resume Normal * Financing					-0.13 (0.28)						
Capacity Utilization * Infrastructure Quality						-0.11 (0.41)					
Capacity Utilization * Financing							0.10 (0.37)				
Log likelihood	-317.51	314.80	317.00	315.05	316.09	316.80	316.73	-343.18	342.593	-342.783	-342.744
Wald X^2	86.24	89.52	86.49	87.27	85.23	86.03	85.23	77.93	78.19	78.51	78.99
Observations	698	698	698	698	698	698	698	698	698	698	698
AIC	719.01	715.59	720.01	718.10	720.18	721.59	721.47	770.362	771.19	773.5656	773.4872
BIC	910.04	911.16	915.58	918.22	920.30	921.72	921.59	961.39	966.76	973.69	973.61
Country dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

P values are in parentheses.

5. Discussion and conclusions

This research sought to understand whether or not firms are willing to innovate in the current COVID-19 crisis. It modelled firms' product and process innovation intent, by considering the (country-level) investment climate and Managers' perceptions about the severity of the COVID-19 crisis as factors in helping them overcome the adverse effects of the crisis. The results of probit regression analyses indicate that Caribbean firms are not in the COVID-19 era, on average, proactive in their innovation intent.

While the presence of the COVID-19 crisis did not enhance the likelihood of process innovation, it reduced the likelihood of product innovation. It may be argued that firms may not have preferred to divert resources away from the generation of existing rents, and so had preferred to delay new innovations. But the macroeconomic crisis as unfolded in the Region typically is associated with reduced consumer demand, and so provided the incentive for firms to capitalize on opportunities for amassing new sources of economic rents. To understand the adoption of a general cyclical response by firms to the COVID-19 crisis, we introduce the role of the investment climate and Managers' perception of the unfolding of the crisis, given that the innovation literature notes that firms' innovation activity is a derivative of both institutional and environmental factors as well as personal and entrepreneurial characteristics of Managers (Fu et al., 2018).

Surprisingly, the results reveal that where expected that the normal course of business operation would resume, the quality of infrastructure featured less as an obstacle to firms' process innovation intent. This is an interesting findings given that there are studies that indicate that the investment climate serves as an obstacle to innovation in the Region. Khadan (2018) for instance, found that constrained access to a skilled workforce is a deterrent to firm innovation in the Region. These indicate that firms were willing to consider improvements in operating efficiencies to cope with the adverse effects of the COVID-19 crisis. In so doing, they considered the costs as imposed by the investment climate to be reduced or negligible relative to the benefits improvements in their operating efficiencies would allow.

Overall, the results suggest that country-level obstacles, though the literature shows that they may have an impact on firms' ability to extract value from business ventures, do not generally feature as obstacles to firm process innovation in the context of the COVID-19 crisis. The results also indicate that firms generally have unexploited opportunities for improving their internal

processes. It appears that the COVID-19 crisis was somewhat instrumental in this realization among firms. Therefore, the COVID-19 period presents the opportunity for governments to provide the awareness among firms on methods for improving their processes that will become useful in the new normal and also help to support the operational efficiency of firms. Enabling legislation that supports e-commerce and e-payments, for instance, is likely to support firms' process innovation efforts as the COVID-19 crisis (also a health crisis) improved the demand for digital interaction with firms by consumers. Because the pursuit of product innovation tends to be procyclical, there is the opportunity for governments to deploy strategies to enable a faster recovery in consumer demand.

Limitations of the study

The study is not without limitations. It is limited in the following ways. First, the analysis would be highlighting the average position in the Caribbean, and there is potentially valuable country-specific information that can be deduced. However, a larger sample of firms per country would be best to attain this. Similarly, the crisis may have a greater impact on consumer demand in some sectors (services, for instance), meaningful insights on firm innovation behavior given the crisis could be had from a disaggregation of the analysis into a sectoral one. A larger dataset at the sector level would be best to obtain stable results as the probit estimations used in this study rely on maximum likelihood estimations and there are known to require larger sample sizes. Finally, the fact that competitive pressure is at play in firms' recognition of profitable opportunities cannot be ignored. It would be an interesting extension of the current study to understand how competition among firms affect their innovation intent in a crisis period.

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Annex 1

Table 6: Description of Variables Used

Variable	Description	Source
Product Innovation	Equals 1 if innovation planned in the next two years; equals 0 if no innovation planned in the next two years.	PROTEqIN; IFPG
Process Innovation	Equals 1 if innovation planned in the next two years; equals 0 if no innovation planned in the next two years.	PROTEqIN; IFPG
Legal Status	Current legal status equals 1 if firm is a shareholding company with shares traded in the stock market or non-traded shares or shares traded privately, equals 0 otherwise.	PROTEqIN; IFPG
Gender	The gender composition of owners/shareholders: 1 if all men; 2 if predominantly men; 3 if equally men and women; 4 if predominantly women; 5 if all women.	PROTEqIN; IFPG
Firm Age	Difference between the current year and the year started operation.	PROTEqIN; IFPG
Exports (%)	Percentage of the firm's sales accounted for by direct exports.	PROTEqIN; IFPG
ln(Firm Size)	The natural logarithm of the total number of fulltime workers at the end of the last fiscal year	PROTEqIN; IFPG
R&D Department	Equals 1 if the firm has a department dedicated to research and development; equals 0 otherwise.	PROTEqIN; IFPG
Infrastructure Quality	Rating (0-4 scale) of factors as obstacles to the current business operation: telecommunications; electricity; access to land for relocation/expansion. Rounded.	PROTEqIN; IFPG
Business-Government Relations	Rating (0-4 scale) of factors as obstacles to the current business operation: tax rates, tax administration, customs, land regulations, business licensing, political, corruption, and theft, Rounded.	PROTEqIN; IFPG
Human Capital	Rating (scale 0-4) of factors as obstacles to the current business operation: inadequately educated workforce.	PROTEqIN; IFPG
Financing	Rating (0-4 scale) of factors as obstacles to the current business operation: access to finance (e.g. collateral); cost of finance (e.g. interest rates). Rounded.	PROTEqIN; IFPG
COVID-19 crisis	Dummy variable equals 1 in the 2020 year, and equals 0 in the 2014 year	PROTEqIN; IFPG
Resume normal operations	Equals 1 if the firm thinks it will resume normal operations (in light of COVID-19); and equals 0 otherwise	PROTEqIN; IFPG
Impact on Capacity Utilization	Equals 1 if the firm thinks that COVID-19 will impact the capacity utilization of the firm; and equals 0 otherwise.	PROTEqIN; IFPG
Product Innovation	Equals 1 if innovation planned in the next two years; equals 0 if no innovation planned in the next two years.	PROTEqIN; IFPG