A relational view of climate adaptation in the private sector: How do value chain interactions shape business perceptions of climate risk and adaptive behaviours?

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Abstract
Studies exploring climate change adaptation in the private sector have seldom investigated the effect of business network interactions on climate vulnerability and adaptation outcomes. This paper proposes a novel theoretical framework to explore how business–network dynamics affect risk perceptions and adaptive behaviours in business firms. The framework is empirically grounded in a comparative analysis of business–network dynamics from three agricultural value chains in Jamaica that are vulnerable to climate change impacts. The results illustrate how the exposure, sensitivity, and adaptive capacity of value chain actors are influenced by business interdependencies and interfirm relationships. We find that the level of formality of business exchanges (contractual or noncontractual), the level of resource interdependency, and the ability to diversify access channels to critical resources can influence the propagation of climate-related risks and influence actors’ exposure and sensitivity to those risks. The study also offers evidence of the role played by bonding and bridging relational ties on adaptive capacity. The framework and findings provide a foundation for a new research agenda exploring a relational view of firm adaptation strategy in response to climate risks.

KEYWORDS
business strategy, Caribbean, climate change impacts, organizational adaptation, private sector, resilience, value chain

1 | INTRODUCTION
There is a growing recognition of the opportunities and challenges posed by climate change to business organisations (Atteridge et al., 2016; Goldstein, Turner, Gladstone, & Hole, 2019; Nitkin, 2009; Pauw & Pegels, 2013; Schneider, 2014; Surminski, 2013; Winn, Kirchgeorg, Griffiths, Linnenluecke, & Gunther, 2011; Sussman, & Freed 2008). In response to the Task Force for Climate Related Financial Disclosures (TCFD), companies and financial institutions have started to evaluate the risks and opportunities generated by climate change in their businesses and value chains. Equally, business strategies incorporating climate issues in corporate governance and risk management have started to emerge (TCFD, 2018). In order to support this trend, analytical approaches that help businesses better
understand climate risks and responses, including their business and customer relationships, need to be developed.

Research on business strategy and climate adaptation has not engaged deeply with strategic management and organisational perspectives on the firm (Daddi, Todaro, De Giacomo, & Frey, 2018; Linnenluecke, Griffith, & Winn, 2013). In response to this research gap, and as part of a broader attempt to develop a relational approach of business adaptation, this paper sets out a framework to analyse how business relationships and business networks influence climate risks and vulnerability. Contributing to the study of climate change adaptation in the private sector, this study introduces a novel approach drawing on business management theories in order to examine how business relationships and interdependencies influence the adaptive behaviours of firms. We integrate findings from strategic management theory to build a conceptual framework that helps examine the critical interdependencies that exist between business relationships, risk perceptions, and adaptive behaviours. In doing so, we offer a new way of examining how business–network interactions affect firms’ adaptation and lay the basis for the analysis of adaptation barriers and opportunities that span beyond the organisational boundaries of the firm, as conventionally understood.

The notion that firms do not operate in isolation and that their adaptive behaviour is influenced by business relationships is well established in the strategic management and organisational literature (Blau, 1964; Granovetter, 1973; Håkansson & Snehota, 2006; Huggins, 2000; Pfeffer & Salanick, 1978; Porter, 1998). Studies examining the role exerted by business relationships on firms’ economic behaviours have spanned different scales. At the firm level, studies have developed relational resource-based views of firms, focusing on the importance of business relations on firms’ core capabilities and competencies (Dyer & Singh, 1998; Wieland & Wallenburg, 2013). Studies on groups of firms have investigated the effects of network-oriented dependence reduction and restructuring strategies (such as resource dependency theory; see Pfeffer & Salanick, 1978). At a more aggregate scale, studies have related firm behaviour to macroeconomic trends (including technological, economic, or structural change), finding different forms of institutional isomorphism on firms’ choices and adaptive behaviours (e.g., Di Maggio & Powell, 1983).

Moving from an organisational focus towards a network approach is an important step for climate adaptation research. A relational approach helps to advance our understanding of the barriers and opportunities to business adaptation to climate change, complementing existing frameworks to diagnose drivers and trade-offs in adaptation (see Eisenack et al., 2014; Moser & Ekstrom, 2010). Moreover, in shifting attention towards influences beyond organisational boundaries, the development of a relational approach is better aligned with other approaches investigating network-centric organisational structures (Allenby & Fink, 2005; Huggins, 2000; Porter, 1998). Additionally, the shift in focus helps to reflect forms of business organisation currently proliferating under the new “network economic paradigm” (Powell, 1990) and embedded within the social dynamics of a “network society” (Castells & Cardoso, 2005).

This paper explores the influence of business relations on the network-sensitive elements of firms’ exposure, sensitivity, and adaptive capacity, with an emphasis on the effect of dyadic (business-to-business) interfirrm relationships. We introduce these elements in the following section with a summary in Figure 1. To illustrate this framework, we present a comparative case study analysis to explore how different types of business relations within three agricultural value chains in Jamaica can influence the risk perceptions and adaptation attitudes of value chain actors.

To date, most studies investigating climate change vulnerability and impacts in agricultural production systems have focused on the effects of climate change at the farm level and on farmers’ risk perceptions and adaptive capacity (Ali & Erestein, 2017; Elum, Modise, & Marr, 2017; Knudson, 2015; Rhiney, Campbell, & Barker, 2015; Tripathi & Mishra, 2017). The approach presented here complements these efforts by providing a more comprehensive account of climate change challenges across agricultural value chain systems. In adopting a whole value chain approach, the study also responds to recent calls for the development of system-wide approaches to value chain risk management (Benedikter, Laderach, Eitzinger, Cook, & Bruni, 2013; Lim-Camacho et al., 2017; Rhiney, Eitzinger, Farrell, & Prager, 2018).

In the following section, we set out a conceptual framework, grounded on strategic management theories, for investigating the role exerted by business network relations on the adaptive behaviours of firms. Section 3 provides background information on the methodology used and on the three case studies. Section 4 develops a critical analysis of the results stemming from a comparative case study analysis. Finally, in Section 5, we offer some analytical conclusions.

# THEORY AND CONCEPTS

In this paper, we seek to build a relational approach to understanding the adaptive behaviours of private actors embedded in value chain networks by drawing on critical theories from strategic management and organisational studies. A critical component of this approach is the notion that business relationships can moderate the "fit" between the capabilities of an organisation and the characteristics of its operational environment; and they can shape an organisation’s strategic identity, its strategy choices, and adaptive behaviour (Håkansson & Snehota, 2006).

The motivation to cultivate business interactions is first driven by firms’ desire to maximise efficiency and reduce uncertainties in their operational environments (Pfeffer & Salanick, 1978). Yet once embedded in a net of business relationships, a firm’s network generates opportunities for and barriers to its development, and it becomes a way for businesses to influence and be influenced (Canevari-Luzardo, 2019; Håkansson & Ford, 2002). It is therefore a firm’s capacity to manage its relationships with partners in its operational environment,
as defined by the relevant business network arrangements, that determines its "fit" and performance.

In this study, we focus on business relationships and interdependencies that occur within the context of value chain networks, a type of business network in which "... connected and interdependent organisations are mutually and co-operatively working together to control, manage and improve the flow of materials and information from suppliers to end users" (Aitken, 1998, p. 316). Our definition of value chain, however, also accounts for counter flows (e.g., information from customer to supplier) that can increase the competitive advantage and value creation process of a value chain (Porter, 1998) and incorporates also flows of financial resources, as this can influence value chain dynamics and value creation.

As with other types of business networks, value chains comprise a set of coordinated activities, actors, and resources (Anderson, Håkansson, & Johanson, 1994) that interact according to different types of network relationships. The focus on network interactions helps to uncover the complex dynamics of value chain relationships, moving away from a linear view of value chains. From an analytical standpoint, the influence of business relations can be examined at two main scales: At the whole network level, it is possible to investigate how structural network attributes (such as network connectivity and actor's centrality) influence adaptation and resilience outcomes (Canevari-Luzardo, 2019, under review); contrastingly, a closer look at dyadic (i.e., business-to-business) relationships embedded within broader business network environments can inform our understanding of the inference of network dynamics on the risk exposure and adaptation space of specific actors. This paper emphasises the effect of dyadic relationships on the risk attitudes and adaptive behaviour of value chain actors, as this level of analysis aligns better with the strategic management literature. A separate publication by one of the authors explores the broader effect of network-level attributes (including connectivity and actor's centrality) on value chain climate resilience (see Canevari-Luzardo, 2019, under review).

At the dyadic level, different taxonomies to describe interfirm relations have been developed. Typically, they entail a bifurcated route between different business modalities (e.g., formal or informal, hard or soft, and vertical or horizontal), although in some cases, differences have been characterised across a broader range of factors (see Huggins, 2000, for a full review). The contrast between bonding (or embedded) and bridging (or weak) ties, in particular, has been extensively explored in the strategy management literature (Uzzi, 1997; Granovetter, 1973), and its importance has also permeated some of the social capital literature on adaptation (Kinlocke et al., 2015; Smith, 2015). In the next section, we discuss in greater detail how some of these properties can infer in the exposure, sensitivity, and adaptive capacity of firms.

2.1 Influence of business relations on firms' exposure, sensitivity, and adaptive capacity

Networks confer both benefits and risks on firms. Supply chain risk management studies have found that alternative value chain business models (e.g., outsourcing, leaning, offshoring, and use of just-in-time models) generate different network configurations; in turn, these network arrangements can generate different risk propagation mechanisms across a value chain, affecting the level of exposure of individual actors to cascading impacts (Bandaly, Satira, Kahyaoglu, & Shanker, 2012; Otto, Willner, Wenz, Frieler, & Levermann, 2017; Punter, 2013; Scheibe & Blackhurst, 2018 Simchi-Levi, Schmidt, & Wei, 2014). The type of relationship between two actors can influence whether risk will be transferred or absorbed by either one, or whether the risk will be shared.

Similarly, businesses sensitivity (understood here as proneness to damage of a particular business unit) is influenced by a business's dependence on other actors' resources and activities: the more an actor relies on the resources or activities of another, the more the
other can exert its control and influence (Benedikter et al., 2013; Pfeffer & Salanick, 1978). Accordingly, the higher an actor’s dependency on the resources or activities of another actor, the higher the impact of risk propagation and disruption (Scheibe & Blackhurst, 2018). Cascading impacts through the network may be the effect, affecting the adaptive responses by others in the network.

Finally, the ability of a business to adapt can be dependent on the actors’ capacity to access resources and collaborate with others. As noted by organisational theorists Uzzi (1997) and Granovetter (1973), and more recently evidenced in the social capital literature (Adger, 2003; Lowitt et al., 2015; McGregor, Barker, Rhiney, & Edwards, 2015; Pelling & High, 2005), actors who develop and retain bridging (or weak ties) can gain better access to resources that are locked in other network communities. Similarly, actors who develop bonding (or embedded) ties develop higher levels of trust towards each other and are better able to engage in collaboration, knowledge sharing, and joint problem solving (Bodin & Crona, 2009; Jones & Woolcock, 2007). High levels of embeddedness have been shown to speed up decision-making processes and business heuristics, reduce uncertainty in longer term forecasts, help reduce errors in development cycles, and help promote learning and innovation (Håkansson & Snehota, 2006; Cooke & Morgan, 1993). As observed by Uzzi (1997, p. 54), embeddedness in relationships “… assists adaptation because actors can better identify and execute coordinated solutions to organisational problems.” However, overembeddedness can also challenge business survival. It can reduce the flow of novel information due to a lack of exposure to other external organisations (Burt, Kilduff, & Tasselli, 2013) and lead to the development of “us-versus-them” dynamics, which can be detrimental to value chain performance (Wyss et al., 2015).

Together, these three network-sensitive aspects of vulnerability affect businesses’ perceptions towards risks as well as their adaptive behaviours, ultimately influencing their performance, both in standard and exceptional operating conditions. The interaction between value chain network attributes, dimensions of climate vulnerability influenced by networks, and business attitudes and performance are described in Figure 1.

Value chain interdependencies and their possible effect on the exposure, sensitivity, and adaptive capacity of actors have been widely recognised. However, as Andreoni and Miola (2015) and Ridoutt et al. (2016) have pointed out, most studies and methodologies investigating the impacts of climate change on agricultural commodities have sought to quantify direct costs on specific production areas (e.g., crops or processing factories). Few studies have examined how climate risks are transmitted through whole food chains (see, e.g., Challinor et al., 2018; Hedlund et al., 2018). Some have acknowledged the role of social networks on farmers’ vulnerability and adaptive capacity (Ali & Erestein, 2017; Rhiney et al., 2015) and mapped the role of value chain information networks on adaptation decision outcomes (Nidumolu, Lim-Camacho, Gaillard, Hayman, & Howden, 2018). Similarly, other studies have described the interdependencies of adaptation actions between value chain actors (Crick, Gannon, Diop, & Sow, 2018; Fleming et al., 2014; Lim-Camacho et al., 2015; Lim-Camacho et al., 2016), as well as the role of power dependencies articulated through network relations on adaptive behaviours (Benedikter et al., 2013). These studies have helped conceptualise adaptive behaviour within the context of value chains as a system of interactions and interdependencies working towards adaptation goals (e.g., Lim-Camacho et al., 2017), or as systems of linked communities of practice combining their capabilities to foster innovation (Lowitt, Hickey, Ganpat, & Phillip, 2015). However, these approaches have not drawn on well-established strategic management theories. Thus, they have not explored how business interactions affect business risk perceptions and adaptive behaviour or developed a relational approach founded on strategy management theories.

### 2.2 Applying the framework on three agricultural value chains

Building on the conceptual framework developed in Figure 1, we now discuss its application to three agricultural value chains in Jamaica: the cassava, tilapia, and ornamental fish industries. We explore how network relationships affect perceptions of climate risk and adaptive behaviour by firms and apply a relational view of adaptation to try to understand the following:

- How do resource flows and exchanges influence actors’ risk perceptions and their attitudes towards climate change?
- Can a relational view of strategy choice and adaptation help in understanding the barriers to climate adaptation and trade-offs between climate risk mitigation objectives and other business priorities?

We start from the premise that business relationships may influence risk perceptions and the adaptive behaviour of firms by changing firms’ exposure, sensitivity, and capacity to adapt to climate stressors. According to the characteristics of business relationships, actors display differing levels of exposure and sensitivity, operational flexibility, and adaptive capacity. These influence their perceptions of business risk and adaptive behaviour.

### 3 METHODS AND CASE STUDIES

#### 3.1 Geographical context

Agricultural actors in Jamaica, as in many islands in the Caribbean, are exposed to multiple external stressors. On the one hand, the region is exposed to trade liberalisation policies, increased competition with international products, and international commodity price shocks (Rhiney et al., 2015). Additionally, in Jamaica, the conditions for domestic business growth are highly unstable and affected by macroeconomic instabilities, high inflation rates, and a large fiscal deficit (IADB, 2014). On the other hand, the sector is highly
sustainable to climate hazards, which have been seen to affect agricultural productivity. For example, Jamaica’s damages as a result of Hurricane Ivan (2004) generated a nearly 62% loss of earnings in the agricultural sector (FAO, 2008). More recently, the drought that affected the country between 2013 and 2014 (described by many as one of the worst droughts in the country’s history since the 1970s) was estimated to have generated nearly 7.7 million USD in agricultural losses (Government of Jamaica, 2015; Bullock, 2015). Moreover, climate change is likely to affect agricultural productivity through higher temperatures, stronger droughts, and greater climate variability (Mycoo, 2018; Rhiney et al., 2018), and significant impacts are projected to occur under both a 1.5°C scenario and a 2°C warming scenarios (Thomas, Schleussner, & Kumar, 2018).

3.2 | Characterisation of case studies

The three value chains selected have been exposed to similar climate change challenges (particularly water scarcity), yet they represent quite different relational structures. This offered an opportunity to analyse comparatively the influence of relations in value chains on climate sensitivity, vulnerability, and adaptive capacity. Jamaica is a small middle-income economy with sufficient homogeneity to limit the variation of other business and economic factors across these three agricultural value chains.

In the following subsections, we will provide a short introduction to each value chain case study. Further information on the main actors, resources, activities, and climate sensitivities of each type of value chain tier is in Annex 1 of this paper.

3.2.1 | Cassava bammies

There are different uses for cassava in Jamaica, each reflecting a different type of value chain. Traditionally, cassava has been used for the production of bammies, a form of flat bread. The bammie value chain is composed of small-scale farmers (operating individually or through agricultural cooperatives), small cottage producers, and a small group of larger processors. This chain is oriented to both the local and export markets and is characterised by informal noncontractual arrangements between primary producers and processors, low input-to-output ratios, and low levels of mechanisation (Caribbean Agricultural Research and Development Institute [CARDI] Pers. Comm., 2016).

Additionally, cassava is being used in Jamaica as a substitute for barley in the production of beer, and its use as a substitute for wheat is being explored, too. In both of these new value chains, farmers have much higher input-to-output ratios due to the acquisition of modern farming technologies (e.g., mechanisation and fertigation techniques) and better plant strains. They also have also established set price and volume agreements with the processing facilities in operation.

Although it is difficult to estimate the total number of small cottage facilities, according to data from the Agricultural Business Information System (RADA, 2016), there are 122 registered cassava-focused farmers in the country and 11 cassava-processing factories. There are approximately 30 major bammie processors in Jamaica, although a larger number of small cottage operations may be scattered close to major production areas. Through the information collected on this value chain, the total number of primary actors is estimated to be around 220.

3.2.2 | Tilapia

Tilapia fish farming was first introduced to Jamaica in the 1940s (Aiken, Morris, Hanley, & Manning, 2002; FAO, 2005). The industry peaked at 7,500 tons around 2006 with the development of a lucrative export market for fresh and value-added fillets (Wurmann, 2011). Despite a steady rise in the global production of tilapia, the production in Jamaica declined down to 600 tons in 2012 (Aquaculture Branch, Ministry of Industry, Commerce, Agriculture and the Fisheries [MICAF] Pers. Comm., 2017). This dramatic fall in production levels was partly the result of challenges faced by the industry, such as increases in production costs, inadequate supplies of fish stock, cheaper imported fish substitutes, and larceny. However, the exit of one of the key players in the industry (Jamaican Broilers—former major fish producer and the only local producer of fish meal in Jamaica) has been most commonly cited as the main cause for the sector’s contraction. Due to the collapse of the export market, the value chain is now composed primarily of semi-intense and extensive fish farms, and most fish are now sold live or fresh at the farm gate or through higglers to local vendors. Additionally, there are three processors of tilapia in the country, one of which produces its own tilapia. In 2012, it was believed that there were around 120 fish farmers in the country (Fisheries Division, 2012). However, these figures are now outdated, and the current number is likely smaller (Aquaculture Branch, MICAF Pers. Comm., 2017). Through the information collected on this value chain, the total number of primary actors is estimated to be around 165.

3.2.3 | Ornamental fish

The production of ornamental (pet) fish in Jamaica dates back to the 1970s. Studies have suggested that the country holds excellent conditions for the production of tropical freshwater ornamental fish and that there are great opportunities to increase export volumes to supply the United States and Canada (ABD, 1996; Gray, 2011; JBDC, 2003). However, these opportunities have remained mostly untapped. If anything, over the past two decades, the sector experienced a significant decline in fish production and saw some of the major exporters turn their production towards local retailers, generating a saturation in the local market. However, in parallel, The Competitiveness Company (TCC) has initiated an export-focused strategy through the development of a Jamaican ornamental fish cluster and the provision of equipment, training, and input supplies to urban, “backyard”-dwelling, low-income households, mostly located within the Kingston area. TCC has also developed an export facility with the support of international donors, seeking to increase
the share of exported ornamental fish in the North American market. As a result of this new initiative, two distinct value chain typologies can now be distinguished, differentiated by the type of producer. On the one hand, there are larger, well-established fish farmers who are currently supplying an already saturated local market but who, in the future, could supply the international markets, as well. On the other hand, the urban backyard fish farmers have been organised through the TCC ornamental fish cluster. In total, there are currently between 70 and 80 active ornamental fish farmers in Jamaica. Through the information collected on this value chain, the total number of primary actors is estimated to be around 100.

3.3 | Data collection and analysis

This research drew on the results from information collected through semistructured interviews, closed questionnaires, field visits, and validation workshops. A total of 136 interviews with 122 organizations in Jamaica were carried out in 2016 and 2017 as part of both the scoping and implementation of the project (see Table 1 and Table 2). Consultations include primary actors (i.e., those engaged in the exchange of material resources) and secondary actors (additional actors necessary for value creation, such as regulators, financial institutions, and extension services). Value chain actors were first identified with the support of CARDI (in the case of cassava), the Fisheries Division at the MICAF (in the case of both tilapia and ornamental fish), and TCC (in relation to urban ornamental fish farmers). Additional informants were identified following a snowball technique. The interviews collected information on the actors’ economic operations and interactions with other actors along the value chain (in terms of material, financial, and information flows); as well as concerns regarding major climate and non-climate hazards, and adaptation strategies to mitigate existing climatic and non-climatic risks (in alignment with O’Brien & Leichenko double exposure framework, 2000). A closed questionnaire was provided to 81 of the primary actors at the end of the interview, asking them to rank the rate of threat they perceived from a range of climatic and non-climatic risks. Considering the small number of actors involved in these three value chains, the number of actors surveyed across each value chain can be considered as representative of the entire population.

The interview and survey protocols were informed by a desk-based review of the literature and finalised in consultation with CARDI and the Fisheries Division. The interview information from written notes and recordings was processed using a hybrid approach (Fereday & Muir-Cochrane, 2006): first inductively (by organising information according to themes emerging from the interviews) and then deductively (by searching for elements present in the conceptual framework within the information collected). The survey results were first aggregated and analysed for each value chain and then compared across the three case studies. Further qualitative analyses of responses were carried to understand variations in survey responses between different actors in each value chain, incorporating responses from the interviews. See Annex 2 for further information on the research design and stakeholder engagement.

4 | A RELATIONAL VIEW OF RISK PERCEPTIONS AND ADAPTIVE BEHAVIOUR ACROSS VALUE CHAINS

4.1 | Drought: The most recurrent source of concern across the three value chains

To simplify the analysis, this section examines how business relations influence risk perceptions and adaptive behaviour to one type of climatic hazard: the droughts. According to the survey results in

| TABLE 1 | Profile of organisations consulted under this study. Primary actors represent actors in the cassava, tilapia and ornamental fish material value chains |
| Category (primary actors) | CASSAVA | ORNAMENTAL | TILAPIA |
|--------------------------|--------|-----------|--------|
| Input supplier           | 4      | 2         | 2      |
| Producer                 | 10     | 16        | 14     |
| Producer and higgler     | 3      | 0         | 0      |
| Producer and processor   | 6      | 0         | 1      |
| Processor                | 14     | 0         | 3      |
| Distributor              | 1      | 0         | 1      |
| Vendor                   | 0      | 4         | 4      |
| Exporter                 | 1      | 1         | 0      |
| End consumer             | 2      | 0         | 1      |
| TOTAL                    | 41     | 23        | 26     |

| Field visits | 7 | 14 | 10 |
| Workshop participants | | | |
| (8 were interviewed) | 31 | 16 | 14 |
| (7 were interviewed) | | | |
| Surveys | 34 | 21 | 26 |

| TABLE 2 | Profile of organisations consulted under this study. Secondary actors are those operating across the three industries providing additional support and services |
| Category (secondary actors) | No. of organisations |
|-----------------------------|----------------------|
| Financial Institution      | 9                    |
| Government                  | 12                   |
| R&D                         | 4                    |
| Education Institution      | 4                    |
| Business association        | 2                    |
| Insurance                   | 1                    |
| NGO                         | 1                    |
| TOTAL                       | 32                   |
the three Jamaican value chains, the potential incidence of drought was perceived as a significant problem or somewhat a problem by 80% (cassava), 62% (ornamental fish), and 72% (tilapia) of the respondents, making drought the highest ranked risk factor across all climatic and non-climatic variables (see Figure 2). The second climate risk factor of concern was hurricanes—regarded as a significant problem or somewhat a problem by 62% (cassava), 62% (ornamental fish), and 50% (tilapia) of the respondents, followed by heavy rainfall.

In relation to economic challenges, market volatility (fluctuations in the price of raw products and general instability of market conditions) was perceived as a significant problem by actors in the tilapia and cassava industries. Additionally, over half of the respondents in all three industries perceived costs of production as a problem.

The high levels of concern about drought compared with other risks may have been due to the recent impact of this climatic event generating a bias in the responses, but it could also have been because actors felt less prepared for these events than towards other stressors and shocks. During the interviews, actors across all three value chains identified lack of access to capital, as well as conflicts or lack of coordination between producers as significant challenges affecting value chain operations. In the case of actors in the tilapia and ornamental fish industries, it was also noted that the lack of an adequate government extension service and absence of business management and marketing training were posing constraints to production, exports, and to their ability to adapt to changing climatic conditions.

4.2 | Climate risk perceptions across value chains

Perceptions of risk between actors across value chains reveal different levels of concern towards similar threats. Although one would expect climate risks to be of greater concern at the farm level due to the high climate sensitivity of agricultural crops, our results point to a more complex picture. For example, in the cassava value chain, the majority of the processors perceived drought as a significant problem (nine out of 11 respondents), whereas only one third of producers displayed the same level of concern. In contrast, in the tilapia value chain, risk perceptions towards drought were highest among producers and vendors but not among the intermediary processors.

Two possible factors may help explain these divergences. First, activities along a value chain may have varying sensitivity to climate risk, depending on the resources needed to mitigate or respond to these risks, and the exposure of locations where these activities take place (see Annex 1). In the case of bammies, both producers and processors need access to water. Second, and as it will be explored in the following sections, risk perceptions are partly the consequence of the conditions generated by business network relationships, which influence the exposure, sensitivity, and adaptive capacity of value chain actors and, accordingly, their perceptions of risk and adaptive behaviour.

4.3 | Effect of network interdependencies on climate exposure

Exposure is the extent to which a particular business unit is subject to a climate-related hazard. Although in the past, climate risk exposure has been related mainly to the geographic location of a business activity to specific hazards, we argue that exposure can also be the product of the type of interactions forged between network actors, as well as the position an actor holds within the value chain network. In the event of exposure to a hazard, value chains may dampen or propagate impacts to other actors along the chain. In principle, risks would be expected to be transferred to actors with the weakest bargaining power or the highest levels of dependency on other actors in the value chain, according to these two factors.

In the cassava value chain, for example, farmers in the traditional value chain sell their products informally to the highest bidder outside formal contractual agreements. During the drought of 2014–2015, the quantity of available cassava dropped, allowing farmers to increase the price significantly (from an average 20 JMD per pound up to 35 JMD per pound; RADA Pers. Comm., 2016). Contrastingly, bammie processors typically have fixed price arrangements with retailers and exporters, meaning they have very limited capacity to pass increased costs along the chain. As noted by one bammie processor,

*Most of the bammies were previously exported but with the drought and short supply the farmers increased the price so significantly that ... we had to shut down a lot of the export market. We have not started to re-*
establish these markets because we are not sure what is going to happen in the future so we are not sure what is going to happen in the future so we are not sure how we do it now is sell locally. (Pers. Comm., 2016)

Not all producers can pass-on higher prices. As noted by a tilapia vendor, the "... fish price has been stable for the last 5-6 years, but farmers move the price according to how much they have available" (Pers. Comm., 2017). Tilapia vendors have been unable to increase price to their customers, primarily because of competition from alternative fish supplies from the marine capture fisheries.

Therefore, mechanisms that affect risk transfer or risk absorption can alter the extent to which an actor is exposed to climate-related risks. This aligns with results from Mulhall and Bryson (2013), who illustrated how formal and informal agreements between suppliers and customers in metal processing firms in the United Kingdom could critically affect suppliers' abilities to transfer energy price risks. In this sense, the exposure of an actor in a value chain should be evaluated from the perspective of the actor's relationships with its suppliers and customers, as the extent to which an actor will receive and be able to transfer risk is related to the nature and dynamics of these relationships.

Actors may also be exposed to climate risks generated within the broader network context, becoming subject to the influence of network dynamics that they are not directly exposed to. This is illustrated in the tilapia value chain, where conditions generated by the global 2008 food crisis led the major exporter of tilapia (Aquaculture Jamaica Limited or AJT) to exit the industry. The company had always struggled to maintain good profit margins due to tight competition with other seafood products in the United Kingdom and European markets. In 2009, the company experienced a significant increase in the price of one of its major inputs for fish meal, due to an increase in the international price of grains (primarily corn) - which was driven by reductions in agricultural production in some parts of the world, an increase in oil (and air freight) prices (FAO, 2009).

To sustain an increase on grain price, one would have to pass the price increase to the consumer. But when capture fisheries are the ones setting the price and they provide other options in the market, it's more difficult. With grain price increases, there is no effect in the fish stock of capture fisheries, and they retain their stability. [...] When margins turned negative in foreign exchange, that meant no business for us. (Representative from Jamaican Broilers, mother company of AJT, Pers. Comm., 2016)

Two key reflections can be drawn from this case. First, it shows how high dependency on resources traded internationally frames inflexibility for local market actors. At the global scale, it demonstrates how actors can be exposed to cascades of climate-related risks, with limited capacity to rapidly adapt to them (Challinor et al., 2018; Helbing, 2013). At the regional level, this reflects the Caribbean's long-term dependency on global markets for imports of primary commodities (either raw or semiprocessed), like feed corn (Wilson, 2016; Beckford & Campbell, 2013).

Second, the case also illustrates that different business network structures and business models may hold different levels of climate resilience. Had there been alternative (or stock-piled) grain supplies, or a substitute value chain in the domestic or international market to supply inputs for feed pellets, the sensitivity of the tilapia value chain and of Aquaculture Jamaica Limited would have been lower. This case illustrates how network structural attributes (such as network connectivity and network redundancies) may influence on risk propagation mechanisms and on the ability of actors and entire value chains to respond to systemic risks - a factor that only very recent explorations have tackled (see Han & Shin, 2016; Helbing, 2013; Ledwoch, Yasarcan, & Brintrup, 2018; Otto et al., 2017; Scheibe & Blackhurst, 2018).

4.4 | Effect of network interdependencies on climate sensitivity

Business interdependencies can affect the sensitivity of business activities and consequently influence their perceptions and attitudes towards climate risks. A higher level of dependency on another actor's activities can result in a higher sensitivity towards the adaptive behaviour of that actor. In the case of the tilapia value chain, 8 out of 17 producers perceived the drought to be a significant problem, and another eight believed that the drought did not pose a problem at all. After verifying that the difference between the responses was not generated by differences in local climatic conditions (by assessing farmers' responses against mapped drought conditions in their localities), it became apparent that farmers' risk perceptions were being affected by water access dependency. In other words, farmers with direct access to their own water supply (e.g., access to a river or deep well) did not perceive the drought as a problem, whereas farmers relying on the national water utility believed the drought to be a significant problem. In fact, water utilities enforce water rationing during periods of water scarcity, forcing the fish farmers relying on their service to cut production.

Interestingly, actors that were dependent on the water utilities believed that water access was not only an issue during periods of drought, but also under normal operating conditions. This was best captured in the response by a fish farmer who noted that they "... don't have a water problem but a [water provider name not disclosed] problem" (Pers. Comm., 2017). This example shows that within the same tier of a value chain, risk perceptions can significantly differ as a result of resource network interdependencies.

Overreliance on utility providers was also noted as a problem by cassava processors and urban ornamental fish farmers. In both cases, actors affected by water rationing typically did not have access to on-site water storage infrastructure (e.g., water tanks). Consequently, during a drought, they were forced to source water from local natural sources, or to purchase water from water trucks, significantly increasing production costs (further details on the effects of water rationing on cassava processors can be found in Canevari-Luzardo, 2019) A
question was posed to the water utilities as to whether they promoted water storage devices and water efficient technologies (e.g., water recycling) as a means to reduce water consumption in these industries. Interestingly, their response was as follows:

> It is an issue we struggle with—where you have a high user but a good paying user and there have been arguments saying if they are happy using our water and paying for it, we shouldn’t be the ones to be discouraging their use. But the more enlightened argument has been that whilst that may be true for most times, there are going to be times where if they are using more than they need to, you may not have the means to serve them or others. We’ve had that debate internally. I suspect it is a common debate with water utilities. (Water Utility Pers. Comm., 2016)

These cases illustrate how resource dependency can shape climate sensitivity of firms. It also shows the commercial logics that act as a barrier to building more resilient resource management processes in the long term and trade-offs between climate risk mitigation objectives and other business priorities (Surminski 2013).

### 4.5 Effect of network interdependencies on adaptive capacity

The ability of an actor to reduce reliance on resources provided by others in their network may increase private adaptive capacity, while imposing new costs. For example, fish farmers who gained direct access to water by building deep-water wells were affected less by the impacts of drought than those relying on the water utilities. This required new capital investments but conferred independence from service utility providers.

In other cases, adaptive capacity may stem from resource diversification strategies. Our research confirmed that most tilapia vendors perceived the drought to be a significant problem, whereas the two main processors and distributors of tilapia did not perceive it as a significant problem. When processors were asked why the drought did not pose a problem, they explained that tilapia processing represented only a small fraction of their activities, as most operations were focused on the processing of seafood products. In cases when tilapia availability declined due to a drought, they shifted to processing other seafood products, without major disruption to their operations. In contrast, vendors relied entirely on selling fresh or live tilapia for their livelihood, so impacts caused by a drought to fish yields would have directly resulted in losses for them. As noted by one of the vendors, “the drought is a problem [because] fish become scarce and then we have no fish to buy” (Pers. Comm., 2017).

Resource diversification strategies have been acknowledged as an important adaptive strategy for firms that rely on yields and operations that are highly affected by climate (Bren D’Amour, Wenz, Kalkuhl, Christoph Stechel, & Creutzig, 2016; Crick et al., 2018; Linnenluecke, Stathakis, & Griffiths, 2011). Diversification, however, requires new network relationships to be fostered and developed, either within existing or new business environments. For example, tilapia vendors could diversify their activities by selling other live products (such as farmed shrimps or basa). This however would require them developing the relationships with suppliers of these alternative products and also finding a market for these products.

### 4.6 Effect of bonding and bridging ties on adaptive capacity

Most economic activities carried through value chains rely on the mutual orientation of actors and collaboration activities through which resources are leveraged to generate products and services (Huggins, 2000). The higher the levels of horizontal and vertical collaboration and communication within a value chain, the more effective the flow of resources, and the greater the ability of value chain actors to respond adequately (i.e., as a cohesive network) to external stressors. When evaluating the network-level factors that influence actors’ adaptive capacity, it becomes important to examine the presence and nature of weak and embedded ties. A lack of weak (bridging) ties can affect actors’ adaptive capacity to the extent of preventing critical resources from flowing to where they are needed. For example, actors in the tilapia value chain expressed serious concerns over their lack of access to business and marketing training, noting that this had negative impacts on their revenue flows and, consequently, on their ability to invest in adaptation. When examining patterns of how information was flowing in the value chain, it was noted that there were basically no weak (bridging) ties between fish farmers and country agencies dedicated to education and training. It seemed that only the Fisheries Division had supplied this type of service in the past, compared with a greater number of government and nongovernment agencies that provide this service to other agricultural industries.

Similarly, a lack of strong bonding (embedded) ties can result in a lack of trust and collaboration between actors. Trust was a key theme discussed in all three value chains. In the case of the tilapia and casava value chains, the lack of trust and the rivalries between primary producers generated instabilities in the market price (a race to the bottom) and also prevented processors from being able to determine the reliability of the quality and the volumes of produce that they required. This situation can be countered when primary producers organise and become able to negotiate with processors as one voice (a process of unionisation that increases their bargaining power). This has been shown to be an effective strategy within well-organised casava cooperatives, which are now reaping the benefits of coordinating farming activities and, as a group, reliably supply to large single buyers. Additionally, cassava producers belonging to a cooperative are more likely to use best practice approaches, to receive some form of climate change-related training, and to have better access to financial assistance. This ability to cooperate and reap the benefits of acting as a cooperative is the result of individual actors’ ability to develop and retain bonding (embedded) ties.

In the case of the ornamental fish industry, there were no cooperatives, but there was a clear divide between the cluster of urban fish
farmers and the large-scale fish farmers. It was noted through the interviews and at the workshop that this opposition has negative impacts on the export industry. The lack of a single voice in such a small industry has prevented adequate advocacy for the development of favourable export-driven legislation and has inhibited the dissemination of best practices to enhance productivity; it has also exposed primary producers to input supply monopolies. As noted in the Plan for Aquaculture Development in Jamaica 2012–2025, “no single Jamaican producer is able to consistently supply the number of fish needed to satisfy [US] import orders [...] poor organization [...] could completely prevent commercial access to the main US buyers/importers” (p. 36). Lack of collaboration and the presence of a strong culture of “us versus them” has reduced opportunities in the industry and government support, ultimately affecting the adaptive capacity of the actors involved in this industry.

5 | CONCLUSIONS

This study explored how business relationships affect businesses’ climate risk perceptions and adaptive behaviours, drawing on strategic management theories to uncover the business dynamics affecting strategic choice and adaptation. It shows how different types of resource flows and exchanges between actors operating in value chain networks can affect the exposure, sensitivity, and adaptive capacity of businesses. We framed a relational view of climate adaptation that shifts the focus of analysis from internal factors and capabilities affecting firms’ adaptive behaviours, to factors spanning beyond traditional organisational boundaries. The benefits of this approach were illustrated in three empirical case studies that investigated business dynamics and attitudes towards climate change stressors (especially droughts) within three agricultural value chains in Jamaica (the cassava, tilapia, and ornamental fish industries).

Illustrative examples of the business network dynamics at play that influence the exposure, sensitivity, and adaptive capacity of actors were captured, and shown to affect businesses’ risk perceptions and adaptive behaviour. We found that the level of formality of business exchanges (contractual or noncontractual), levels of resource dependency, and diversification strategies to access critical resources shape business risk propagation channels and, consequently, influence actors’ exposure and sensitivity to climate risks. Actors’ exposure was also shown to be dependent on external network dynamics and risks which smaller local actors are subject to and are less able to transfer. The exposure framework applied accounted for both climatic and non-climatic risks, embedding climate hazards in broader operational concerns, and illustrating how trade-offs emerge between climate risk mitigation objectives and other business priorities.

In addition, we have shown the role exerted by bonding and bridging relational ties on adaptive capacity. Bonding (or embedded) ties were shown to affect the development of trust and collaboration between actors and to influence their ability to act collectively. Bridging ties were shown to influence access to critical resources and information exchanges between different communities of practice.

The application of a relational view of climate adaptation provides a more complete view of business adaptation in agricultural value chains. Although the focus of this study was the analysis of business-to-business relationships, studies can extend the analytic scope by examining the relationship between network structural attributes (e.g., network density, modularity, and actors’ centrality) and resilience outcomes, drawing in more technical network analysis approaches (see Canevari-Luzardo 2019, under review).

Finally, the focus on underexploited value chains and the strong engagement of local stakeholders has allowed for outputs from this analysis to advise the formulation of recommendations for the development of climate resilience value chain strategies within the three case studies of interest in Jamaica. Similar problem-oriented research endeavours should be encouraged in other agricultural value chains worldwide, in support of the further development of science-based adaptive decision-making processes.

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SUPPORTING INFORMATION
Additional supporting information may be found online in the Supporting Information section at the end of the article.

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