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Abstract

This paper explores the link between innovation and firm performance for seven Caribbean countries based on data obtained from the Inter-American Development Bank's Innovation, Firm Performance, and Gender (IFPG) Surveys conducted during 2020. Our findings align with previous literature in that innovation and firm performance are positively related in the region; however, our results suggest that innovative firms switched markets favoring domestic sales, which could be interpreted as a resilience strategy in light of the pandemic shock. The paper shows that innovation, broadly defined to include methods and processes, allowed firms to obtain larger revenues, even per worker, that also translated into better worker compensation, on average. Innovation is also highly correlated to Total Factor Productivity (TFP). The evidence presented in this paper suggests that innovation is mostly financed by the firm itself, and the main obstacles to innovation perceived by companies are related to lack of human capital. Innovation outputs in women-led firms are indistinguishable from male-led companies controlling for other determinants of innovation and productivity, despite having been more affected by the pandemic. Furthermore, COVID-19 may have exacerbated firm perceptions of market-wide obstacles to innovation. The paper concludes by identifying potential policy and private sector recommendations for multilateral development banks, development finance institutions, and governments to stimulate innovation in the private sector.

JEL Codes: O12, O31, O32, O33

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1. Introduction

Innovation is at the core of economic growth. There is a well-established causal link between innovation and productivity growth, which are mutually reinforcing, creating a virtuous cycle of sustained growth. The available evidence is profound; research and development (R&D) spending, innovation, productivity, and per capita income reinforce each other and lead to sustained long-term growth (Solow, 1956; Duarte & Restuccia, 2006). Innovation pays off at the microeconomic level as well; innovation drives firm-level productivity growth and more innovative firms tend to pay higher wages and sell and export more than less innovative firms (Schumpeter, 1927; Grazzi et al., 2016).

Furthermore, the evidence suggests that more innovative firms experienced lower losses when the COVID-19 shock took place. This evidence is just emerging for other parts of the world (World Bank Business Pulse Survey, 2022), and still little is known about the Caribbean. On a related note, a causal link was found between more educated and productive workers and a reduced incidence of job losses during the pandemic in Barbados (Beuermann et al., 2021).

Despite these findings and the consequent vast potential returns to innovation, developing countries invest far less in it, measured along a variety of dimensions (e.g., R&D expenditure), than advanced countries (Cirera and Maloney, 2017; Crespi and Zuñiga, 2012). Addressing the causes of this innovation paradox is important for governments and multilateral organizations to respond to the development challenges faced by smaller developing countries.

This paper takes advantage of a unique dataset to document how innovation relates to firm performance in the Caribbean and how innovation shaped firm responses to the COVID-19 shock. Secondly, it explores how innovation takes place in the Caribbean, including how it is financed, and the (perceived) obstacles to innovation. It also provides insight on how the private sector has changed since the COVID-19 pandemic.

The Innovation, Firm Performance, and Gender (IFPG) survey conducted in 2020 in seven Caribbean countries (Barbados, The Bahamas, Belize, Guyana, Jamaica, Suriname, Trinidad & Tobago), collected a comprehensive dataset including questions on innovation and firm characteristics and performance. Previous analysis of this survey (Acevedo, et al., 2021) focused on the effects of COVID-19 on firms, suggesting that: i) small and medium-sized enterprises (SMEs) and women-led firms were the hardest hit; ii) firms that adopted measures to cope with supply chain disruptions fared better after the onset of the pandemic; and iii) digitalization and online production/operation as well as market/client diversification were top priorities for firms.

The Caribbean lags behind other regions of the world in terms of innovation and developing innovation ecosystems.[6] According to the Global Innovation Index (GII),[7] Caribbean countries have stagnated in terms of innovation: Trinidad & Tobago ranked 98 (out of 131 countries) in the 2020 GII report and ranked 97 (out of 132 countries) in the 2021 report, while Jamaica went from 72 to 74 across the same reporting

[6] Caribbean countries have also lagged in terms of GDP growth due to various structural factors, including high levels of debt, frequent natural disasters, financial sector vulnerabilities, and overall weak competitiveness. There is also a consensus that the economic growth challenges of the region are partly due to high labor, financing, and energy costs, but also to weak political, rule of law, economic, and social institutions (Beuermann & Schwartz, 2018, Beuermann & Schwartz, 2021) and a complex business climate (Donhert, et al., 2017). All these conditions have translated into slow productivity growth (Ruprah et al., 2014).

[7] The GII captures the innovation ecosystem performance of 132 economies and tracks the most recent global innovation trends. Read about the GII at https://www.wipo.int/global_innovation_index/en/2021/.

periods. For context, while most countries featured in the GII also stagnated during the same period, likely a result of pandemic-related disruptions, many similarly sized[8] countries continue to outperform the Caribbean in terms of their current GII rank: Estonia (21), Malta (27), Slovenia (32), Latvia (38), Lithuania (39), and Mauritius (52). Several factors affect these scores, including innovation inputs such as R&D, the use of information and communication technologies (ICT), and the production of innovative outputs such as new and significantly improved products or processes (WIPO, 2021).

This paper contributes to the literature on innovation and firm performance in developing countries by linking the inputs and outputs of the innovation process to measures of firm performance in seven Caribbean countries and by showing complementarities in the innovation process (i.e., the most productive firms undertook complementary innovations in distribution methods and the development of new services during the COVID-19 pandemic), suggesting that innovation could be a relevant lever for firm resilience to adverse shocks. This paper also contributes to the literature on the Caribbean, shedding light on the main barriers to broader levels of innovation in the region.

Finally, the paper contributes to the knowledge base on gender and firm performance by showing that when we compare otherwise similar firms by the gender of the manager, the differences in innovation outputs are indistinguishable from zero. This result is economically relevant given that women-owned or led businesses are 7% more likely to cite access to financial resources, an important input for innovation, as a key obstacle for growth versus their male counterparts (Acevedo, Alviarez and Lennon in Powell and Valencia, 2023, ch. 11), and that women-led firms were the hardest hit during the pandemic (Acevedo et al., 2021).

Our analysis shows that innovation and firm performance are positively related during the pandemic shock; innovative firms are more productive, sell more, and pay higher wages. However, contrary to other contexts,[9] these firms sell mostly in local markets. This could be due to the nature of the pandemic shock and suggests that the most successful firms in terms of productivity and sales per worker improvements were able to switch markets toward those with the least disruptions (i.e., mostly domestic markets). The analysis presented in this paper shows that innovation is mostly financed by the firm itself, consistent with how firms in Latin America and the Caribbean finance their investments in productive assets (i.e., Powell and Valencia, 2023, ch 11). On the other hand, the paper suggests that the main obstacle perceived by firms is the lack of talent. Analysis from the survey also suggests that the pandemic may have enhanced negative perceptions of market-wide obstacles to innovation among firms across the board.

The paper is organized as follows. Section 2 provides a literature review and the conceptual framework we utilize. Section 3 describes the data, followed by the empirical strategy. Section 4 describes the main stylized facts from the data and presents the results linking firm innovation with performance. Section 5 concludes with recommendations for governments and multilateral organizations.

[8] Following the methodology of Ruprah et al. (2014) countries with a population of less than 3 million at the time of analysis are considered as comparators.

[9] Economic theory suggests that firms who operate primarily in foreign markets are more likely to be exposed to higher standards and levels of competition and therefore need to innovate to remain competitive. See Crespi et al. (2014) or Zuniga et al. (2007) for an in-depth review of this phenomenon in the region.

2. Literature Review and Conceptual Framework

The notion of innovation was initially restricted to R&D (Crépon, Duguet and Mairesse, 1998), or product or process innovation (Loof and Heshmati 2002; Van Leeuwen and Klomp 2006; Mohnen et al., 2006). There is a clear rationale for this, particularly in developed countries.

However, more recent literature describes innovation as a multidimensional and marginal process of complementary investments in processes and products (Cirera and Maloney, 2017). Furthermore, innovation in developing countries is less about R&D than about the slow and incremental adoption of processes and products (Navarro, et al., 2010; Cirera and Maloney, 2017). As Ayllene, et al. (2017) report in their literature review, the most common definition refers to the introduction of a new product or process within the last three years (Ahmed and Mahmud, 2011). However, definitions of innovation can be expanded to include renewal and enlargement of products, services, and markets; development of new methods of production; and establishment of new management systems (Edison et al., 2013). Furthermore, any of these innovations is preferably introduced by way of incrementally innovative products to manage the potential risk caused by challenging financial conditions (Gamal, et al., 2011).

The literature has identified firm characteristics that are positively correlated with innovation. First, firm capabilities are important factors behind innovation. Evidence from 17 Latin American countries (Crespi, Tacsir and Vargas, 2016), suggest that the decision to invest in innovation (R&D) and the intensity of these investments are strongly correlated with firm size, capabilities (human capital and previous knowledge stock), access to external knowledge (via licenses and connections), and is also significantly and positively affected by public support. Evidence from the Caribbean also suggests that certain attributes are positively and significantly correlated with innovation, such as the presence of an R&D department, competition (formal and informal), and patent protection among medium-sized, domestic enterprises and some exporters make these firms more likely to innovate (Mohan, et, al, 2016).

There is also evidence that specific interventions can spur innovation. For instance, firms that participated in publicly funded innovation programs in the Caribbean experienced concrete impacts on sales and the ability to develop new goods and services or improve their production processes and spent more on innovation as an intermediate outcome (Berini, Figal and Maffioli, 2017). Furthermore, the evidence suggests that innovation and market/firm performance are mutually reinforcing forces (Mohan, Strobl and Watson; 2016).

3. Data and Empirical Strategy

Estimating equation

To explore the link between innovation and firm performance, we estimate equation (1):

$$y_i = \mathrm{f}(\alpha + \beta * \mathrm{X}_i + \mathrm{FE}_i + \varepsilon_i) \qquad (1)$$

where y_i represents the performance variables under study for firm i, X_i a set of composite innovation indicators, FE_i a set of fixed effects which includes country, sector, size and manager's gender fixed effects and ε_i the error term.

These metrics of firm performance are grouped into three categories: diversification, growth, and productivity. Under diversification, we include metrics of direct exports as a share of total exports and a

binary indicator of whether the market for the main product is international. To measure firm growth, we use both sales and capacity utilization metrics. Finally, productivity is measured by the Total Factor Productivity (TFP), and by a metric of revenue per worker. Since the IFPG survey follows a similar survey design to its predecessor, the Productivity, Technology, and Innovation survey (PROTEqIN,2014),[10] we estimate measures of TFP in a standardized way similar to other firm-level surveys such as in the World Bank Enterprise Surveys (Francis, et al., 2020; Saliola and Seker, 2011).

In this paper, we adopt the concept of innovation as multidimensional and follow the conceptual framework in Cirera and Maloney (2017) which utilizes indexed measurements of innovation inputs and outputs and is similar to that developed under the GII (Dutta, et al., 2012, 2021). We therefore characterize innovation as a production function in which innovation inputs map to innovation outputs, which in turn map to measures of firm performance (Dutta, et al., 2021; Cirera and Maloney, 2017). This approach follows the knowledge production function literature (Pakes and Griliches, 1980) and is also at the foundation of globally used metrics for innovation (GII, 2021).

Firm-level innovation indexes are simple averages of the following variables:

1) Innovation inputs: use of ICT, payment methods accepted, and dummies for the introduction of human resource innovations, marketing, and the presence of a R&D team. The ratios of skilled and management workers to total workers are also included as part of the index.

2) Innovation outputs: binary variables for new processes, methods, goods, and services, and future product and process innovation in the last three years. Additionally, the (log of the) three-year product and process innovation expenditures are normalized and included in the output index.

Data sources

The data used in our analysis comes from the Innovation, Firm Performance, and Gender Survey (IFPG)[3], a collective effort by the Compete Caribbean Partnership Facility, the Inter-American Development Bank, and IDB Invest to collect up-to-date and statistically representative data on the Caribbean region. The survey is unique in that it provides granular private sector data on firms both prior to as well as since the COVID-19 outbreak. This allows us to track changes in the innovation habits of firms in light of the pandemic. The selection of firms was done by stratified random sampling to generate a representative country and sector-level sample. The survey sample includes small, medium, and large firms.[11] The period for data collection covers March to November 2020, but the questionnaire included data points for the firms' previous fiscal year (2019), which provides the baseline information.

[10] Both the IFPG and PROTEqIN are outputs of the Compete Caribbean Partnership Facility: a multi-donor program funded by Inter-American Development Bank (IDB), the UK's FCDO, and the Government of Canada.

[11] We divide firms in three groups based on their number of full-time employees. Large firms are those with 100 or more employees, medium firms have between 20 and 99 employees, and small firms have fewer than 20 employees. This definition is aligned with other prominent cross-country surveys such the World Bank Enterprise Survey (https://www.enterprisesurveys.org/en/enterprisesurveys).

4. Results

Summary statistics

Table 1 shows the basic descriptive statistics for the variables considered. While only 4.6% of firms have an R&D team, on average about half of workers are skilled and most firms declare using some ICT 3.0 (mainly e-mail, mobile, and social media). Changes in human resource management, new ICT or new marketing strategies were introduced in 6%, 7%, and 16% of firms in the previous three years, respectively, suggesting that innovation tends to advance rather slowly in this sample.

Regarding innovation outputs, 9% of firms introduced new services, 17% introduced new goods, 13% introduced new marketing methods, and 20% implemented new distribution channels, marketing or HR strategies during the three years prior to the survey. Interestingly, firms plan to innovate in larger magnitudes than what the past would suggest: the share of firms expressing to have plans of pursuing product or process innovation in the sample increased to 23% and 29%, respectively, in 2020. This might be related to the perceived need to innovate to face disruptions brought by the pandemic at that time.

Table 1. Measures of Innovation and Firm Performance. Descriptive statistics

Innovation Inputs	Indicator	Mean	Median	S.D.	Min	Max
Management & organizational capabilities	I[New HR introduced in last 3 years]	0.058	0.000	0.234	0	1.000
	I[New ICT introduced in last 3 years]	0.068	0.000	0.251	0	1.000
	I[New marketing introduced in last 3 years]	0.159	0.000	0.366	0	1.000
	Labor in management to total workers ratio	0.209	0.200	0.107	0	0.750
	Skilled workers to total workers ratio	0.490	0.500	0.213	0	0.975
R&D	I[Presence of R&D team]	0.046	0.000	0.210	0	1.000
Usage of ICT 3.0	I[Uses any ICT 3.0 (e-mail, mobile, social media, website)]	0.995	1.000	0.072	0	1.000
	Online sales (in log)	4.09	0.00	6.27	0.00	19.61

Innovation Outputs	Indicator	Mean	Median	S.D.	Min	Max
Innovation expenditure	Process innovation expenditure, last 3 years sum (in log)	3.93	1.10	4.19	0.69	14.48
	Product innovation expenditure, last 3 years sum (in log)	3.37	1.10	3.93	0.69	14.73
New or improved products or processes	I[New goods introduced in last 3 years]	0.17	0.00	0.38	0.00	1.00
	I[New methods introduced in last 3 years]	0.13	0.00	0.34	0.00	1.00
	I[New distribution or new HR or new marketing in last 3 years]	0.20	0.00	0.40	0.00	1.00
	I[New services introduced in last 3 years]	0.09	0.00	0.29	0.00	1.00
	I[Plans to pursue process innovations]	0.29	0.00	0.46	0.00	1.00
	I[Plans to pursue product innovations]	0.23	0.00	0.42	0.00	1.00

Firm Performance	Indicator	Mean	Median	S.D.	Min	Max
Diversification	Direct exports as share of total exports	19.56	0.00	29.36	0.00	100.00
	I[Min market main product is international]	0.20	0.00	0.40	0.00	1.00
Growth	I[Sales prices increased last fiscal year]	0.30	0.00	0.46	0.00	1.00
	I[sales quantities increased last fiscal year]	0.23	0.00	0.42	0.00	1.00
	Capacity utilization, %	75.65	75.00	11.04	10.00	100.00
Productivity	Sales (in log)	13.23	12.98	1.67	9.48	20.00
	Sales/full time workers (in log)	10.28	10.26	0.99	7.98	13.52
	Average wage, in USD (in log)	8.97	9.04	0.76	6.76	11.32

Notes: Sample size is 1,153 firms except for indicators Online sales (1,133), Sales and Sales/FT workers (1,133 each), and Average wage (1,152). "I[indicator statement]" refers to a binary indicator which takes the value 1 if the indicator statement applies to the firm and 0 otherwise. Currency values in nominal USD. Average wage estimated as all workers' average annual wage in LCU, transformed to USD using annual averages for nominal exchange rates, extracted from the IMF's WEO.

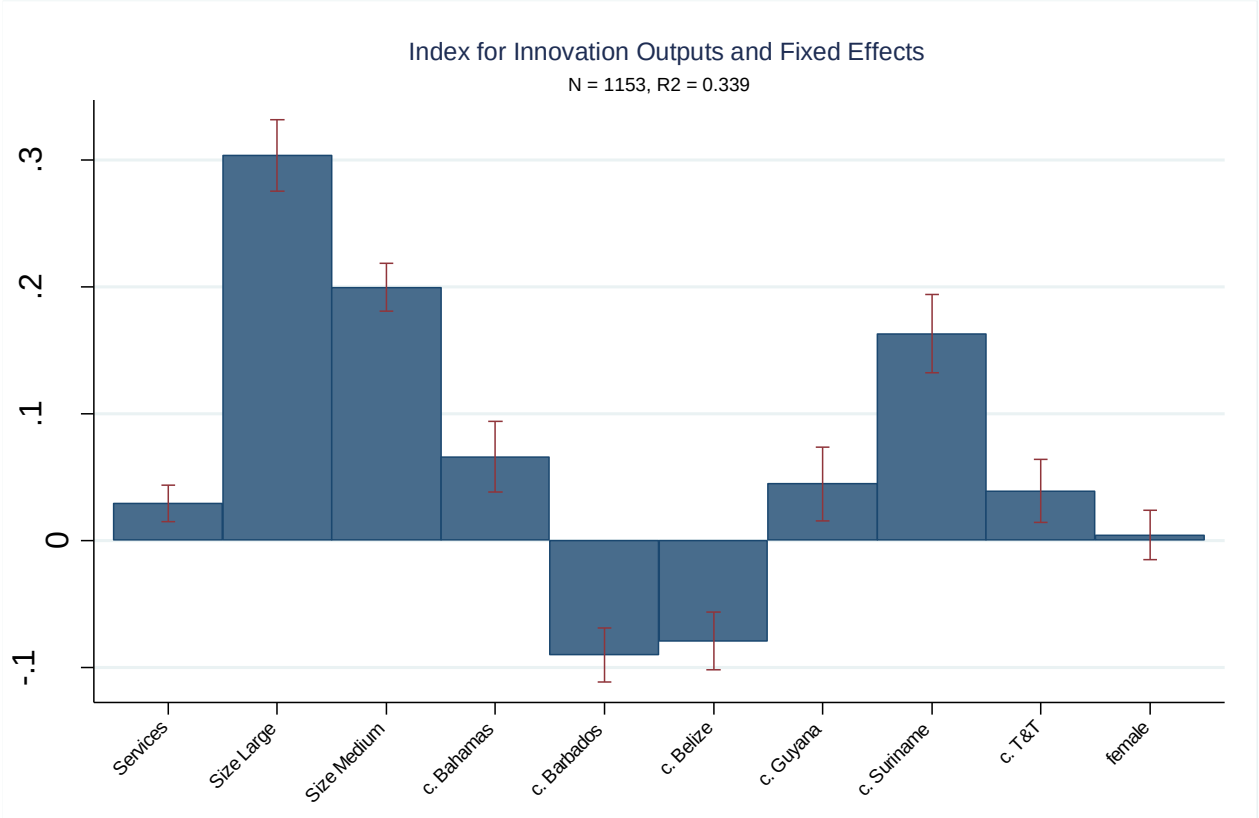
How are innovation outputs related to firm characteristics and country location?

We explore whether firm and context characteristics are correlated with innovation outputs, as described earlier.

Figure 1 depicts the coefficients of firm characteristics, including size, sector, and gender of the manager, as well as a country binary indicator in a regression of the innovation output index on these characteristics. Holding everything constant, firm size matters: large firms are more innovative than SMEs. This is consistent with the literature as firm size has been identified as one of the most robust determinants of innovation in developed countries (Cohen 1995; Mohan et al., 2016). This relationship has also been examined and found to be significant in developing countries (Rahmouni et al., 2010; Crespi et al., 2014).

Service firms in this sample also tend to be more innovative relative to manufacturing firms, holding all other variables constant. Innovation in the services sector generally relates to innovations in engineering and industrial design, disembodied technology, training, and marketing activities (Crespi et al., 2014). Another result is that similar companies with respect to size and sector, but differing in the gender of the manager, spend, on average, similar amounts on innovation and present similar outcomes such as new goods or services during the three years before the pandemic. Finally, the estimate suggests that Suriname has the highest innovation rates among the studied Caribbean countries included in the sample, which is consistent with results from previous survey rounds (Grazzi and Pietrobelli, 2016).

Figure 1. Attributes of Innovation[12]



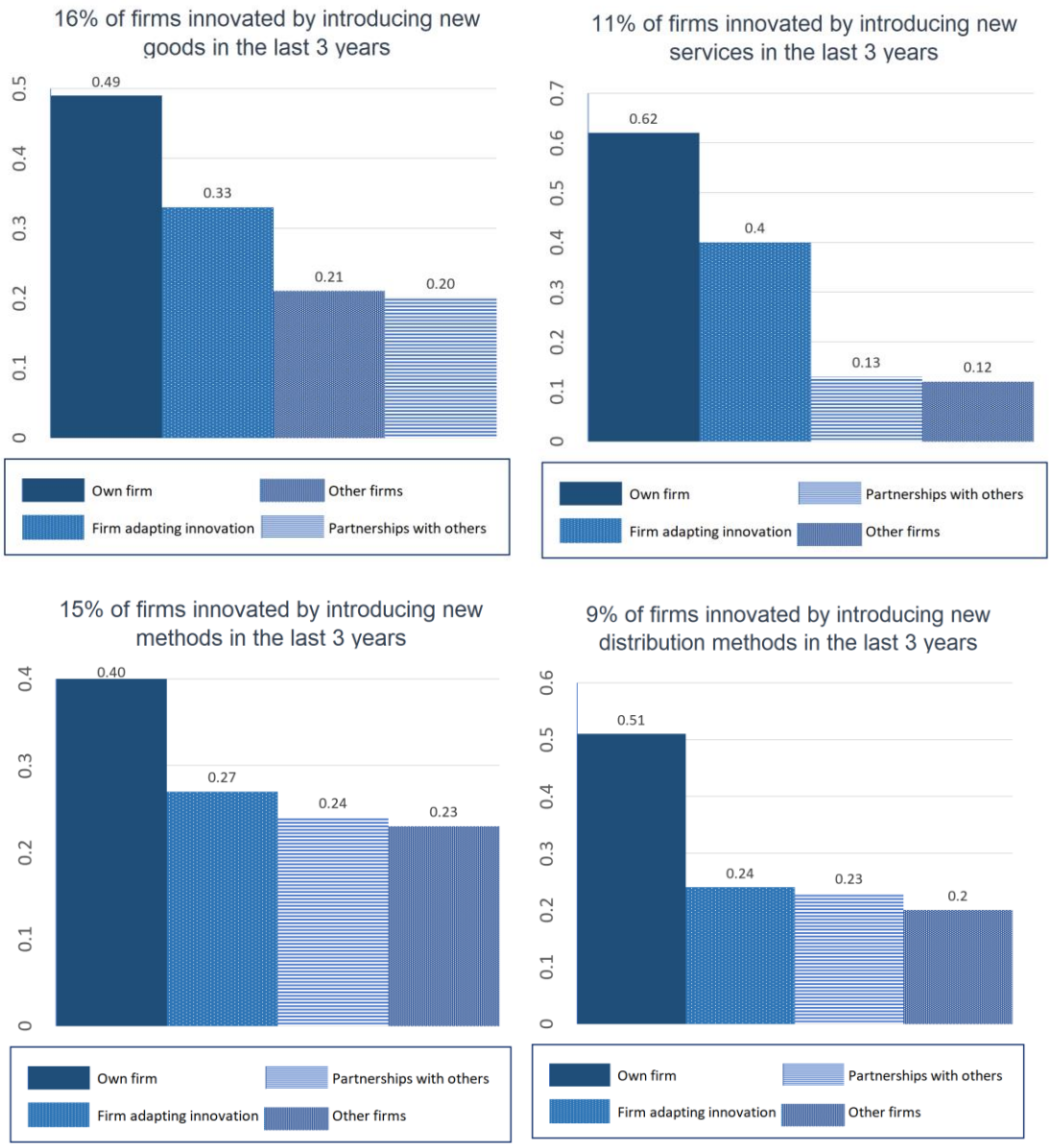
The innovation process within firms

Less than 20% of firms innovate in this sample, either by launching a new good or service, or introducing new production or distribution methods. This number is consistent with that reported by Mohan, et al. (2017), who find that the proportion of innovative firms is relatively small (26% of surveyed firms) and that there is a much larger proportion of potential innovators (59%) who are willing to innovate but may not have been successful in doing so due to various barriers.

As showed in Figure 2, approximately 16% of firms introduced a new or significantly improved good, a majority of which were developed by the firms themselves (49%). Self-developed innovations by firms were also the most prominent way in which they introduced new or significantly improved services, methods for development and production, and improvements in distribution and logistics. Across the board, approximately half as many innovations were introduced via partnership with other enterprises or organizations compared to firms developing them on their own. Nonetheless firms that introduced new methods for production or distribution were more likely to have partners related to innovation (23% and 24%, respectively).

[12] The displayed coefficients are obtained using an OLS estimation. Jamaica is the excluded country dummy for this estimation as well as the manufacturing firm dummy and the small-sized firm dummy. Female refers to firms led by women (men-led companies is the excluded dummy).

Figure 2. Who's Responsible for Innovation in Caribbean Firms?



Note: Values displayed in all graphs are averages using sample weights

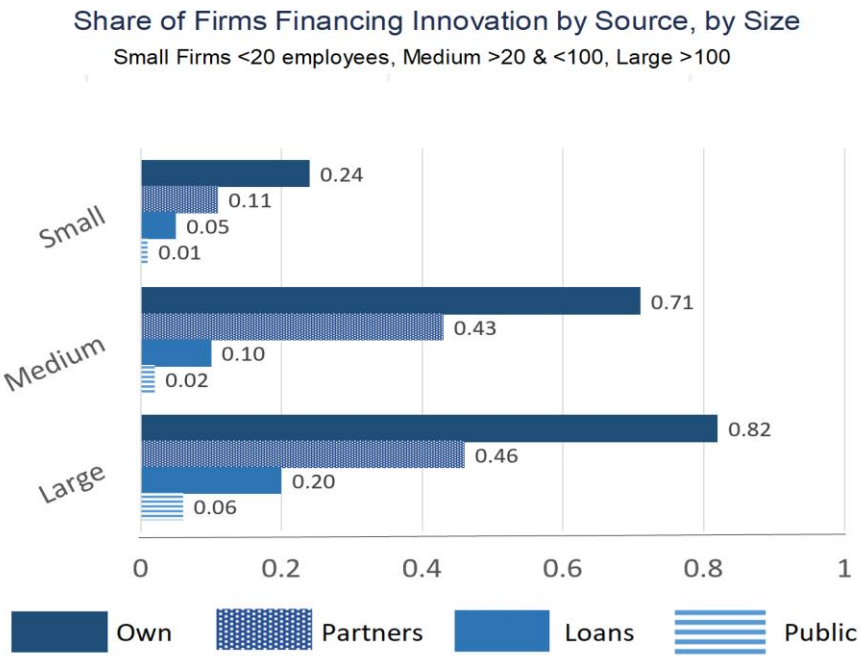
How do innovators finance these investments?

Over the last three years, Caribbean firms have financed the development of innovation via different sources, mostly using their own resources (Figure 3). This is not surprising, as firms' retained earnings tend to be the main source of investment financing worldwide. One striking finding from this data is the stark difference in the share of small firms that fund innovation on their own compared to larger firms. Only 24% of small firms report funding innovations using their own resources compared to 71% of medium-sized firms and 82% of large firms. Overall, few firms take out loans specifically to fund innovation (8.5%), with only 5% of small companies utilizing lending to finance innovations versus 20% of large enterprises. While the survey does not allow us to further explore the dynamic of private partners who are part of the

funding process (i.e., loans or equity), this finding certainly reflects the relevance of attracting private investment and leveraging partnerships in terms of promoting innovation.[13] Less than 10% of firms report accessing public funds to finance innovation: 6% of large, 2% of medium-sized, and 1% of small firms.

Another way to examine how innovation is financed is to look at the share of the innovation cost that is covered by different resources. Firms of all sizes predominantly fund innovation using their own resources, with small firms self-funding 82% of their innovation costs, followed by large firms at 80% and medium-sized firms at 76%. Even though very few firms reported accessing public funds to cover innovation costs, among those that did access such funds, the amounts were similar to those reported for financing innovation through loans and private investment. For example, among medium-sized firms with access to public funds, 42% of their innovation expenses were covered by public resources and 42% by loans and private investment, consistent with previous evidence (i.e., Berini et al., 2017). In other words, public resources help a relatively small number of firms innovate, but the amount provided for each beneficiary firm is crucial for their innovation efforts.

Figure 3. How do Caribbean Firms Finance their Innovation Efforts?



Note: Averages using sample weights

What are the main obstacles to firm innovation in the Caribbean?

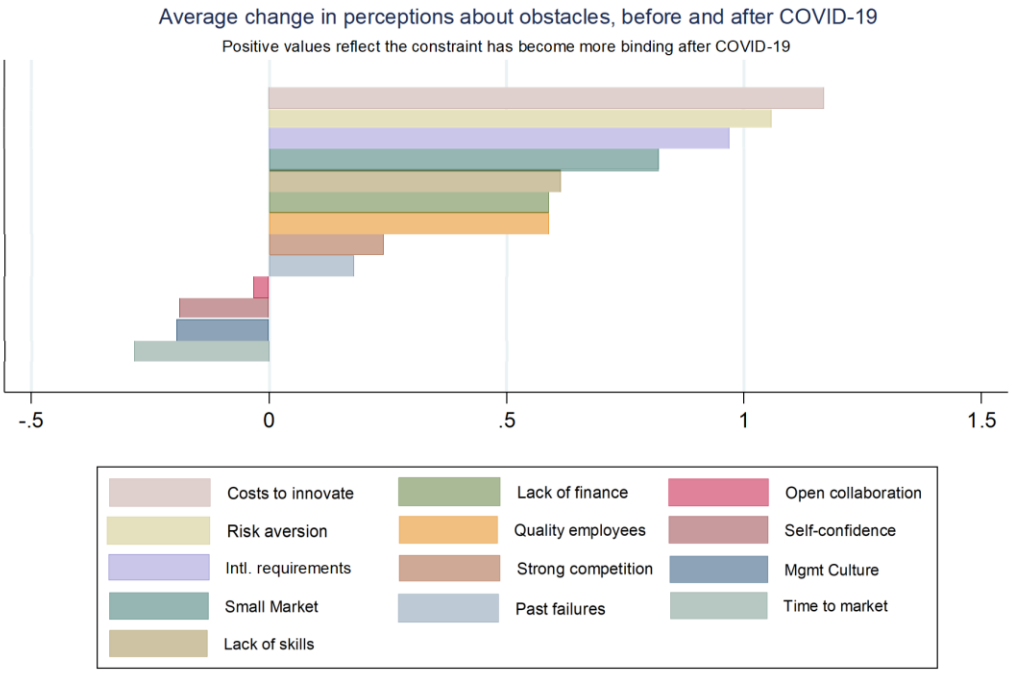
Comparing survey responses before (2019) and after the COVID-19 outbreak (2020) reveals some interesting trends (Figure 4). The quality of employees is still the top obstacle to innovation, becoming even more acute in 2020: after the pandemic about 90% of firms considered it a major or very severe

[13] See Morris (2017) and Presbitero and Rabolletti (2016) for further exploration of this topic.

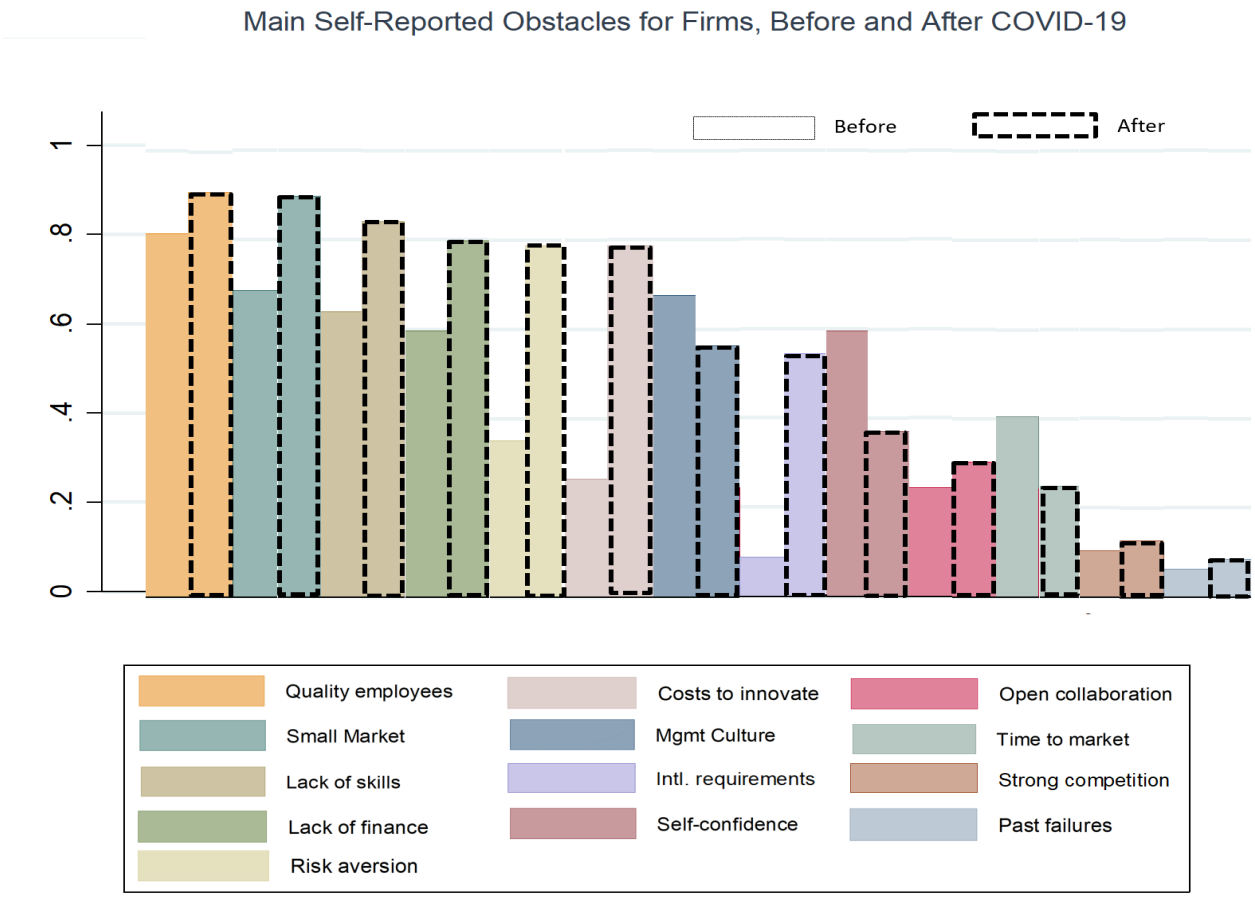
constraint. In addition to the challenges faced by small and island countries as far as limited market scale and the ability to access goods and services in a timely manner, firms increasingly perceived "small markets" as a major constraint to innovation during the pandemic, maintaining its second-place ranking. Coming in third is lack of finance, which 80% of firms identified as a major constraint to innovation, up from 60% pre-pandemic, surpassing other categories that were more prevalent before the pandemic such as management culture and self-confidence. This finding is consistent with the previously mentioned stylized facts about financing innovation, reinforcing the idea that financial services for innovation in the Caribbean are underdeveloped. There was also a big jump regarding perceptions of the financial cost of innovation pre- and post-pandemic, from 26% of firms to 78% of firms citing this as a major or severe constraint. Similarly, a larger share of firms (53%) cited compliance requirements for international standards as a major or severe obstacle to innovation, up from 8% pre-pandemic. This significant increase could be partly due to publicly mandated restrictions for controlling the spread of COVID-19. Additionally, the proportion of firms that perceived risks associated with innovation as a major or severe constraint rose from 34% to 78%. Surprisingly, the share of firms that cited lack of confidence has a major constraint to innovation has fallen since the pandemic, from 60% to 36%.

After COVID-19, firms across the board had more negative perceptions of nearly all obstacles to innovation considered in the survey. One interpretation is that firms might have been naïve regarding the true magnitude of the obstacles prior to the shock, as reflected by the change in perceptions with respect to market size opportunities, international market requirements for firms, and the cost of innovation. Alternatively, the more negative perceptions may simply reflect the overall pessimism of respondents given the timing of the survey in the throes of the pandemic. In general, in 2020, firms felt more confident about their internal strengths than about market conditions, as reflected in the significant decline of management culture, self-confidence, and time to market as major/ or severe obstacles to innovation.

Figure 4. What are the Main Obstacles to Innovation?



Note. Values displayed are averages are weighted by sample weights
Perceptions measured in a scale ranging from 0 = No Obstacle to 4 = Very Severe Obstacle



Note. Values displayed are averages are weighted by sample weights
Perceptions measured in a scale ranging from 0 = No Obstacle to 4 = Very Severe Obstacle

How is innovation related to firm performance in the Caribbean?

We also explored the association between innovation and firm performance. Table 2 presents the results of estimating equation (1), where Y_i is a set of firm-performance outcome variables and X_i is a set of composite input or output indicators, as listed in the table, controlling for other factors that could be correlated with both performance and innovation.

As expected, innovation is associated with improved productivity (columns 1 and 2) and increased sales per worker (columns 3 and 4) and is also correlated with the ability of firms to sustain better salaries (columns 5 and 6) and larger amounts of sales (columns 7 and 8). An increase in one standard deviation of the innovation output index is associated with an increase of 6% in productivity measured by TFP, a 20% increase in wages, and 111% larger sales. On the other hand, the clients of innovative firms are mainly located in local markets (columns 9 and 10). This result may be partially explained by the fact that international supply chains were particularly disrupted during the COVID crisis, and more successful firms were able to switch to local markets.

The results confirm what has been documented in previous research for the Caribbean (Mohan, et al., 2016 and 2017). Moreover, in the context of a crisis, innovation has been associated with an increased effect on SME resilience (Nah & Siau, 2020, Gupta, 2020) and survival premium (Cefis et al., 2020), which

is consistent with the positive relationship we found between innovation and firm performance for the Caribbean during the COVID-19 pandemic.

Changes in innovation decisions after the pandemic

We now turn to the innovation decisions made within firms to better understand the type of investments that had the greatest effect on increasing productivity. Table 3A shows how much a set of innovation outputs are correlated with firm productivity, measured by TFP (log USD). Table 4A replicates this exercise but considers sales per worker (in log) as the main output variable. In both cases, the regressions control for country, sector, size, and gender of the manager fixed effects to try to isolate as much as possible the effect of each innovation indicator on the corresponding firm performance measure.

These coefficients need to be interpreted with caution since they are not independent from each other. However, improvement of innovation in methods such as those for developing goods or services and for information processing and communication (column 3) seems to be one of the most effective ways to increase TFP, followed by innovations in accounting and human resources (column 8). Innovations in services (column 2), distribution methods (column 4), and marketing (column 9) are also effective ways to improve productivity in the Caribbean. For instance, having innovated in methods (column 3) since the onset of the pandemic is associated with a 14% increase in the TFP of the firm. Likewise, innovation in services (column 2), accounting (column 6), and HR (column 8) yield improvements in productivity of 10% to 12%, and innovations in marketing (column 9) are associated with a positive, though lower, increase in productivity. Table 3B in the Appendix presents the results when country and sector fixed effects are included additively rather than interacted, with similar conclusions.

Innovations are also correlated with sales per worker: 40% of changes in sales are explained by changes in innovation decisions. As shown in Table 4A, the three largest effects of innovation on sales since the pandemic are: innovation in distribution (with an estimated 74% increase in sales per worker, column 4), innovation in methods (49%, column 3), and innovation in services (39%, column 2). These results are economically and statistically significant, and suggest that during shocks, firms that are most able to introduce changes to adapt to the disruptions will not only survive but thrive.

Table 2. Innovation Indexes and Firm Performance

	Log. TFP, in USD #		Log. Sales (USD) /FT workers		Log Wage Average, in USD		Log Sales (USD)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Input Innovation Index	0.47*		4.69***		1.61**		8.90***	
	(0.28)		(1.37)		(0.68)		(1.67)	
Output Innovation Index		0.059*		0.58***		0.20**		1.11***
		(0.03)		(0.17)		(0.08)		(0.20)
R^2	0.007	0.007	0.4	0.4	0.674	0.674	0.682	0.682
N	1,011	1,011	1,133	1,133	1,152	1,152	1,133	1,133

	I[Main market main product is international]		I[Sales quantities increased last fiscal year]		I[Sales prices increased last fiscal year]		Share direct exports	
	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Index Input Innovation	-1.52***		0.40		-0.22		-84.96**	
	(0.50)		(0.66)		(0.69)		(33.968)	
Index Output Innovation		-0.19***		0.05		-0.028		-10.62**
		(0.06)		(0.08)		(0.08)		(4.24)
R^2	0.1	0.1	0.027	0.027	0.041	0.041	0.161	0.161
N	1,153	1,153	1,153	1,153	1,153	1,153	1,153	1,153

Note. The table shows results of the equation $y_i = \alpha + \beta * \mathrm{X}_i + \mathrm{FE}_i + \varepsilon_i$, where y_i is the output variable under study for firm i, X_i a set of composite input indicators, FE_i a set of fixed effects which includes country, sector, size and gender fixed effects and ε_i the error term.

Observations in the regression are weighed using samples weights. Robust standard errors reported. # TFP estimates are based on a flexible Cobb-Douglas Translog production function. * indicates statistical significance at the 10% level; ** indicates statistical significance at the 5% level; *** indicates statistical significance at the 1% level.

Table 3A. Innovation Indicators and Firm Performance since COVID-19: Total Factor Productivity

	Productivity: Log (TFP in USD)								
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**
I[Innovation goods since COVID]	0.01								
	(0.05)								
I[Innovation services since COVID]		0.10**							
		(0.04)							
I[Innovation methods since COVID]			0.13***						
			(0.04)						
I[Innovation distribution since COVID]				0.10					
				(0.06)					
I[Innovation ICT since COVID]					0.028				
					(0.04)				
I[Innovation accounting since COVID]						0.12***			
						(0.03)			
I[Innovation client since COVID]							0.000		
							(0.13)		
I[Innovation HR since COVID]								0.11*	
								(0.05)	
I[Innovation marketing since COVID]									0.06**
									(0.02)
R^2	0.003076	0.0111086	0.0091514	0.0075893	0.0035143	0.0068606	0.0030023	6.85E-03	0.0060438
N	1,011	1,011	1,011	1,011	1,011	1,011	1,011	1,011	1,011
Country* Sector FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Size FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Gender FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: The table shows results of the equation $y_i = \alpha + \beta * \mathrm{X}_i + \mathrm{FE}_i + \varepsilon_i$, where y_i is the output variable under study for firm i, X_i the vector of covariates, FE_i a set of fixed effects which includes country*sector, size and gender fixed effects and ε_i the error term. Observations in the regression are weighed using samples weights. Clustered standard errors at the country*sector reported. * indicates statistical significance at the 10% level; ** indicates statistical significance at the 5% level; *** indicates statistical significance at the 1% level.

Table 4A. Innovation Indicators and Firm Performance since COVID-19: Sales per Worker

	Log (Sales/worker in USD)								
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**
I[Innovation goods since COVID]	0.21								
	(0.23)								
I[Innovation services since COVID]		0.39**							
		(0.13)							
I[Innovation methods since COVID]			0.49*						
			(0.24)						
I[Innovation distribution since COVID]				0.74***					
				(0.16)					
I[Innovation ICT since COVID]					0.18				
					(0.19)				
I[Innovation accounting since COVID]						0.05			
						(0.40)			
I[Innovation client since COVID]							0.14		
							(0.16)		
I[Innovation HR since COVID]								0.26	
								(0.18)	
I[Innovation marketing since COVID]									-0.21
									(0.13)
R^2	0.382	0.387	0.385	0.392	0.383	0.382	0.382	0.383	0.383
N	1,127	1,127	1,127	1,127	1,127	1,127	1,127	1,127	1,127
Country* Sector FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Size FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Gender FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: The table shows results of the equation $y_i = \alpha + \beta * \mathrm{X}_i + \mathrm{FE}_i + \varepsilon_i$, where y_i is the output variable under study for firm i, X_i the vector of covariates, FE_i a set of fixed effects which includes country, sector, size and gender fixed effects and ε_i the error term. Observations in the regression are weighed using samples weights. Clustered standard errors at the country*sector reported. * indicates statistical significance at the 10% level; ** indicates statistical significance at the 5% level; *** indicates statistical significance at the 1% level.

Conclusions and Recommendations

Innovation drives productivity and can be a decisive factor in firm survival during a crisis such as the COVID-19 pandemic, which hit the Caribbean region particularly hard. Our results show that innovative firms are more productive, pay higher salaries, and sustain higher sales, increasing firm contributions to economic development and welfare. The pandemic caused major disruptions in global value chains and underscored the need for new business models, which aligns with our findings that the most productive firms in the Caribbean innovated in their distribution methods and in the development of new services during the pandemic.

However, the share of firms introducing any type of innovation in the region is still relatively low at 15% or less. Nonetheless, there is a much larger proportion of potential innovators; 59% of firms are willing to innovate but may not have been successful because they face various barriers.

Improvements in sales, wages, and productivity are associated with a standard deviation increase of the innovation output index (111%, 20%, and 6%, respectively). In turn, our results suggest that improved innovation in methods, followed by accounting and human resources are the most effective ways to increase Total Factor Productivity (14%, 12%, and 11%, respectively). Similarly, we found that the top three innovation investments for increasing sales per worker are in distribution (74%), methods (49%), and services (39%).

In summary, our results shed light on several factors that should be considered by decision makers, governments, and multilateral institutions when planning how to expand innovation among firms and untap its potential in the Caribbean region.

- **Worker skills.** Enhancing the availability and quality of human capital is key for promoting innovation, considering that lack of skills is cited as the top constraint to innovation among firms.
- **Small market size.** Small local markets not only pose challenges for firms in terms of growth, worker skills, and access to inputs, but they are also an important barrier to innovation, as reported by firms. Therefore, strengthening strategic trade and labor integration, as well as promoting both the retention of local human capital and the immigration of skilled workers, seem particularly relevant to address this challenge.
- **Access to finance.** Expanding access to finance for firms, particularly products and services targeting innovation, may have a large impact on increasing innovative practices in the region. In fact, 80% of firms cited lack of finance as a major constraint to innovation, up from 60% pre-pandemic, making it the third highest barrier. Deepening the reach of innovation financing models offered by fintechs and other digital solutions may help address firm financing constraints in the Caribbean.
- **SMEs and women-led SMEs.** Emphasis should be placed on policies and programs that promote innovation among SMEs more broadly, taking into account the particular challenges facing the creation and growth of women-owned and led SMEs.
- **Greater public support for private sector innovation.** Governments have a key role to play in supporting innovation among firms in the Caribbean, particularly in the context of market failures, such as lack of knowledge of the potential benefits of the innovation or insufficient human capital, among others.

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Appendix

Table 3B. Innovation Indicators and Firm Performance since COVID-19: Total Factor Productivity

	Productivity: Log (TFP in USD)								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
I[Innovation goods since COVID]	0.01 (0.079]								
I[Innovation services since COVID]		0.103** (0.043)							
I[Innovation methods since COVID]			0.141** (0.064)						
I[Innovation distribution since COVID]				0.109* (0.063)					
I[Innovation ICT since COVID]					0.026 (.045)				
I[Innovation accounting since COVID]						0.119** (0.051)			
I[Innovation client since COVID]							0.001 (0.147)		
I[Innovation HR since COVID]								0.111* (0.066)	
I[Innovation marketing since COVID]									0.071* (0.036)
R^2	0.0301019	0.0000759	0.0085655	0.0063168	0.0049422	0.0004901	0.0039718	0.00000058	4.02E-03
N	1,011	1,011	1,011	1,011	1,011	1,011	1,011	1,011	1,011
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Size FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Gender FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: The table shows results of the equation $y_i = \alpha + \beta * \mathrm{X}_i + \mathrm{FE}_i + \varepsilon_i$, where y_i is the output variable under study for firm i, X_i the vector of covariates, FE_i a set of fixed effects which includes country, sector, size and gender fixed effects and ε_i the error term. Observations in the regression are weighed using samples weights. Clustered standard errors at the country*sector reported. * indicates statistical significance at the 10% level; ** indicates statistical significance at the 5% level; *** indicates statistical significance at the 1% level.

Table 4B. Innovation Indicators and Firm Performance since COVID-19: Sales per Worker

		Log (Sales/worker in USD)							
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
I[Innovation goods since COVID]	0.21** (0.055)								
I[Innovation services since COVID]		0.392** (0.115)							
I[Innovation methods since COVID]			0.497 (0.273)						
I[Innovation distribution since COVID]				0.742*** (0.150)					
I[Innovation ICT since COVID]					0.188 (0.203)				
I[Innovation accounting since COVID]						0.050 (0.179)			
I[Innovation client since COVID]							0.146 (0.210)		
I[Innovation HR since COVID]								0.267** (0.073)	
I[Innovation marketing since COVID]									-0.219* (0.106)
R^2		0.397	0.382	0.387	0.385	0.392	0.383	0.382	0.382
N		1127	1127	1127	1127	1127	1127	1127	1127
Country FE		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector FE		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Size FE		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Gender FE		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: The table shows results of the equation $y_i = \alpha + \beta * \mathrm{X}_i + \mathrm{FE}_i + \varepsilon_i$, where y_i is the output variable under study for firm i, X_i the vector of covariates, FE_i a set of fixed effects which includes country, sector, size and gender fixed effects and ε_i the error term. Observations in the regression are weighed using samples weights. Clustered standard errors at the country*sector reported. * indicates statistical significance at the 10% level; ** indicates statistical significance at the 5% level; *** indicates statistical significance at the 1% level.