

Business model responses to exogenous supply-side shocks

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ABSTRACT

Business models (BMs) represent a firm's strategic and operational choices to create solutions and extract value from targeted markets. BMs were therefore required to have an inherent adaptive ability for changes to the business environment. Exogenous supply-side shocks often led to broad and non-uniform changes to target markets and supply-chains, and therefore impacted firm BMs. This research effort examined factors that influenced business model change (BMC) in response to the exogenous and supply-side oriented Covid crisis. In doing so, it sought to expand the range of explanatory factors for firm BMC responses to crises. The research responded to academic calls to broaden the BM literature with empirical research using BMC as the dependent variable and for further research on BMC responses to crises. Using the population of JSE-listed companies, the research applied a quantitative approach that examined BMC relationships with (a) the persistence of the Covid shock, (b) reductions in income of primary customers, and (c) pre-Covid increases in inventory levels. In the context of the research setting, the research found statistically significant support for the positive linkage of firm BMC with the persistence of the Covid shock, both on a standalone basis and when combined with the reductions in customer incomes. The research findings therefore contributed to the developing literature on firm BMC responses to crisis conditions.

KEYWORDS

Business model, business model change, exogenous supply-side shock, persistence of shock, supply chain resilience

DECLARATION

I declare that this research project is my own work. It is submitted in partial fulfilment of the requirements for the degree of Master of Philosophy in Corporate Strategy at the Gordon Institute of Business Science, University of Pretoria. It has not been submitted before for any degree or examination in any other University. I further declare that I have obtained the necessary authorisation and consent to carry out this research.

Name & Surname

Signature

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1. CHAPTER 1: INTRODUCTION TO THE RESEARCH PROBLEM

1.1 Business models

1.1.1 Positioning business models

A firm's business model (BM) connected a firm's identified area of opportunity with the organisation of their value creation and delivery capabilities (Teece, 2010). In so doing, the BM represented a simplification of the firm's operations towards generating stakeholder returns (Bidmon & Knab, 2018). The BM thus encapsulated the relevant arrangement of firm activities to extract value from identified markets or opportunities. Although not all firms articulated their BM, a BM was present in every firm (Bidmon & Knab, 2018; Chesbrough, 2007a).

1.1.2 Business model change

As BMs were developed for specific opportunities or markets, it was important that firms had the capability to change their BMs to adjust for changing operating environment contexts (Fjeldstad & Snow, 2018; Teece, 2010). Businesses had continued to face dynamic operating environments that sometimes shifted at an evolutionary pace and sometimes through rapid disruptions. There was evidence that firms that were capable of adapting their BMs to shifts in market conditions, were generally more competitive (Hsu, Kovács, & Koçak, 2019). However, BMs were generally difficult to change (Broekhuizen, Bakker, & Postma, 2018). Changing a BM was a challenge for managers (Schneider, 2019) as extant BMs exhibited inertia due to existing interrelationships between components (Mehrizi & Lashkarbolouki, 2016; Saebi, Lien, & Foss, 2017; Snihur & Wiklund, 2019).

The research on BM changes demonstrated that periods of threat or crisis were considered as catalysts for changes to BMs (Saebi et al., 2017; Snihur & Zott, 2020), where BMs followed either exploitative or explorative BM changes (Osiyevskyy & Dewald, 2018). However, research also showed that firms could exhibit risk aversion when facing a threat (Kreiser, Anderson, Kuratko, & Marino, 2019) and rather seek familiarity (Brenk, Lüttgens, Diener, & Piller, 2019; Staw, Sandelands, & Dutton, 1981). When facing the effects of a crisis, firms could therefore have retained their extant BM or decided to change the BM. Research contributing empirical findings in the space of BM change was required to enhance the understanding of BM dynamics (Wirtz, Pistoia, Ullrich, & Göttel, 2016).

1.2 The Covid crisis

1.2.1 A recap of the last global crisis that firms faced

The 2008 global financial crisis (GFC) emerged as an endogenous financial sector shock from within the United States (U.S.) (Strauss-Kahn, 2020). Financially engineering risky residential real-estate loans transformed them into lower-risk financial instruments that were distributed throughout the global financial system (Strauss-Kahn, 2020). Increasing U.S. customer defaults on residential mortgage loans led to sharp declines in U.S. residential property values and as investors simultaneously sought to exit risky assets, a contagion effect drove global asset prices lower (Danielson, Macrae, Vayanos, & Zigrand, 2020). The rate and scale of the drop in asset prices resulted in a market liquidity and banking capital crisis, as well as a demand shock that was primarily driven by a decreasing wealth effect (Danielson et al., 2020). Notwithstanding synchronised levels of regulatory interventions to maintain market liquidity and economic activity, a global recession ensued (Danielson et al., 2020; Strauss-Kahn, 2020). Customer and supplier markets remained open through the GFC and customer movement was unrestricted, but there was a drop in consumer demand primarily due to decreasing wealth levels. Hence firms had to review their BMs and the underlying demand assumptions as the GFC dampened demand and drove recessionary conditions (Saebi et al., 2017).

1.2.2 The unique characteristics of the Covid crisis

The Covid-19 pandemic (hereinafter referred to as the Covid crisis) was “threatening the survival of firms at a global scale, with potentially devastating societal and economic outcomes” (Wenzel, Stanske, & Lieberman, 2020, Abstract section, para. 1). In contrast to the GFC, the Covid crisis was exogenous in nature to many industries and negatively impacted the real economy directly (Danielson et al., 2020; Euromonitor International, 2020). The Covid crisis represented a significant supply-side shock (Euromonitor International, 2020; Lin & Lanng, 2020; Strauss-Kahn, 2020) but its global impact was significantly swifter than the GFC (Roubini, 2020). In attempting to respond, governments around the globe initiated social distancing and economic lockdown protocols to slow down the virus transmission.

1.2.3 The challenges of the Covid crisis for firms

The resulting consumer and business restrictions led to the emergence of a concurrent demand shock (Lin & Lanng, 2020; Strauss-Kahn, 2020), primarily from income reduction, supply chain disruptions and consumer mobility effects. The rapid rate and scale of disruption across society and the economy (Lin & Lanng, 2020) combined with the uncertainty of the timing and shape of the economic recovery (Euromonitor

International, 2020; Roubini, 2020) meant that firm BMs faced a significant stress test. From a timing dimension, the general market guidance advised businesses to expect a protracted disruption. Of specific relevance was the guidance that the effect of the pandemic was likely to cause permanent shifts in customer demands and channel preferences, while firms would also need to review their workforce policies in light of the remote working conditions that were thrust upon employees (McKinsey & Company, 2020). Therefore, considering that BMs were built to allow firms to leverage value opportunities, these shifts may have warranted a review of firm BMs in response to the Covid pandemic disruptions. A further degree of complexity that firms had to manage was that different governments responded at different speeds, so that supplier and destination markets were at different stages of economic activity. In South Africa, government social distancing and lockdown measures to slow virus transmission had negatively impacted business activity and consequently led to negative economic growth forecasts (South African Reserve Bank, 2020b). In contrast with the GFC, the Covid crisis had resulted in significant supply chain disruptions, legislated reductions in economic activity and a reduced consumer and business income effect from restrictions on economic activity.

The actions taken to curb the spread of the Covid pandemic had also significantly impacted consumers and businesses in terms of income. Restrictions in trade meant that many businesses could not operate and had to lay-off staff. Roubini (2020) positioned that the predicted unemployment level in the United States as a result of Covid may end at a higher level than the Great Depression. In South Africa, National Treasury (2020) noted that there would be elevated unemployment (and therefore a reduction or complete loss of income) for semi-skilled workers, while businesses faced lower demand as well as lost production and associated revenues. Therefore, as consumers and businesses faced income stresses during the Covid crisis, firms were likely to review their BMs to align their value propositions to a more stressed customer base.

The Covid pandemic resulted in a major disruption to, and in some cases a shutdown of, global trade and investments (Lin & Lanng, 2020). During the early stages of the pandemic, the economy faced uncertainty with respect to the resumption of supply chains (Lin & Lanng, 2020). This was due to the significant reduction in global trade activity from the impact of legislative restrictions (Lin & Lanng, 2020), as well as uncertainty on the shifts and levels of consumer demand (Lin & Lanng, 2020; McKinsey & Company, 2020). Seric and Winkler (2020) had noted that even prior to the Covid pandemic, global firms had been investing in reducing supply chain risks. However, Lin and Lanng (2020) noted that many firms were facing a solvency crisis as the disruption

in integrated global supply chains resulted in non-payment for goods or services that were promised but were unable to be delivered. As firms faced up to the supply chain challenges brought about by the Covid crisis, they relied on their prior decisions to build forms of supply chain resilience to help them weather the storm relative to their peers. For the unique nature of the Covid crisis, it was possible that supply chains that were built on lean principles would be exposed (Lin & Lanng, 2020), and therefore it may have been that redundancy-based supply chains that favoured actions like increasing inventory levels or strategic stockpiling provided an advantage to firms. As the supply chain formed an important BM component, it was therefore of interest to understand whether firm BM change decisions were affected by their pre-Covid investments in inventory.

1.3 Business models and crisis conditions

Business model adaptation referred to deliberate firm actions that realigned their BM to external environmental conditions while business model innovation referred to instances where deliberate disruption took place (Saebi et al., 2017). Saebi, Lien, and Foss (2017) utilised the GFC as context and leveraged prospect and threat-rigidity theories to demonstrate that firms were more likely to engage in BM adaptation when they were facing conditions of threat and were strategically oriented towards market development. The primary interest of Saebi et al. (2017) was in non-financial firm BM responses to the GFC and they therefore excluded financial sectors and other sectors that may have had direct government support.

The Saebi et al. (2017) study conceptualised the firm BM along the dimensions of value proposition, target markets, value delivery architecture and value capture methods. Using BM adaptation as the dependent variable, they argued that a change in some or all of the dimensions would constitute a change in a firm's BM. Saebi et al. (2017) considered the firm's supply chain within the value delivery architecture. While the Saebi et al. (2017) study focussed on BM adaptation, the literature had shown levels of overlap with the definitions of BM adaptation and BM innovation (Fjeldstad & Snow, 2018; Geissdoerfer, Vladimirova, & Evans, 2018) such that they could both be reasonably considered to demonstrate BM change (BMC).

1.4 Positioning the research problem

The Saebi et al. (2017) model was based on firm BM responses to the GFC. However, the range of choices available to firms in an exogenous supply-side shock were likely to be different from a demand shock. As an example, in testing for changes to a firm's value delivery architecture, Saebi et al. (2017) sought evidence of firms strengthening

partnership networks, broadening supplier bases or pursuing reorganisation activities. These change options were reasonable for firms to consider within the demand shock context of the GFC, as customer and supplier markets were operational with no limitations on economic activity. However, it was unclear whether these value delivery architecture options were available to firms in a supply-side shock crisis.

As businesses confronted the challenges of the Covid crisis, they had to consider and assess choices that impacted the manner in which they created, delivered and ultimately captured value. In doing so, they were actively reviewing their extant BMs and making choices that could have evidenced BMC.

2. Theory and literature review	3. Research hypotheses	4. Research methodology	5. Results	6. Discussion	7. Conclusion
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2.2 Business model responses to crisis conditions	3.2 The identified research gap	4.2 Population	5.2 Descriptive statistics	6.2 Reviewing the research population	7.2 Research contribution
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		4.10 Validity and reliability			
		4.11 Limitations of the research design			

Figure 1: Outline of remaining document

Source: By Author

It was therefore relevant to examine firm BMC responses to the idiosyncrasies of the Covid crisis, as characterised by the exogenous supply-side shock. Figure 1 outlines the structure and key topics addressed in examining firm BMC responses to the exogenous supply-side shock, with a review of the extant BM literature following.

2. CHAPTER 2: THEORY AND LITERATURE REVIEW

This chapter demonstrates the development of the research problem and supporting hypotheses through the “analysis, critical evaluation and synthesis of existing knowledge” (Hart, 2018, p. 3) in the area of research interest. As outlined in Figure 2 below, it has been structured to review the BM research history and definitions, discusses the emergence of research interest in dynamic business models and examines BM responses to crisis conditions. This was followed by a discussion on supply chain resilience before positioning the resulting research problem that emerged from the literature review and the articulation of the linked research hypotheses.

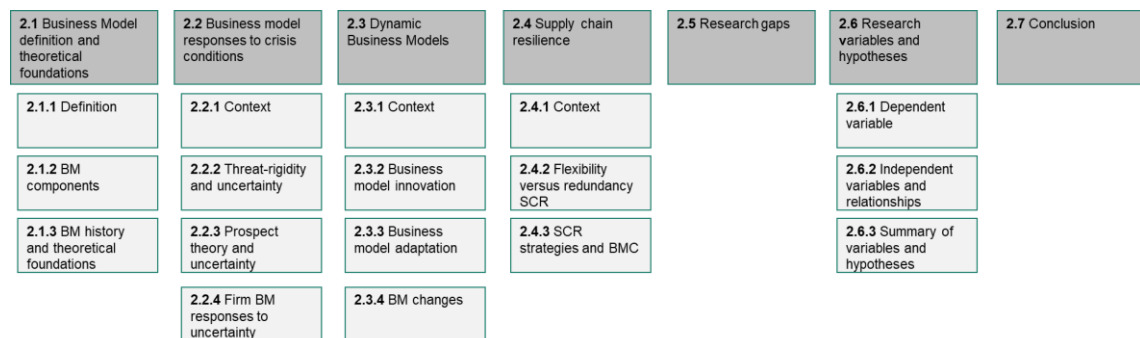


Figure 2: Map of theory and literature review section

Source: By Author

2.1 Business model definition, history and theoretical foundations

2.1.1 Definition

A business model represented the holistic arrangement of interconnected components that firms utilised to create, deliver and extract value (Teece, 2018; Wirtz et al., 2016). Chesbrough (2002) positioned that a “successful business model creates a heuristic logic that connects technical potential with the realization of economic value” (p. 529). Six dimensions of a BM were put forward by Chesbrough (2002) that assisted with the definition of a BM (a) value proposition, (b) target market, (c) value chain, (d) financial, (e) relative value chain positioning, and (f) competitive strategy. Hence, the dimensions of value proposition, target market and value chain could be considered the value creation architecture, while financial, relative value chain positioning and competitive strategy could be considered the value delivery and capture architecture of the BM.

However, despite multiple research efforts into business models (BMs) the development of theoretical foundations was hindered by the lack of a clear definition (Ritter & Lettl, 2018; Wirtz et al., 2016). Foss and Saebi (2018) similarly found a broad array of BM

definitions in BM research efforts that included (a) transactional dynamics; (b) bridging value potential with value realisation; (c) orchestration of strategy, governance and economic variables towards creating competitive advantage; and (d) boundary spanning activity dependencies. Teece (2010) positioned the BM as organisational and financial architecture that allowed a business to create customer value, induced customer transactions and generated profits. Ritter and Lettl (2018) identified five different BM perspectives as (a) activities, (b) logics, (c) archetypes, (d) elements, and (e) alignments. Bidmon and Knab (2018) noted that there were complex relationships within and between the BM components and their arrangement for creating, delivering and capturing value. McDonald and Eisenhardt (2019) elaborated on the business model definition as “granular systems of specific activities” (p. 2) where two closely related systems of value proposition and activity, combined to create and deliver value to customers. An “intertwined revenue model” (McDonald & Eisenhardt, 2019, p. 2) then provided the enabling mechanism for value capture to the firm. While organisational design had been noted as a possible component of a BM (Fjeldstad & Snow, 2018), BMs were not purely representations of organisational forms (Teece, 2010).

Prior research on BMs had nuanced adjustments in defining the BM, likely due to the BM being used across various research disciplines and lacking a clear theoretical foundation. Therefore, while there had been many attempts at defining the BM, it served to obfuscate the phenomena of interest further (Foss & Saebi, 2018). However, the key elements that had appeared relatively commonly in defining the BM were (a) strategic choices related to firm value considerations, (b) connecting customer or market opportunity with firm activity choices, and (c) arrangement of interconnected activities towards final value capture mechanisms (Wirtz et al., 2016). BMs therefore provided a clear description of what the business actually did in seeking to create and subsequently capture value (Spieth, Schneider, Clauss, & Eichenberg, 2019; Teece, 2010). Foss and Saebi (2018) agreed with the Teece (2010) architecture view of a firm’s ability to create, deliver and capture value, as the appropriate construct of BM and BM innovation that offered the most unifying definition of the BM theories.

For the purpose of the research report, the BM was therefore defined as the architectural linkage of a firm’s targeted markets to the value creation, distribution and capture activities together with their inter-relations (Saebi et al., 2017). The BM definition was selected to highlight its permeating role in linking firm value activities to markets – a linkage that was important to address the dynamic dimension of BMs.

2.1.2 BM components

BM conceptualisation had developed primarily along the avenues of (a) arrangement of inter-connected but aggregated BM elements, and (b) “systemic structures of activities that create value” (Spieth et al., 2019, p. 428). Teece (2010) noted that BM design needed “creativity, insight and a good deal of customer, competitor and supplier information and intelligence” (p. 187), and it stood to reason that a differentiated BM could itself have been a source or competitive advantage (Broekhuizen et al., 2018; Viswanadham, 2018). This was possible when the arrangement of the inter-relations of BM factors within the firm were simultaneously effective and efficient in value creation and capture but were not easily imitable (Teece, 2010). Importantly, Teece (2010) further noted that although company structure could be an element of BMs, the terms were not inter-changeable. Viswanadham (2018) explicitly positioned the supply chain network as one of the eight pillars in his conceptualisation of the BM.

Ritter and Pedersen (2020) positioned the core BM elements as (a) customer, (b) value proposition, (c) value demonstration, and (d) capabilities. The inclusion of capabilities by Ritter and Pedersen (2020) as a direct element of the BM was recognition for the importance of the management of the interconnectedness of the BM elements. Effectively, the literature had indicated that the core components of a firm’s BM conceptualised the development of a value proposition (the promise to the customer), the effective and efficient delivery of the promised proposition, and the ability to generate a profit from the process (Wirtz et al., 2016). This simplified down to value proposition, creation and capture (Chesbrough, 2002, 2007a; Foss & Saebi, 2018; McDonald & Eisenhardt, 2019; Spieth et al., 2019; Teece, 2010), with the supply chain considered within the value creation dimension of the BM (Viswanadham, 2018).

Ritter and Pedersen (2020) noted that it was the alignment of the BM components that influenced the effectiveness of the overall BM. This was because the BM components were interconnected, so that alignment of firm BM components ensured “that the right customers are exposed to the right value demonstrations and that customers buy the optimal mix of value propositions” (Ritter & Pedersen, 2020, p. 216).

2.1.3 BM history and theoretical foundations

2.1.3.1 BM history

“Business models matter. A better business model often will beat a better idea or technology” (Chesbrough, 2007a, p. 12). The BM concept emerged during the rise of internet and technology companies and was influenced by commercial market dynamics (Laasch, 2018). The BM concept enabled technology entrepreneurs to simplify their

novel and complex entrepreneurial ideas for investors (Geissdoerfer et al., 2018). Chesbrough (2002) positioned the BM as a framework that enabled firms to extract economic value from technological innovation, acting “as a focusing device that mediates between technology development and economic value creation” (p. 532).

Business models (BMs) were generally interpreted activities composed of interdependent firm activities (Markides & Sosa, 2013), that provided “a simplified and aggregated representation of the relevant activities” (Wirtz et al., 2016, p. 41) of a firm. BMs therefore provided a collated mapping of the firm’s efforts to create, distribute and capture value (Teece, 2018) and was thus a conceptual representation of the interacting firm activities that connected customer needs and expectations with the firm’s organisation of its capabilities (Teece, 2010). Laasch (2018) later proposed a conceptual model of inter-related homogeneous and heterogeneous organisational value logics that allowed the traditional commercial value logic of BMs to be extended to part-commercial or non-profit firms. Therefore, as Chesbrough (2007a) stated “Every company has a business model, whether they articulate it or not” (p. 12).

The specific choices that a firm made on how their BM components interacted, determined the overall performance of the business model, therefore implying that different firms could have had the same access to resources, but utilised them differently so that they had different business models (Markides & Sosa, 2013; Teece, 2018). A firm’s choice of BM logically meant that it refined its efforts to those that it deemed most valuable, and therefore actively constrained the remaining set of choices available to the firm (Chesbrough, 2002), especially if the chosen BM had historically been successful (Mehrizi & Lashkarbolouki, 2016; Saebi et al., 2017; Snihur & Wiklund, 2019).

Snihur and Tarzijan (2018) noted that organisations may have had multiple BMs operating concurrently, although academics still “know little about the challenges of managing a BM portfolio in one organization” (p. 50). Sharing activities, strategic partners and redeployment or resource allocation were key considerations when firms had to manage multiple BMs and this complexity could have acted as a barrier to competitive imitation (Snihur & Tarzijan, 2018). BMs had therefore been positioned as a competitive differentiator for firms (Broekhuizen et al., 2018; Viswanadham, 2018) as differentiated, effectual and hard to imitate BMs were more likely to be sustainably profitable (Geissdoerfer et al., 2018; Teece, 2010).

The lack of a clearly articulated BM definition had earlier led to criticism of the BM concept, however subsequent academic research had established a more standardised understanding of the BM (Wirtz et al., 2016). Elaborating on the importance of the

business model, McDonald and Eisenhardt (2019) positioned the BM as “theoretically and practically important” (p. 2) and the absence of a business model differentiated commercial efforts that experienced short term performance at the expense of overall business sustainability. Firms needed the ability to adapt effectively to changing customer preferences to outperform competitors in dynamic market conditions (Hsu et al., 2019). Hence, there was increasing consensus in the literature that firms should have a dynamic capability to change their BMs for changing market conditions.

The BM literature evidenced a wide range of uses of the BM concept that in part hindered early understanding of the concept, with criticism that the concept was overly broad to be particularly meaningful (Downs & Velamuri, 2018; Foss & Saebi, 2018; Wirtz et al., 2016). More recently however, the BM concept grew in both academic and practical significance (Wirtz et al., 2016). However, Foss and Saebi (2018) positioned that there was a need to understand the antecedents that stimulated BM change, especially in periods of crisis. This was specifically relevant for the context of an exogenous supply-side shock, as much of the prior BM research related to demand-side shocks (Saebi et al., 2017).

2.1.3.2 BM theoretical foundations

Chesbrough (2002) foresaw the difficulties that the BM concept would face in academic focus, noting “that it draws from and integrates a variety of academic and functional disciplines, gaining prominence in none” (p. 533). While the BM term had been in use for a long time, it had no clear theoretical origins (Wirtz et al., 2016) and the BM literature was still at a very early stage of development (Fjeldstad & Snow, 2018). BMs were an “interdisciplinary topic” (Teece, 2010, p. 176) with no “theoretical grounding in economics or business studies” (Teece, 2010, p. 175), where the underlying role of BMs was generally assumed. BMs also lacked a foundational base in organisational, strategic or marketing theory (Teece, 2010). Foss and Saebi (2018) stated that there was a distinct lack of cumulative theory on BMs, due to the lack of “construct clarity” (Foss & Saebi, 2018, p. 9) and non-agreement on definitions, thereby aligning with Wirtz et al.’s (2016) positioning that the varied contextual usage of BMs had contributed to the lack of clarity on the definition. Snihur and Tarzijan (2018) added to the research efforts in the “business model, corporate strategy, and organizational design literatures” (p. 51) when they considered firms with a portfolio of BMs. However, Ritter and Lettl (2018) linked the extant BM perspectives to the strategic management literature, because they believed that BMs played an important connecting or enabling role across strategic literature streams. Over time, the BM literature consolidated in the three key orientations of (a) technology, (b) organisation, and (c) strategy (Wirtz et al., 2016).

Academic literature also debated whether there was a fundamental difference between strategy and a BM. More recent literature indicated that these were separate constructs, with the BM usually following strategy as the implementation force for capturing value (Wirtz et al., 2016). Priem, Wenzel, and Koch (2018) positioned the BM as a connecting concept that enhanced strategy formulation as it “links resource-side and demand-side strategy research, thereby contributing to a more holistic understanding of strategy-making” (p. 23). This was useful as it pointed to direct academic interest in both upstream (resources) and downstream (consumer demand) value chain interactions (Priem, Wenzel, & Koch, 2018). McDonald and Eisenhardt (2019) contributed academically “at the nexus of organization theory, strategy, and entrepreneurship” (p. 3), contributing “a process in which cognition, action, and timing intersect to enable entrepreneurs to design a business model effectively” (p.3). McDonald and Eisenhardt (2019) introduced BM processes as a theory that complemented organisational theory for understanding firm operations that developed firm value creation practices. The BM focal point had also evolved from a technology and process perspective to a firm and industry level perspective (Wirtz et al., 2016).

The BM concept had not explicitly developed from within any particular theoretical base. Rather, it had been used by academics and practitioners as required to support their efforts (Foss & Saebi, 2018; Wirtz et al., 2016) resulting in it contributing to and drawing from many theoretical foundations. Indeed, Priem et al. (2018) noted that the unique characteristic of BMs “is that it simultaneously draws scholarly attention to *both* value creation *and* value capture” (p. 26). Hence, while the diversity in the utilisation of the BM made it difficult to develop cumulative theory (Foss & Saebi, 2018), the core value that has emanated from BM research was the ability to connect existing theories, rather than developing a BM theory (Ritter & Lettl, 2018).

2.2 Business model responses to crisis conditions

2.2.1 Context

“Unexpected events and abrupt changes often surprise organizations” (Linnenluecke, 2017). Knight (1921) argued for the distinction between risk and uncertainty. Risk retained a statistically quantifiable nature even for seemingly unlikely possibilities, while uncertainty was restricted for unknown and non-quantifiable possibilities (Knight, 1921).

A long-standing contextualisation of crisis considered three dimensions of (a) threat to firm survival, (b) limited time and space for decision making, and (c) event shock (Billings, Milburn, & Schaalman, 1980). Staw, Sandelands, and Dutton (1981) challenged this view due to lack of empirical support and positioned threat to firm survival as the key

dimension that indicated a crisis for a firm, whereby “most research has shown a simple, direct effect of the extent of potential loss upon perception of a crisis” (p. 512). While financial risk usually drove firms to action and market disruptions of technological innovation usually drove both explorative and exploitative BM innovation actions by firms (Kaulio, Thorén, & Rohrbeck, 2017), Chesbrough (2007a, 2010) noted that firms should have pre-emptively developed the ability to adjust their BMs. Schoemaker, Heaton, and Teece (2018) noted that innovating a BM was a requirement for firms to perform well in volatile, uncertain, complex and ambiguous conditions.

In conditions of uncertainty, Thompson and MacMillan (2010) positioned that feedback-loop oriented actions were preferred to inaction. When combined with an exploratory mindset, actions during periods of uncertainty worked to enable the transformation of uncertainty and ambiguity into risk and allowed for innovative BMs to emerge (Thompson & MacMillan, 2010). Saebi et al. (2017) used threat-rigidity and prospect theory as foundational theories to test firm BM adaptation responses to threats and opportunities, finding “that an external threat in the business environment is a strong predictor of business model adaptation” (p. 576).

2.2.2 Threat-rigidity and uncertainty

The inability of firms to respond to environmental changes had been a factor in many corporate failures (Staw et al., 1981). Threat-rigidity was positioned by Staw et al. (1981) to explain the constriction of information and control, through predominantly internally focussed actions that firms exhibited when faced with threat conditions. The restriction of information and control, predominantly through centralisation, was understandable as individuals and firms generally sought the comfort of past experience as they attempted to ensure a uniform response to the threat (Brenk et al., 2019; Staw et al., 1981).

Chesbrough (2007b) observed that even in stable conditions, firms would “struggle with concepts that require an unfamiliar configuration of assets, resources and positions” (p. 23). Therefore, firms facing significant uncertainty in a crisis were likely to become more risk averse and exhibit less appetite for engaging in novel experimentation (Kreiser et al., 2019; Staw et al., 1981). However, the rigidity response in threat situations may be nonadaptive for the environmental context (Staw et al., 1981) and therefore could have made firms more vulnerable to any of (a) market shifts (Teece, 2010), (b) supply chain shocks, or (c) new entrants utilising innovative BMs (Markides & Sosa, 2013).

2.2.3 Prospect theory and uncertainty

Prospect theory was introduced by Kahneman and Tversky (1979) as an alternative to the economic utility perspective for "decision making under risk" (p. 263). Prospect theory

indicated that economic outcomes (gains or losses) with low probabilities were preferred with greater sensitivity (higher preference) to avoiding losses. Practically, this was demonstrated by increased risk seeking behaviour when facing losses and risk aversion when facing possible gains (Chattopadhyay, Glick, & Huber, 2001; Kahneman & Tversky, 1979; Saebi et al., 2017).

Kahneman and Tversky (1979) tested the original concept in an economic context. However, it was noted that it was likely to apply to other contexts that faced a change (positive or negative) relative to a consistent starting point (Kahneman & Tversky, 1979). In considering expected firm responses using prospect theory, Osiyevskyy and Dewald (2018) noted that changing a BM entailed significant complexity with uncertain outcomes, hence firm responses will differ significantly depending on the degree of threat to firm survival.

Faced with a crisis, firm managers were more likely to be risk seeking in an attempt to avoid significant losses and thus more likely to engage in BM change (Osiyevskyy & Dewald, 2018). While prospect theory guided that firms would be more risk seeking to avoid losses, it was of interest to examine whether firms had actively made changes to their BMs for the uniquely exogenous context of the Covid crisis.

2.2.4 Firm BM responses to uncertainty

Changing a BM in response to disruptions was difficult as firms need to balance choices for different resources, rearranging of interconnected activities and the required organisational form to support the new BM (Fjeldstad & Snow, 2018) and therefore risky too (Broekhuizen et al., 2018). However, this was a challenge that firms needed to tackle, as retaining trust in a BM that was not effective for the firm's context constricted the focus of a firm and restricted the ability and opportunity to conceptualise more relevant BM changes (Mehrizi & Lashkarbolouki, 2016).

Hacklin, Björkdahl, and Wallin (2018) analysed BM innovation in the context of industry value migration and differentiated between primary and secondary BM innovation. Primary BM innovation referred to changes to the existing BM while secondary BM innovation referred the development of a parallel BM (Hacklin, Björkdahl, & Wallin, 2018). Hacklin et al. (2018) found primary BM innovation as more effective for firms facing high value migration from their industries, further supporting earlier research that effective BMs should also contain a dynamic capability (Teece, 2010, 2018). In the context of the Covid crisis, industry value chains had largely been adversely impacted and resulted in high value migration away from firms and industries. Related back to threat-rigidity, the findings of Hacklin et al. (2018) demonstrated that relying on existing institutionalised

processes (threat-rigidity) helped to steer management attention while reducing complexity within the firm, and thereby allowed firms to navigate through conditions of high value migration. Schoemaker et al. (2018) however, made a pertinent observation in relation to firm changes of BMs in conditions of uncertainty, noting that the focus should be on experimenting with BM changes that were relevant for the firm, to allow for emergent solutions.

Snihur and Wiklund (2019) suggested that dynamically adjusting a firm BM could have been an effective means of revitalising a firm, by stimulating broader innovations and renewing both strategy and core capabilities, especially when the BM changes were enhanced with broad knowledge sources. In responding to a crisis, it therefore highlighted the opportunity for firms to experiment (Schoemaker, Heaton, & Teece, 2018) beyond their core areas of expertise (Snihur & Wiklund, 2019) as a means of discovering a new or refined BM that was more appropriate (Ritter & Pedersen, 2020; Teece, 2010). Snihur and Zott (2020) noted that economic crises could have functioned as an external stimulus for firms to engage in BM innovation as the interconnections of existing BM components were affected by periods of crisis (Ritter & Pedersen, 2020).

The literature demonstrated support for firms adjusting their extant BMs as an effective response to crisis conditions, but there was also support for focussing on the extant BM. While the literature review highlighted increasing focus on the dynamic dimension of BMs (Wirtz, et al, 2016), it also highlighted that research into antecedents of BMC was a developing field (Foss & Saebi, 2017). The Covid crisis had created conditions of uncertainty for firms and introduced significant risks to firm survival. In those conditions of risk and uncertainty, it was of interest to examine whether firms acted to change their BMs or indeed whether firms that had engaged in pre-crisis attempts to mitigate supply chain risk had been less inclined to engage in BMC.

2.3 Dynamic business models

2.3.1 Context

Teece (2010) stated that a BM made assumptions about customer needs but noted that customer needs were prone to shift due to changes in preferences, underlying economics shifts, or cultural factors. Firms therefore required an inherent capability to improve BMs, as the ability to capture value would be adversely affected otherwise (Teece, 2010). Hsu, Kovács, and Koçak (2019) found that the strongest competitors in a market were those firms with the ability to synchronise their business positioning relative to changing market preferences. Fjeldstad and Snow (2018) positioned an operational and dynamic perspective on BMs as the two dominant debates in BM

literature. The operational perspective referenced the extant firm BM that encompassed the existing firm activities towards value creation and capture, while the dynamic perspective referred to the firm's ability to refine its BM in response to contextual changes (Fjeldstad & Snow, 2018). Saebi et al. (2017) noted that the focus of BM research had transitioned from a static perspective of BMs "towards a more dynamic view that examines phenomena like business model innovation and adaptation" (p. 568).

The ability of a firm to capture value effectively was hindered when the firm did not invest in developing institutional space for changing their BM (Teece, 2010). Wirtz, Pistoia, Ullrich, and Göttel (2016) observed that firms needed to actively scrutinize their BMs to maintain current or to develop further competitive advantage. This was especially important for established firms, as late entrants had the option to use innovative BMs to challenge and swiftly overcome incumbent market positions (Markides & Sosa, 2013). As firm BMs were developed to exploit value pockets from addressing a particular client or societal need, it was important for firms to be aware of changes to the underlying value pockets and be capable of adjusting appropriately (Teece, 2010). Importantly, the BM can be changed independently of or concurrently with operational and product refinements (Snihur & Wiklund, 2019). However, having noted the importance of firms having the ability to change their BMs, Foss and Saebi (2018) concluded that there was insufficient empirical evidence to definitively state that changes to a BM led to better firm outcomes.

Dynamic BM descriptions from reviewed literature ranged from the relatively incremental BM evolution (marginal refining of existing BM elements) through to radical BM innovation (novel interconnection of BM elements) (Saebi et al., 2017). Similarly, Osiyevskyy and Dewald (2018) positioned exploitative BM change as refinements "along the established trajectory that provided past success" (p. 540) and explorative BM change as "bringing wholesale change to the way value is created and monetized" (p. 540). However, other authors had considered a broader positioning of dynamic BMs, particularly in relation to BM innovation. Fjeldstad and Snow (2018) positioned BM innovation as "when firms improve their existing business models or introduce new ones" (p. 36) thereby encompassing evolutionary and radical change dynamics. Also using a broad definition for BM innovation that incorporated both refinements to existing and creation of replacement BMs, von Delft, Kortmann, Gelhard, and Pisani (2019) noted that "research on business model innovation is still in its infancy" (p. 3), indicating a need for further research into BM.

Hence for firm BMs to maintain sustainable performance they were required to be dynamic, allowing for the identification of market shifts (Hsu et al., 2019; Teece, 2010;

Wirtz et al., 2016) and the capability to effect BM change (Teece, 2010). The BM change could be internally induced and focussed on efficiency and refinements of existing activities, or externally oriented such that novelty and an exploratory approach was favoured (Osiyevskyy & Dewald, 2018). Importantly, even when firms had developed BM change capabilities for their extant BM, firm managers may have found that they did not have sufficient control to give effect to the required BM changes when facing an external shock (Wirtz et al., 2016).

2.3.2 Business model innovation

Advancements in technology, increased access to new customers with different preferences and easing of regulations had all contributed to the increased relative importance of BM innovation (Broekhuizen et al., 2018; Casadesus-Masanell & Zhu, 2013). Foss and Saebi (2017) defined BM innovation to be “designed, novel, nontrivial changes to the key elements of a firm’s business model and/or the architecture linking these elements” (p. 201). Geissdoerfer, Vladimirova, and Evans (2018) defined BM innovation as the “transformation from one business model to another” (p. 409) and noted that BM innovation “can affect the entire business model or individual or a combination of its elements” (p. 409). Notwithstanding the growing academic and practical interest in BM innovation, Foss and Saebi (2017) noted that the extant BM innovation research was divided in the perception of BM innovation as either a process or an outcome.

Fjeldstad and Snow (2018) positioned BM innovation as an alignment of firm BM elements to its operating environment, indicating the dynamic characteristic required for BM innovation. However, Schneider (2019) noted that external changes were not a pre-condition for BM innovation. Foss and Saebi (2018) positioned complementarity as the key dimension of BM innovation, offering a typology that considered BM innovation along the dimensions of novelty (to firm or industry) and scope (modular versus architectural). Casadesus-Masanell and Zhu (2013) considered BM innovation as “the search for new logics of the firm and new ways to create and capture value for its stakeholders” (p. 464). Fjeldstad and Snow (2018) however positioned value configuration as a contingent variable for BM and BM innovation. Noting the scarcity of empirical evidence, Foss and Saebi (2018) further noted that it was difficult to assess relationships between BM, BM innovation and firm outcomes.

According to Fjeldstad and Snow (2018), considering business model research through both operational (BM) and dynamic (BM innovation) lenses allowed for the analysis of value configuration as a contingency variable, assessing a business as a value chain,

value shop or value network. Schön (2012) positioned strategic flexibility as a firm's ability to successfully effect changes in uncertain conditions. Strategic flexibility comprised the firm's ability to be aware of external dynamics and ability to reconfigure internal processes to respond effectively (Schön, 2012). Teece (2018) built on Schön (2012) and positioned dynamic capabilities as a key element for business model design and innovation, allowing for firms to identify (sense) opportunities, commercialise (seize) ideas and transform the firm to leverage the opportunities. Dynamic capabilities for BM innovation were further highlighted as a potential competitive advantage in that it allowed firms to identify and act on opportunities faster than rivals (Schoemaker et al., 2018). Hsu et al. (2019) found that firms that were exposed to diverse customer feedback drove market attractive innovation, and Snihur and Wiklund (2019) found empirical evidence showing a relationship between successful firm BM innovation and an exploratory culture towards new information.

Clauss (2017) noted that although the BM innovation concept was gaining academic prominence, "a validated measurement scale is still not available" (p. 385). In developing a validated BM innovation scale, Clauss (2017) positioned that BM innovation occurred only if all three value dimensions of proposition, creation and capture were changed. This contrasted with Fjeldstad and Snow (2018) as well as von Delft et al. (2019) who considered BM innovation to include refinements to existing BM components. Wirtz et al. (2016) positioned that the BM innovation concept had developed through the literature to include "a more comprehensive approach and more revolutionary implications than the long-term evolutionary change of business models" (p. 45). However, Foss and Saebi (2017) noted that extant BM innovation literature did not focus materially on theories of BM innovation antecedents.

The BM innovation literature exposed differing lenses on BM innovation characterisations. Some academics had treated BM innovation as distinctly novel (Foss & Saebi, 2018) and a holistic change to the entire BM (Clauss, 2017; Wirtz et al., 2016). Others had considered that BM innovation could also be more focussed in nature (Fjeldstad & Snow, 2018; Geissdoerfer et al., 2018). The undisputed area of agreement in the BM innovation literature, was that the starting point was the extant BM.

2.3.3 Business model adaptation

BM adaptation represented incumbent BM changes in response to external stimuli, emanating from a process of environmental scanning (Dopfer, Fallahi, Kirchberger, & Gassmann, 2017; Saebi et al., 2017). It incorporated BM changes where firms adjusted their BM characteristics, components and inter-connected activities to the changing

context of their business environment (Saebi et al., 2017). Hence BM adaptation referred to deliberate firm actions to realign their BM to changing environmental conditions and “can be non-innovative” (Saebi et al., 2017, p. 569) in nature while in contrast, BM innovation referred to deliberate firm actions to innovate their BM and “disrupt market conditions” (Saebi et al., 2017, p. 569).

BM adaptation had thus been positioned in the academic literature as more evolutionary in nature than BM innovation (Foss & Saebi, 2018; Saebi et al., 2017). Downs and Velamuri (2018) positioned the importance of BM adaptation when they noted that older BMs were typically devised for specific target markets, and as such were not designed to accommodate the significant rate and scale of changes that firms now faced. BM adaptation allowed firms to retain the incumbent BM essence through the change process, while BM innovation disrupted by creating new markets or by rendering incumbent BMs obsolete (Saebi et al., 2017).

2.3.4 BM changes

The tendency of BMs to change over time posed a challenge for firm managers and BM scholars alike (Schneider, 2019). The dynamic dimension of firm BMs was thus an important aspect as failure to adjust to changing context (whether slow or rapid) directly impacted firm longevity. For incumbent firms that had been able to provide solutions to targeted markets for a period of time, changing a BM was difficult as BMs exhibited inertia due to the strength of existing BM relationships (Mehrizi & Lashkarbolouki, 2016; Saebi et al., 2017; Snihur & Wiklund, 2019). The changing external context could be multi-dimensional, from (a) shifting target market preferences and demand patterns, (b) sudden introduction of novel technologies, (c) new entrants challenging for the same target markets, or (d) disruptions to the firm supply chain. Firms responded to external stimuli through BM changes, however these responses were unlikely to be similar and there was therefore extant academic interest in researching BM changes as a dependent variable. Pati, Nandakumar, Ghobadian, Ireland, and O'Regan (2018) found that BM design especially mattered for emerging market small and medium enterprises. While mature firms appeared to benefit from focusing on making existing models more efficient, younger firms gained from differentiating their BMs (Pati, Nandakumar, Ghobadian, Ireland, & O'Regan, 2018). The Pati et al. (2018) findings highlighted that all firms needed to have a capacity to change their business models, even if the scope of change was different.

However, changing a BM was not a trivial matter (Broekhuizen et al., 2018) even when the environmental context was relatively stable. Firms needed to make strategic

decisions to transform the extant BM (Fjeldstad & Snow, 2018; Geissdoerfer et al., 2018; Schön, 2012) or to pursue a wholly novel BM (Foss & Saebi, 2018). Wirtz et al. (2016) found that BM academics considered the area of change and evolution for BMs as the area that would benefit most from further research. Therefore, understanding firm BM responses during conditions of crisis was of academic interest, given the increasing frequency of disruptions. Aligned to this logic, for the purpose of this research effort, BM change (BMC) was positioned to encompass both BM adaptation and innovation concepts. Indications of BMC were therefore identified on the basis of any changes by a firm to a part or all of their value proposition, creation, delivery or capture activities. This was also in support of the research focus on overall firm BM response to an exogenous supply-side shock.

2.4 Supply chain resilience

2.4.1 Context

The literature on dynamic BMs raised the importance of firms developing a resilience capability to respond to internal and external stimuli that could render the extant BM vulnerable. Resilience in the context of firms had become a topical focal area (Jain, Kumar, Soni, & Chandra, 2017), requiring of firms “to design resilient business models to tackle managerial and environmental disruptions of individual firms and supply chains” (Shashi, Centobelli, Cerchione, & Ertz, 2020, p. 1215). In particular, the resilience concept had gained prominence following recent disruptions, such as the global financial crisis, that had impacted the global market (Namdar, Li, Sawhney, & Pradhan, 2018).

A supply chain referred to coordinated, multi-organisational activities that enabled a focal firm to source and produce goods or services for their targeted customers (Viswanadham, 2018). Supply chains operated within an increasingly volatile global business context (Namdar et al., 2018). Pournader, Kach, and Talluri (2020) noted that academic literature in supply chain risks had “matured substantially over the past two decades” (p. 868). Supply chains had increased in complexity and many firms across the globe had suffered at least one disruption to their supply chain (Shashi et al. 2020). Firms had increasingly sought to mitigate “the impact of supply chain disruptions and develop resilient capabilities” (Azadegan, Parast, Lucianetti, Nishant, & Blackhurst, 2020, p. 39) through focusing on “the design of supply chains that are efficient while resilient to disruptions” (Kamalahmadi & Parast, 2016, p. 116).

Supply chain resilience (SCR) concerned the ability of a supply chain to (a) minimise the likelihood of supply chain disruption, (b) have in place policies and procedures to prevent the disruption from spreading, and (c) swiftly adapting to the disruptions to maintain the

integrity of the supply chain (Shashi et al., 2020). The SCR literature demonstrated that flexibility and redundancy strategies were the more prevalent SCR strategies (Kamalahmadi & Parast, 2016; Linnenluecke, 2017). As a core value creation component of firm BMs, it was of interest to examine whether SCR investments had any impact on a firm's efforts to change its BM.

2.4.2 Flexibility versus redundancy SCR

SCR strategies included flexibility and redundancy (Kamalahmadi & Parast, 2016; Linnenluecke, 2017; Shashi et al., 2020). Flexibility described resource agility such as broad supplier networks (Shashi et al., 2020) and referred to the ability of firms to swiftly adapt and dynamically respond to supply chain disruptions (Kamalahmadi & Parast, 2016). Redundancy described contingency actions such as increased inventory levels, strategic stockpiling or embedding reserve supplier networks within the supply chain design (Kamalahmadi & Parast, 2016; Shashi et al., 2020). Azadegan, Parast, Lucianetti, Nishant, and Blackhurst (2020) found that the firm's orientation towards either flexible or procedural responses influenced the ability of the firm to mitigate the impact of supply chain disruptions. Azadegan et al. (2020) noted that both responses could be effective in combating a supply chain disruption in conditions of uncertainty.

Flexibility SCR strategies were more effective in managing supply chain risk while redundancy SCR strategies were more valuable (Kamalahmadi & Parast, 2016; Shashi et al., 2020). However, Kamalahmadi and Parast (2016) noted that "the discussion on flexibility vs. redundancy is still ongoing" (p. 122). Ultimately, the choice of which SCR strategy to pursue was dependent on the firm's extant ability to manage the required reconfiguration changes (Shashi et al., 2020). With supply chains being a material component of a firm's BM, it raised the question whether firm investment in SCR impacted a firm's BMC response to an exogenous supply-side shock.

2.4.3 SCR strategies and BMC

As the business environment became globalised and supply chains became more complex, firms had to place more emphasis on understanding the concept of resilience (Jain et al., 2017). In considering the linkages of BMs and organisation design, Fjeldstad and Snow (2018) noted that value chains represented firm choices to create products from resources "and therefore the organizational design is focused on the flow of components within the supply chain" (p. 36). Any changes that impacted the supply chain of a firm therefore directly impacted the firm's overall value chain.

Jain, Kumar, Soni, and Chandra (2017) found support for including resilience characteristics in designing supply chains, while Linnenluecke (2017) noted that there

was a concentration of research efforts on supply chain design towards building firm resilience to external shocks. Wirtz et al. (2016) noted the importance of the procurement element within a BM design “since neglecting this aspect can have far-reaching consequences for other components” (p. 42). Extant supply chain research had shown a relationship between investment in SCR and the ability of firms to survive periods of crises (Macdonald, Zobel, Melnyk, & Griffis, 2018). However, the relationship between firm SCR investments and propensity for BMC in the context of crisis remained of interest.

2.5 Research gaps

Research on dynamic BMs was an emerging field that required further empirical studies, and antecedent triggers to firm BM responses continued to attract research attention (Foss & Saebi, 2018). BM researchers considered “empirical research as necessary in order to achieve a major advance in the business model field of research” (Wirtz et al., 2016, p. 50). Wirtz et al. (2016) further noted that both explanatory and exploratory methods of research would benefit the field of BM research.

There was therefore scope to contribute towards empirical dynamic BM research by providing explanatory insights on independent variables that influence BMC. While Saebi et al. (2017) found a relationship between threat conditions and firm BM adaptation responses, there were distinctive characteristics within the Covid crisis that warranted examining factors that influenced firm BMC responses to the unique supply-side shock context.

Having considered that extant BM literature positioned the supply chain as an important component of the BM (Fjeldstad & Snow, 2018; Viswanadham, 2018), investments into SCR were a related element of BM research (Linnenluecke, 2017; Wirtz et al., 2016). The SCR literature had evidenced a relationship between company survival and investments in SCR (Macdonald et al., 2018), however there was scope to examine whether there was a relationship between SCR investment and firm propensity for BMC when faced with an exogenous supply-side shock.

Based on the literature reviewed, the research problem thus sought to test explanatory factors for a firm’s BMC response within the context of an exogenous supply-side shock as characterised by the Covid-19 pandemic. This sought to provide extensions to the Saebi et al. (2017) model and broaden the understanding of the relationship of pre-shock SCR investments and BMC.

2.6. Research variables and hypotheses

Table 1 highlights the variables that were utilised to support the research problem. The distinction between independent and dependent variables are noted in Table 1 followed by a discussion of the variables and the research hypotheses.

Table 1

Variables for research effort

Independent variables	Dependent variable
Persistence of shock	Business model change
Reduction in income levels of primary customers during the Covid crisis	
Increases in pre-Covid inventory levels	

Source: By Author

2.6.1 Dependent variable

Table 2 outlines the dimensions of the BM that were examined for changes to the BM. The dependent variable was BM change (BMC), and the BM was conceptualised by the four dimensions of (a) value proposition, (b) choice of target customers, (c) value creation or delivery structure, and (d) value capture mechanisms (Saebi et al., 2017). Leveraging the work of Saebi et al. (2017), Table 2 highlights the indicators of changes in the BM dimensions. Firms were classified as having evidenced BMC in response to the Covid crisis if there were changes in at least one of the BM dimensions.

Table 2*Change indicators for BM dimensions*

BM dimension	Change indicators for responses to the Covid crisis
Value proposition ('VP')	Had the firm made changes to their existing value propositions or introduced new value propositions?
Choice of target customers ('CoTC')	Had the firm indicated an intent to pursue new markets?
Value creation / delivery structure ('VDS')	Was there evidence that the firm made adjustments to their supplier networks or relationships? Was there an effort to reduce operating expenses or restructure the business?
Value capture mechanism ('VCM')	Had the firm changed their pricing of products or services? Were new payment channels introduced?

Source: By Author

2.6.2 Independent variables and relationships

2.6.2.1 Persistence of shock

Euromonitor International (2020) flagged virus containment as the material factor in alleviating or exacerbating the economic impact of the Covid crisis. Swift containment or discovery of a vaccine would have helped economic activity to return strongly but ineffectual containment measures would have caused significant headwinds to an economic recovery (Euromonitor International, 2020; Roubini, 2020). A short shock was likely to have little impact on firms due to support from a strong economic recovery. A persistent shock however was likely to lead to ongoing uncertainty and a faltering economic recovery (Euromonitor International, 2020; Roubini, 2020). This would have threatened business survival as supplier and target markets were impacted, affecting both a firm's ability to produce and to sell its goods and services.

Governments had moved swiftly to restrict economic activity as part of pandemic containment measures (Lin & Lanng, 2020). In the South African context, the government had enforced a full lockdown of the domestic economy on the 26 March 2020 and thereafter implemented a risk-based approach to the re-opening of the economy from the 01st May 2020 (<https://www.gov.za/Coronavirus>). Under this approach, varied activities within economic sectors were allowed to operate conditional on the rate of virus transmission. The levels of economic activity allowed was therefore

intrinsically linked to the persistence of the virus. Firms were therefore more likely to seek alternative BM options if the shock persisted. The persistence of the shock was therefore likely to have an impact on a firm's BMC response to an exogenous supply-side shock.

Hypothesis 1: The longer that an exogenous shock persists, the greater the likelihood of BMC.

2.6.2.2 Reduction in income levels of primary customers during the Covid crisis

In the Covid crisis, healthy businesses were suddenly impacted by an exogenous shock and had to rely on balance sheet strength or cash reserves to survive. However, very few businesses would have been able to withstand an extended period of restricted economic activity. A survey of businesses by Statistics South Africa (2020a) found that 75.7% of businesses expected the Covid crisis to be worse than the GFC. The survey also found that 36.4% of businesses had experienced workforce layoffs, 32.9% had experienced above normal increases in input costs and 43.8% were not operating under the level four lockdown conditions (Statistics South Africa, 2020a).

At a societal level, there had been evidence of changes in consumer behaviour and spending patterns, negative effects for employment trends (Scott, 2020) and increased digital channel usage, that were likely to reshape the demand landscape (McKinsey & Company, 2020). These changes were evident in both business-to-consumer and business-to-business models (McKinsey & Company, 2020). In South Africa, Statistics South Africa (2020b) found that 15.4% of surveyed individuals reported no income by week six of the lockdown and 25.8% reported lower income than before the lockdown. Indicated coping mechanisms for the income shock were reduced spending patterns and utilising savings (Statistics South Africa, 2020b). There was therefore a reduced income impact on the target markets or primary customer bases during the Covid crisis, upon which firms had developed their extant BMs. It followed that firms would have been more likely to evidence BMC if there had been a reduction in income levels of a firm's primary customers.

Hypothesis 2: A reduction in revenues or incomes of a firm's primary customer base will lead to BMC.

2.6.2.3 Increases in pre-Covid inventory levels

Supply chains were more globally connected now than ever before (Euromonitor International, 2020). The Covid-19 virus was first noted in China and since many global supply chains had some degree of exposure to China, there was a material supply chain disruption globally (Euromonitor International, 2020; Seric & Winkler, 2020). SCR

concerned the ability of a firm to minimise the likelihood of supply chain disruptions, contain the impact and adapt quickly to maintain the integrity of the supply chain (Shashi et al., 2020). Firms that had invested in developing contingency actions such as increased inventory levels to develop a strategic stockpile of inventory would evidence investment in developing SCR (Shashi et al., 2020). Hence, while disruptions in the supply chain were likely to be a catalyst for firms to swiftly engage in BMC in response to an exogenous shock, pre-Covid crisis investments in increasing inventory levels as a SCR strategy were likely to have a relationship with a firm's BMC decision in response to the Covid crisis.

Ivanov, Dolgui, Sokolov, and Ivanova (2017) noted that developing buffers in inventory levels was a method of increasing SCR. However, Pournader et al. (2020) noted that improving SCR by increasing redundancy came at significant cost, as firms needed to decide which nodes of the supply chain to target. Ivanov et al. (2017) further observed that academic research into SCR preferred both a quantitative approach and a focus on the redundancy area of SCR. In the case of the Covid crisis, it followed that firms that had invested in a redundancy SCR strategy through increased inventory levels before the Covid pandemic, should have been better positioned to withstand an exogenous supply-side shock that disrupted global supply chains. These firms therefore should have been less likely to evidence BMC, as the additional levels of inventory would have provided a buffer to supply chain disruptions and have enabled ongoing business operations within the existing BM.

Hypothesis 3: Firms that increased inventory levels prior to the Covid crisis were less likely to evidence BMC.

While hypotheses one to three defined expected relationships between BMC and the individual independent variables, there was also consideration for the interacting effects of the independent variables. These were theorised and positioned as two further hypotheses for testing within the research effort.

2.6.2.4 Persistence of shock and reduction in income levels of primary customers

Having positioned that BMC was expected to be individually sensitive to the persistence of the shock and to reductions of income levels of primary customers, it followed that the combination of these factors would have also led to BMC. Section 2.6.2.1 and Section 2.6.2.2 outlined that both of these factors were present in the research setting. Hence it was of interest to examine whether the combination of these two independent variables impacted the firm's BMC decision. Specifically, it was expected that the combination of these independent variables would increase the likelihood of BMC.

Hypothesis 4: Exogenous shock persistence and reduction in incomes of a firm's primary customer base will increase the likelihood of BMC.

2.6.2.5 Persistence of shock and increases in pre-Covid inventory levels

Hypothesis 1 positioned the persistence of the shock as a factor that would increase the likelihood of firm BMC. However, hypothesis 3 positioned that increases in pre-Covid inventory levels of a firm were expected to indicate a lower likelihood of BMC. The nature of the South African lockdown regulations was limiting to trade activity and constrained supply chains for an extended period of time. Hence, there was the likelihood that even firms that had increased pre-Covid inventory levels may have reached a point where their BMC behaviour was similar to other firms. Therefore, it followed that there could have been interactions between the persistence of the shock and the increases in pre-Covid inventory levels that may have impacted the firm's BMC decision.

Hypothesis 5: Increases in pre-Covid inventory levels and the duration of the exogenous shock influence BMC.

2.6.3 Summary of variables and hypotheses

Section 2.6.2 provided a discussion of the independent variables for the research effort. Figure 3 represents the hypothesised relationships between the individual variables that the research sought to test, highlighting the expected direction (positive or negative) of the hypothesised relationship.

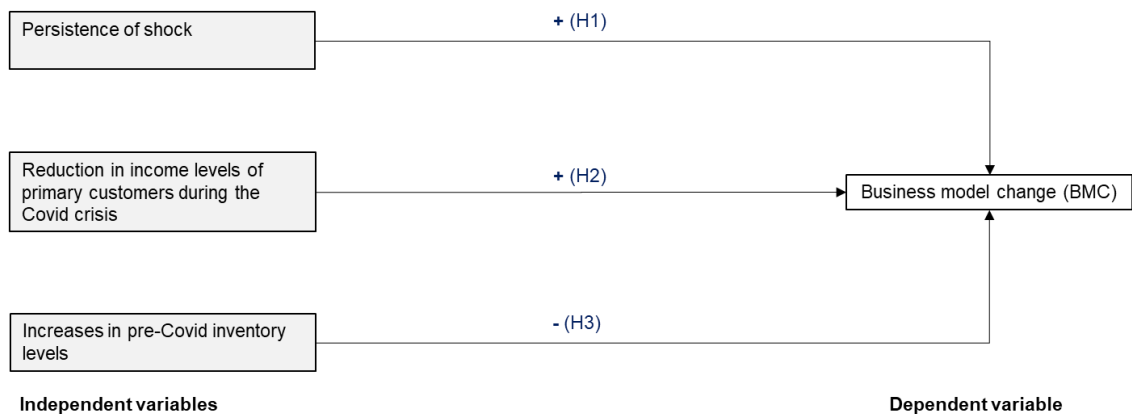


Figure 3: Variables and direction of hypothesised relationships to BMC

Source: By Author

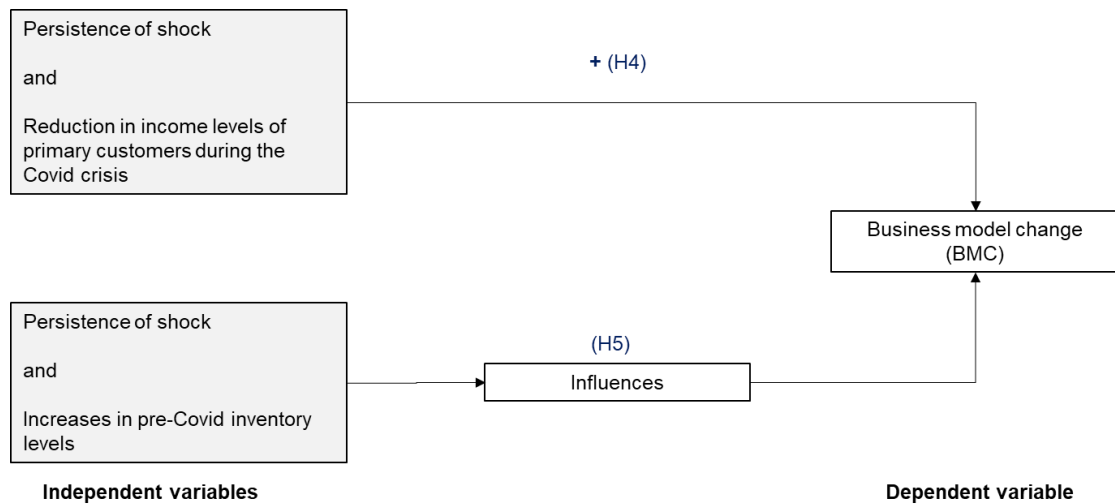


Figure 4: Related variables and hypothesised relationships to BMC

Source: By Author

Figure 4 represents the hypothesised relationships between the combination of variables and BMC. In combination, these hypotheses sought to address research gaps that emerged from the literature and theoretical review and in so doing make a research contribution to the understanding of BMC in the context of an exogenous supply-side shock.

2.7 Conclusion

Having reviewed the BM and related literature, Chapter 2 provided a discussion of the key concepts that emerged as relevant for this research effort. The BM literature positioned that a firm's BM could itself be a competitive advantage (Broekhuizen et al., 2018; Viswanadham, 2018). However, BMs were also characterised by complexity (Bidmon & Knab, 2018) and extant BMs were often difficult and risky to change (Broekhuizen et al., 2018; Fjeldstad & Snow, 2018). BMs had to have a dynamic component to respond to changes in internal or external contexts for them to be relatively successful (Hsu et al., 2019; Teece, 2010; Wirtz et al., 2016).

While there had been a wide range of conceptualisations and applications of BMs, the BM literature had been trending towards alignment on material concepts of definitions and components (Foss & Saebi, 2017; Wirtz et al., 2016). There was an ongoing need however, for further empirical studies to assist in the development of the BM body of knowledge (Wirtz et al., 2016), especially in areas that had changes to the BM as the dependent variable (Foss & Saebi, 2017). The dynamic element of BMs in conditions of threats or crises was an area that required further insights (Saebi et al., 2017).

This research effort developed five hypotheses that sought to test for explanatory insights on independent variables that may have influenced BMC decisions in response to the Covid crisis. While prior BM research had modelled firm BM responses to crises (Osiyevskyy & Dewald, 2018; Saebi et al., 2017), the distinctiveness of the Covid crisis was academically relevant as it allowed for the examination within a unique crisis context. As a result of the supply-sided nature of the Covid crisis, SCR literature was therefore also reviewed for the intersection with and implications for BMs in the Covid crisis. The development of the hypotheses was guided by the literature reviewed and considered factors that were important to the BM construct and relevant to the exogenous and supply-sided context of the Covid crisis.

The core variables of research interest within the research setting and Covid context were (a) persistence of shock, (b) reduction in customer income levels during the Covid crisis, and (c) pre-Covid increases in inventory levels. Chapter 3 summarises the research problem and outlines the hypotheses that were used in the research effort.

3. CHAPTER 3: RESEARCH HYPOTHESES

3.1 Research problem context

BM scholars noted that BMs were required to have the capability to adjust for changing contexts (Foss & Saebi, 2018; Teece, 2010). However, changing a BM could be difficult (Mehrizi & Lashkarbolouki, 2016; Saebi et al., 2017; Snihur & Wiklund, 2019) even during periods of relative stability (Chesbrough, 2007b). Changing a BM in periods of crisis was even more challenging (Broekhuizen et al., 2018; Fjeldstad & Snow, 2018) and more empirical research was required to further the understanding of the antecedents to BMC (Foss & Saebi, 2017; Wirtz et al., 2016), especially in response to crisis conditions (Saebi et al., 2017). Hence, what were the factors that influenced a firm's BMC response when faced with an exogenous supply-side shock? The research effort sought to respond to this research problem by testing explanatory factors for a firm's BMC response to a crisis within the context of an exogenous supply-side shock, as characterised by the Covid crisis.

The Covid crisis was an exogenous supply-side shock that especially exposed firms with business models that were dependent on global supply chains (Alessi, 2020; Lin & Langg, 2020; Seric & Winkler, 2020). However, the complex interconnections of national and global economies meant that firms all around the world were impacted by the Covid crisis. Firms needed to review their BMs for BMC options or solutions that were relevant to their context. However, they needed to do this within conditions of uncertainty. Post-Covid economic recovery forecasts considered the discovery of a vaccine (McKinsey & Company, 2020; Roubini, 2020) and the consequent full return to economic activity as the key factors that drove the varied range of economic recovery forecasts. However, it became clear during the second half of 2020 that there would not be a swift economic recovery and businesses globally had to brace themselves for a persistent Covid pandemic. As the Covid pandemic persisted, many countries faced second waves of increased Covid infection rates. The likelihood of a prolonged period of seasonal Covid-19 outbreaks was also a consideration, as firms had to factor further economic contractions from government containment actions (Roubini, 2020) that were likely to impact firm BMs.

The range of BMC options available to firms during the Covid crisis were likely to be constrained. As an example, in considering the change options available for the firm value delivery architecture, Saebi et al. (2017) considered three actions. However, it was unclear whether those same options were available to firms in the Covid crisis. Firstly, strengthening partnership networks may have been the preferable firm option, however

economic restrictions and the cross-sectional nature of the Covid crisis meant that firms all along the supply chain were trying to survive, possibly limiting ability of firms to pursue this option. Secondly, broadening the supplier base may not have been an option either as supplier markets were closed and import restrictions were imposed. Seeking domestic suppliers was also difficult, as economic restrictions only allowed sectors classified as essential services to operate. In contrast, engaging in firm reorganisation was reasonably considered as a cost or process efficiency dimension for the supply chain. This was likely to have been an option in this crisis as well, as firms sought to conserve cash-flow through the crisis. It followed that there was an academic gap and practitioner interest to examine firm BMC responses in the unique context of the Covid crisis for explanatory insights that enhanced the BM body of knowledge.

3.2 The identified research gap

The increasingly interconnected global economy resulted in heightened academic interest in understanding the dynamic nature of BMs (Foss & Saebi, 2018; Saebi et al., 2017; Wirtz et al., 2016) even prior to the Covid crisis. The development of cumulative theory in BM changes would have benefited from amongst others, research that sought to test and understand BM changes (Foss & Saebi, 2018). With the significant differences of the Covid crisis (a threat that was uniquely exogenous and supply-side focussed) to the last major global economic crisis (the GFC), there was a need for examining further factors that informed firm BMC responses. There was therefore academic research interest for developing greater understanding of the drivers of firm BMC decisions in the Covid crisis.

From the reviewed BM literature, it followed that persistence of the shock (the coronavirus pandemic in this context) and the reduction in primary customer base income levels during the Covid crisis were factors that were unique to the Covid crisis that could have affected a firm's BMC response. With the uniquely exogenous and supply-side nature of the Covid crisis, it was also of academic interest to examine whether SCR investments towards increased inventory levels had differentiated firm BMC responses (Ivanov, Dolgui, Sokolov, & Ivanova, 2017; Pournader, Kach, & Talluri, 2020). Having noted that increasing inventory levels could be an effective SCR strategy for disruptions in the supply chain, firms that had made pre-Covid investments into increased inventory levels should have had an inventory buffer. With the disruption to global supply chains, it therefore followed that an investment in a stock-based redundancy SCR strategy may have caused firms to differentiate their relative BMC responses.

The review of the BM literature guided the identification of variables and the development of the five research hypotheses. The hypotheses were formulated to respond to academic calls for further research into BMC and provide empirical research towards filling extant research gaps.

3.3 Hypotheses for the research effort

Hypothesis 1: The longer that an exogenous shock persists, the greater the likelihood of BMC.

Hypothesis 2: A reduction in revenues or incomes of a firm's primary customer base will lead to BMC.

Hypothesis 3: Firms that increased inventory levels prior to the Covid crisis were less likely to evidence BMC.

Hypothesis 4: Exogenous shock persistence and reduction in incomes of a firm's primary customer base will increase the likelihood of BMC.

Hypothesis 5: Increases in pre-Covid inventory levels and the duration of the exogenous shock influence BMC.

3.4 Research aims

The research aimed to test variables that explained firm BMC responses to threat conditions characterised by an exogenous supply-side shock. The results sought to make a research contribution by offering empirical research that furthered the understanding of BMC drivers in conditions of crisis. It also sought to contribute an extension to the Saebi et al. (2017) model of BM responses to conditions of threat, through the testing of further explanatory factors for firm BMC in the context of an exogenous supply-side shock.

4. CHAPTER 4: RESEARCH METHODOLOGY

4.1 Choice of methodology

The research problem sought to test for explanatory factors for firm BMC in response to a crisis. The theory and literature review led to the development of five hypotheses for the relationship between BMC and independent variables. Bell, Bryman, and Harley (2019) positioned quantitative research strategy as “a research strategy that emphasizes quantification in the collection and analysis of data” (p. 35). Creswell and Creswell (2018) further stated that “*Quantitative research* is an approach for testing objective **theories** by examining the relationship between variables” (p. 4). A quantitative method utilising statistical analysis and interpretation was appropriate for this research effort as the researcher sought to statistically test hypotheses on the relationship between variables (Creswell & Creswell, 2018). A quantitative research approach was therefore followed, utilising publicly available company reports and data sources to generate a cross-sectional dataset for South African listed firms.

The research approach path was informed by the researcher’s positivist worldview that valued empirical evidence as well as data accessibility considerations. Quantitative research “entails a deductive approach to the relationship between theory and research, in which the emphasis is on the testing of theories” (Bell, Bryman, & Harley, 2019, p. 35) so as “to isolate the cause(s) and assess whether and to what extent these ‘cause(s)’ result(s) in effect(s)” (Ghauri, Grønhaug, & Strange, 2020, p. 65). This was aligned to a positivist worldview with the research need to objectively identify relationships and understand causality between inputs and outcomes (Creswell & Creswell, 2018). The research need was supported with the gathering of observable data “using surveys or other instruments” (Bell et al., 2019, p. 30) that allowed for statistical analysis. The nature of the research problem sought to examine the BMC responses of firms to the Covid crisis, and therefore the ability to access reliable data was a key research design consideration.

Wirtz et al. (2016) found that a significant amount of BM research utilised quantitative research designs and noted that researchers believed that large sample empirical studies were beneficial to developing the BM research field. The choice of research approach therefore responded to calls for BM research with BM changes as the dependent variable (Foss & Saebi, 2018) and for further empirical support (Saebi et al., 2017; Wirtz et al., 2016) utilising population-based analysis.

4.2 Population

The research problem sought to empirically test relationships for variables that could have influenced BMC in response to an exogenous supply-side shock. The research was cross-sectional in nature as it gathered population data at a single point in time in order to empirically assess a characteristic of research interest (Allen, 2017). This also guided the choice of research population. Population in the research context “refers to all possible units of observation, and these units may be people, firms, products, or countries, depending upon the context of the project” (Ghauri et al., 2020, p. 161). The population for this research effort was publicly traded firms in South Africa that traded on the Johannesburg Stock Exchange (JSE). Using South Africa for the population allowed for effective testing of the variable relationships, as the exogenous factor would be common to all firms in South Africa. This was important as government interventions to contain the spread of coronavirus varied across countries. The list of firms that traded on the JSE ranged across economic industries, as noted by different JSE indices (Absa, n.d.), and firm market capitalisations. The entire population was included as the population was small and sampling would not have been appropriate. The population was relevant as the research focussed on the firm’s BM and the researcher was able to access published data on South African listed companies from reputable sources.

The research sought to examine firm BMC responses to an exogenous supply-side shock and was focussed on listed South African firms. Five hypotheses were tested in the pursuit of the research aim. The nature of the independent variables for hypothesis 1, hypothesis 2 and hypothesis 4 led the researcher to consider a range of firms across industries. Due to the exogenous nature and wide-ranging impact of the shock, it was necessary to consider firms across sectors to introduce variability within the independent variable. hypothesis 3 sought to test for the effect of supply chain resilience investments on firm BMC responses. Supply chain resilience was sought for through increased reported inventory levels that would have demonstrated a redundancy-based SCR strategy. The test for a SCR investment effect used firms that reported stock levels in their annual financial reports and therefore applied to hypothesis 5 as well. The population for testing hypothesis 1 and hypothesis 5 therefore comprised a specific subset of overall JSE firms, namely all JSE firms that consistently reported inventory levels in their prior three annual financial reports.

Beginning with the full list of JSE listed firms, the population was subjected to the following initial exclusions (a) dual-listed firms, (b) holding companies, and (c) banks. These exclusions allowed for the variables of interest to be examined while avoiding the possible introduction of stimuli that could have distorted the analysis. Excluding dual-

listed firms ensured that the effect of the independent variables was contained and examined in the South African context. Holding companies did not have underlying operations that they were directly responsible for managing and were therefore excluded. In South Africa, the Covid crisis had seen banks receiving support through stimulatory monetary policy as well as capital relief (National Treasury, 2020; South African Reserve Bank, 2020a). Those actions likely influenced any BMC responses outside of the shock stimulus, and thus banks were excluded.

The final population for this research effort therefore consisted of JSE listed firms, excluding dual-listed firms, holding companies and banks. As the research problem sought to explain firm BMC responses to the exogenous supply-side shock, further exclusions were warranted. Cases where firms had not published documents nor had Stock Exchange News Services (SENS) announcements for the period 01st March 2020 to 30th September 2020 were excluded as it was not possible to determine a dependent variable value.

4.3 Unit of analysis

The unit of analysis in a research effort referenced “the right person/group/organization to be consulted/studied” (Ghauri et al., 2020, p. 267). It was therefore important that the researcher selected an appropriate unit of analysis that enabled the researcher to effectively test their hypotheses with confidence. The research problem sought to understand firm BMC responses to an exogenous supply-side shock, therefore the unit of analysis for this research effort was the firm. This was aligned with the Saebi et al. (2017) approach. The choice of the firm as the unit of analysis was relevant as it aligned the intent of the research problem with availability and accessibility of objective firm level data.

4.4 Sampling method, sampling frame and size

Researchers employing sampling methods must have followed either a “systematic or probabilistic” (Creswell & Creswell, 2018, p. 150) or “nonprobability” (Creswell & Creswell, 2018, p. 150) approach. A non-probabilistic sampling method was effectively utilised as data for the entire population was sourced. The sampling frame referred to a subset of the population, which the researcher had identified as relevant for drawing a sample from (Allen, 2017) and was useful in assisting researchers to assess the representativeness of their sample relative to the population of interest (Ghauri et al., 2020). Representativeness was not an issue in the research effort as the population was used. Therefore, a sampling frame was not utilised for the research effort.

Utilising the Bureau van Dijk Electronic Publishing's Osiris database (Osiris) of publicly listed companies, the number of JSE listed companies as at the company list extraction date of 05th August 2020 was 283. Subsequent to the initial exclusions that were discussed earlier in Section 4.2, further exclusions that were made through the data collection and preparation process are detailed in Table 3. The final population of 88 firms was arrived at after application of all exclusion rules.

Table 3

Exclusion rules applied and final number of companies in population

Case identifier	Exclusion Rule applied	Number of records
Original cases		283
Based on Osiris data fields (167 exclusions)	Financial instruments and ETFs ^a	-21
	Main exchange not equal to JSE	-1
	Banks	-11
	Multi-exchange listed	-128
	Holding offices	-3
	BEE ^b structures (Not operating businesses)	-3
Based on Moneyweb identifiers (20 exclusions)	Firms flagged as "Delisted"	-5
	Firms flagged as "Suspended"	-10
	Investment holding companies (Manual flag)	-5
Document collection (4 exclusions)	Regulatory exclusions (Business rescue, no documents or regulatory censures)	-4
Data gathering exclusions (4 exclusions)	Investment holding company, De-listing in progress, and Holding company of existing entity in dataset	-4
Total companies		88

^a ETF = Exchange Traded Fund. ^b BEE = Black Economic Empowerment.

Source: By Author

Table 3 outlines the exclusion rules applied to the population. From the extracted population of 283 companies, 167 exclusions were made based on identifiers from the Osiris database. These rules excluded entries that related to equity instruments, multi-exchange listed companies, banks, holding companies and black economic

empowerment holding structures. For the remaining 116 companies, the researcher utilised the Moneyweb website (www.moneyweb.co.za) to gather industry classifications for each company. This resulted in 20 further exclusions for firms flagged as investment holding companies or flagged as either de-listed or suspended. The SENS data collection process yielded a further eight exclusions for firms facing regulatory actions (firm's actions were likely to have been impacted by factors other than the Covid crisis), de-listings that were in progress or investment holding companies. The final population for the research effort was therefore 88 companies.

4.5 Measurement instrument

For the dependent variable, a content analysis approach allowed for the development of a quantitative dataset from qualitative sources (Allen, 2017). Qualitative data for the dependent variable was collected prior to being coded into quantitative data for statistical analysis. A combination of qualitative and quantitative data was collected for the independent variables that enabled levels of differentiation to emerge. Therefore, there was no reference to a measurement instrument as a survey instrument was not utilised. The data sources and processes for all variables utilised in the research effort were detailed in the report.

4.6 Data gathering process

4.6.1 Nature of data

The research effort utilised public non-human data from secondary sources. Data for this research effort was generated from publicly available published company information. This was relevant for this study based on the unit of analysis, the variables of interest and data accessibility considerations.

4.6.2 Sourcing of data

The researcher first obtained ethical clearance for the research effort prior to commencing the sourcing of data. The researcher ensured that reputable data sources were utilised. TimBukOne was utilised for gathering firm level SENS announcements, company financial reports and annual reports. This source provided a reputable source of collated, public company data and therefore reliability and validity of collected company data were enhanced. The data sources were accessed using the GIBS student access, hence costs incurred were time rather than financial, while the benefit to the research effort was significant. These data sources also provided research convenience, as they allowed the researcher a common source for company-related key documents. Access to the TimBukOne and Osiris databases through the GIBS Info Central portal (<https://www.gibs.co.za/students/research-information-centre/pages/default.aspx>).

4.6.2.1 Dependent variable data sourcing

To assess the dependent variable, firm annual financial statements, annual reports and SENS notices for the period 01st March 2020 to 30th September 2020 were sourced. The first recorded coronavirus case reported in South Africa was on the 05th March 2020 (National Institute of Communicable Diseases, 2020). The South African government declared a national state of disaster on the 15th March 2020 as early Covid-19 cases emerged. As the early number of Covid-19 cases began to increase, the South African government officially legislated lockdown conditions that commenced on the 26th March 2020. However, there were already precedents of lockdowns across the globe from as early as February 2020. It was therefore likely that firms may have prepared for possible lockdown scenarios in the South African context prior to the official commencement of the national lockdown. In the context of the research effort, the temporal research window for determining changes in the dependent variable was set as 01st March 2020 to 30th September 2020. This sought to ensure that any firm BMC decisions were most likely due to the actual or expected effects of the Covid crisis, rather than regular business motives, as may have been the case prior to the temporal research window.

Using the TimBukOne platform, SENS alerts were collected for each firm in the final population. SENS alerts gathered were restricted to announcements of financial results, operational updates and specific Covid response announcements. SENS announcements that referred to general director dealings and non-operational updates (e.g. Share incentive schemes, dealings in securities) were excluded, as these did not refer to BM related activity.

The data collection of reports off TimBukOne was based on data availability. Reported annual or interim financial reports as well as annual reports were collected for firms from TimBukOne. Changes in a firm's BM or BM components, especially in listed firms would have indicated a material firm-level change. It was therefore likely that BM component changes would be communicated to shareholders, hence the financial statements and annual reports were the appropriate documents to review. Listing requirements also carried stringent rules on reporting material changes in business or financial changes. The review of formal SENS announcements relating to trading and operational updates was therefore also appropriate to review for evidence of BMC.

The initial data collection step off TimBukOne gathered documents that were made public over the period 01st March 2020 to 30th September 2020, subject to them being reported financial results, annual reports, Covid related disclosures or general business operating updates. Table 4 outlines the researcher's gathering, and filtering of firm

documents collected to obtain the final set of 273 documents that were utilised for the dependent variable dataset.

Table 4

Overview of company documents collected and used

Company documents collected by type	Count of documents gathered	Count of documents shortlisted	Count of final documents used
SENS announcements	260	260	173
Financial statements	60	57	47
Annual Integrated Report	62	53	53
Total	382	370	273

Source: By Author

From the original set of 382 documents gathered, all documents were reviewed to ensure that they were in reference to the research period of interest. Based on this review, three exclusions for financial statements and nine exclusions for annual reports were applied. The shortlisted documents were then utilised in a content analysis utilising a keyword search, that yielded further exclusion of documents that had no information related to the Covid pandemic and resulted in the final set of 273 documents. With 88 companies in the population, this resulted in an average of 3.10 documents per company. In the final population, the maximum documents utilised for a company was six (two cases) and the minimum was one (six cases). On average, there were therefore multiple documents utilised to assess the status of the dependent variable, thereby aiding in the robustness of the research effort.

4.6.2.2 Independent variables data sourcing

For the independent variables, public non-human data was gathered. The South African Government coronavirus information website (<https://www.gov.za/Coronavirus>) was utilised for measuring the persistence of the shock. Data and reports from the Statistics South Africa website (<http://www.statssa.gov.za/>) were used for the drop in income levels of the customer bases during the Covid crisis. Firm annual financial data was extracted off the Osiris database for the prior three reporting periods for measuring the firm's reported inventory levels.

4.6.3 Storage of data

All documents gathered, datasets generated, and outputs of data analyses ('research data') were stored electronically. Storage of research data adhered to all applicable GIBS

requirements. The research data was transferred to an acceptable GIBS format and submitted to GIBS through the appropriate platform, in line with the requirements.

4.7 Analysis approach

A content analysis method was applied to the documents collected and allowed for the development of a quantitative dataset from qualitative, text sources (Allen, 2017). Due to the nature of the independent variables the sourced data was segmented into economic and customer categories, to enable the identification of differentiation levels.

4.7.1 Overview of variable types

Following the gathering of the data, the researcher assessed the type of variables collected (Allen, 2017). Table 5 provides an overview of the variable types at the point of data collection. At the data analysis stage, variables were adjusted further or grouped to enable statistical testing.

Table 5

Overview of data collected by type

Variable	Numerical Measurement recorded
Business Model	Outcome variable
Change Indicator (BMC)	Descriptive (nominal) No BMC, BMC - Single dimension, BMC - multiple dimensions
Duration of industry impact (DUR)	Discrete Actual number of days that an industry was impacted by Covid lockdowns in South Africa, over the period 26 March 2020 to 30 September 2020
Reduction in customer incomes during the Covid crisis (IMP)	Discrete The estimated percentage change in income / revenue of a firm's customer base. Values were limited to a finite set of calculated values.
Percentage change in pre-Covid inventory levels (INVPERCHG)	Continuous Actual percentage change in a firm's reported level of inventory over their last three annual reporting cycles.

Source: By Author

4.8 Approach to determining the veracity of the data

Saunders, Lewis, and Thornhill (2009) guided that data sources should (a) be generally suitable for the research effort, (b) be precisely suitable for the required analyses, and (c) balance the benefits gained relative to costs incurred. In the context of this research effort, data was sourced from publicly available firm financial reports, firm annual reports

and SENS company announcements. These documents were collected for the entire population and provided the relevant information for testing the research hypotheses and therefore provided appropriate coverage and measurement validity (Allen, 2017).

4.9 Statistical tests conducted

Empirical BM studies were identified as one of the key types of research that was needed to develop the BM literature (Wirtz et al., 2016). Saebi et al. (2017) utilised a multinomial logistics regression in testing hypotheses for BM adaptation in response to threats, opportunities and strategic orientation. That was positioned as appropriate for their study, as the dependent variable was categorical and non-binary (Saebi et al., 2017).

The choice of statistical tests for this research effort was guided by the research intent and the nature of the dependent and independent variables. For this research effort, the research intent sought to examine whether firms engaged in BMC as a response to the Covid crisis and the factors that influenced the BMC decision. The dependent variable was therefore categorical and ultimately binary in nature. The explanatory variables were originally a mixture of categorical and continuous variables before data transformations were applied. The final set of independent variables were also categorical in nature.

Knapp (2018c) and Frey (2018) positioned the logistic regression model as the appropriate model for a binary dependent variable as it allowed for a wide range of explanatory variable types. The logistic regression method further considered “the relationships among the variables to provide a model that describes the (predictive) factors associated with the observed outcome” (Knapp, 2018c, p. 4). The researcher therefore utilised the logistic regression methodology for hypothesis 1 (the longer that an exogenous shock persists, the greater the likelihood of BMC), hypothesis 2 (a reduction in revenues or incomes of a firm’s primary customer base will lead to BMC), hypothesis 4 (exogenous shock persistence and reduction in incomes of a firm’s primary customer base will increase the likelihood of BMC), and hypothesis 5 (increases in pre-Covid inventory levels and the duration of the exogenous shock influence BMC).

This approach was a deviation by the researcher from the approach of Saebi et al. (2017), who had used the multinomial logistic regression method. The deviation was warranted, as Saebi et al. (2017) had gathered dependent variable data with non-binary outcomes, while the researcher had gathered dependent variables to examine a dichotomous outcome.

For hypothesis 3 (firms that increased inventory levels prior to the Covid crisis were less likely to evidence BMC), the research intent was to check whether there was a significant relationship between a particular redundancy SCR strategy and firm BMC. The

independent variable data was collected as continuous data. The continuous data was arranged into categorical data that was ultimately ordinal and binary in nature. The chi-square test was appropriate for categorical variables when researchers were seeking to examine if there were statistically significant differences among the variable categories (Knapp, 2018b). Table 6 outlines the statistical tests applied by the researcher for each of the hypotheses considered.

Table 6

Statistical test conducted per hypothesis

Hypothesis	Statistical test conducted	Note
Hypothesis 1: The longer that an exogenous shock persists, the greater the likelihood of BMC	Logistic regression	Model with single explanatory variable (DUR2)
Hypothesis 2: A reduction in revenues or incomes of a firm's primary customer base will lead to BMC	Logistic regression	Model with single explanatory variable (IMP2)
Hypothesis 3: Firms that increased inventory levels prior to the Covid crisis were less likely to demonstrate BMC	Chi-square test	Model with single explanatory variable (INVPERCHG2)
Hypothesis 4: Exogenous shock persistence and reduction in incomes of a firm's primary customer base will increase the likelihood of BMC	Logistic regression	Model with two explanatory variables (DUR 2 and IMP2)
Hypothesis 5: Increases in pre-Covid inventory levels and the duration of the exogenous shock influence BMC	Logistic regression	Model with two explanatory variables (INVPERCHG2 and DUR 2)

Source: By Author

Table 6 further notes the models used for statistical testing. For statistically testing the first three hypotheses the researcher chose to test single explanatory variable models. This was to eliminate the effect of any other variable and allow for the results to be interpreted directly in relation to the effect of interest. Although the explanatory variables were not continuous, the researcher's approach eliminated the risk of multicollinearity (Knapp, 2018c) from the testing of hypothesis 1 and hypothesis 2. Two-variable models were used to test hypothesis 4 and hypothesis 5 as these hypotheses sought to test for combined explanatory potential. Neither of these two-variable models contained

continuous independent variables and therefore there was no risk of multicollinearity in these models as well.

4.10 Validity and reliability

Credible research efforts must have demonstrated that the researcher reasonably attempted to reduce the chance of arriving at conclusions that were incorrect (Saunders, Lewis, & Thornhill, 2009). Reliability and validity of the overall research design were considered by the researcher, with validity considered for internal and external dimensions. The appropriate mitigation actions taken by the researcher are detailed in the section that follows.

4.10.1 Validity considerations

4.10.1.1 Internal validity

Internal validity referred to the alignment of logic between research intent and the operationalised research design (Neuendorf, 2017a) and whether relationships between variables in a research effort were definitively causal (Frey, 2018). For empirical research in particular, where research efforts were focussed on drawing valid inferences from the variables of interest, internal validity was a key consideration (Frey, 2018). The researcher sought to reduce internal validity concerns in three ways through the research design. Firstly, the choice of the BM dimensions assessed for BMC were aligned to the Saebi et al. (2017) study. The researcher therefore utilised a BM conceptualisation that had been employed by academics for BM testing in a different context. Secondly, the researcher employed pre-checks on the gathered data prior to conducting the statistical tests and reported on these pre-checks, noting any limitations discovered. This therefore provided a level of statistical validity to the tests conducted (Creswell & Creswell, 2018) and provided increased credibility in the validity of the model outputs. Thirdly, the researcher eliminated selection bias from the research, as the population was utilised.

4.10.1.2 External validity

External validity referred to the degree to which a researcher's findings from relationships between variables in their research sample, could be generalised across the population or other contexts (Allen, 2017; Frey, 2018). Frey (2018) noted that external validity concerns were present whenever sample based empirical research was conducted. Allen (2017) noted that external validity could be reduced in part by designing objective data collection, transparent documentation of research results, and clearly articulating the research setting. The researcher utilised the population and therefore employed a census approach to data gathering that did not necessitate sampling. The census approach allowed for the specific item of research interest to be assessed for all

members of the population (Salkind, 2010). As there was no sampling involved, the results of the research were relevant to the population and concerns on external validity were not warranted. However, population-based empirical research was also vulnerable to external validity concerns in cases where researcher sought to use findings to make inferences on other populations (Frey, 2018). In mitigation of this concern, the researcher clearly articulated the limitations of the research within the research setting in the research conclusions.

4.10.2 Reliability considerations

Neuendorf (2017b) defined reliability in content analysis as “the extent to which a measuring procedure yields the same results on repeated trials” (p. 2). The researcher applied the following actions toward ensuring reliability in the content analysis that generated the dependent variable dataset. Firstly, the researcher collected multiple documents to ensure consistency of the keyword search and reduce the risk of misidentification. Secondly, as the data was gathered through a keyword search, the process to generate the dependent variable dataset was time consuming. There was therefore the risk that process fatigue may have influenced the researcher’s interpretation of the extracted strings in determining whether a BM dimension had in fact changed in response to the Covid crisis. To reduce the possibility of this, the researcher reviewed the entire set of interpretations applied, and aligned the consistency of interpretations to ensure that the dataset generated was reliable. This resulted in the development of an interpretational logic for determining the status of the dependent variable that could be utilised by future researchers. In the case of the explanatory variables, the documentation of the process and the detailing of the calculations applied provided a clear guide to replicate the results, thereby preserving reliability.

4.10.3 Summary of reliability and validity considerations for the research effort

Based on the mitigating actions taken by the researcher, reasonable actions were taken in this research effort to reduce threats to internal and external validity as well as overall reliability. Notwithstanding the mitigating actions taken, the possible limitations from the research effort have been documented and ensured that the reader was aware of the limitations to generalising the research findings.

4.11 Limitations of the research design

The Covid crisis was a unique and unprecedented event that had an impact on a global scale. While this research effort utilised a quantitative research design that was deemed appropriate for the research intent, the limitations of the research design were considered.

A qualitative research design using a phenomenological approach may have been useful in using an explorative method to identify new variables for BMC by understanding from the participant's perspective, the context specific firm considerations as they navigated uncertainty (Creswell & Creswell, 2018). The use of publicly available documents to develop the dataset provided an accessibility benefit but at the cost of a data-specification limitation. A survey instrument would have enabled the utilisation of existing measurement instruments and the ability for the researcher to specify the data of interest (Allen, 2017).

The researcher conducted pre-testing on the research data prior to the statistical testing for significance. The researcher used a chi-square test for hypothesis 3 and noted that the data did not meet the pre-test criterion, in that one out of the four cells in the cross tabulation yielded a count of less than five. The researcher proceeded with using the chi-square test, having noted this limitation and utilised Fisher's exact test to supplement the chi-square test, as guided by Knapp (2018b).

Notwithstanding the limitations that were noted due to the research setting, this research effort and findings were envisaged to contribute to the BM literature by answering the call for further quantitative research into dynamic BMs using the BM as a dependent variable. Additionally, this research effort was envisaged to contribute academically by offering a real-time study on possible factors that drove firm BMC responses in response to the Covid crisis.

5. CHAPTER 5: RESULTS

Section 4.4 earlier described the rules applied to derive the population of 88 companies for the research effort. A description of the process followed by the researcher to generate the dependent and independent variable datasets for the research effort has been provided, followed by the descriptive statistics for the variables. The results of the statistical tests conducted then follows.

5.1 Overview of datasets for variables

5.1.1 *Dependent variable dataset: Overview of content analysis process*

For the dependent variable, the researcher sought evidence of BMC in response to the Covid crisis as described in Table 2 of Section 2.6.1. A content analysis approach using a keyword search was used to highlight if any of the four dimensions of the BM had changed. In addition to the four BM dimensions in Table 2, two additional search categories were utilised to assist the researcher. These were to cover keywords related to the BM in general or specifically to the Covid pandemic. The collected firm documents were subjected to a keyword search and Table 7 provides a guide to the researcher's application of the keyword search.

Table 7

Keyword search application for evidence of BM dimension changes

Element of interest	Keywords searched for
Changes in value proposition	Value proposition, New product, New service
Changes in choice of target customers	Target customers, Sales strategy, Business development, New markets, Target markets, New client
Changes in value delivery structure	Value delivery, Supplier networks, Supplier relationships, Cost optimisation, Cost reduction, Restructure, Reconfigure, Expense
Changes in value capture mechanism	Value capture, Product pricing, Service pricing, New payment channels
General	Business model
Covid	Covid, Coronavirus, Pandemic

Source: By Author

When keywords were found, then the full string was examined so that the context could be determined. When the context described a BM component, then the string was

extracted and examined. In cases where the extracted string described a change through actual or anticipated changes as a direct response to the Covid crisis, the researcher flagged the firm as having made a change to that component of their BM. The researcher's applied logic in making these interpretations were documented for each firm.

Firms therefore were categorised as having not evidenced BMC, evidenced BMC through changes in a single BM dimension or having evidenced BMC through changes in multiple BM dimensions. This level of BMC granularity was important for the researcher to understand the data. However, as the intent of the research sought evidence of BMC, rather than relative degrees of BMC, the granularity was not required for the testing of the hypotheses of interest. Therefore, in line with the researcher's positioning in Chapter 2, both single and multiple dimension BMC in response to the Covid crisis were considered as evidence of firm BMC in response to the Covid crisis. This treatment allowed the researcher to generate a final dependent variable dataset that was binary in nature.

5.1.1.1 Managing interpretational consistency

The process to generate the dependent variable dataset was time consuming due to the application of a keyword search method. There was therefore the risk that process fatigue may have influenced the researcher's interpretation of the extracted strings in determining whether a BM dimension had in fact changed in response to the Covid crisis. To reduce the possibility of this, the researcher continually reviewed the entire set of interpretations applied and aligned the consistency of interpretations to ensure that the dataset generated was reliable.

Table 8 provides an extract of the researcher's dependent variable data gathering file and illustrates the application of the interpretation logic. The fundamental logic applied was to ensure that BMC was only flagged when the data evidenced changes in BM components in response to or as a result of the Covid crisis. As an example, in the first row of Table 8 (unique identifier 6), although the firm exhibited evidence of changes to some BM dimensions, these were not contextualised as Covid responses, but rather as regular operational changes. Therefore, the firm was flagged as not having evidenced BMC in response to Covid. This contrasts with the last row of Table 8 (unique identifier 87), where the changes in the BM dimensions were directly attributable to the Covid crisis, and hence the firm was flagged as having evidenced BMC in response to the Covid crisis.

The researcher was able to flag the firms that had only changed a single BM dimension as well as those that had changed multiple BM components, as shown in Table 9. The process also yielded a view that indicated the spread of the individual BM component indicators that were identified as being changed (see Table A1 in **Appendix A** for the overall flagging of individual BM component changes).

Following the application of the coding logic, the final dependent variable dataset yielded a set of indicators for BM dimension changes in response to Covid for each firm. Aligned to the research intent, the researcher considered BMC in response to Covid to have occurred if at least one of the BM dimensions had changed in response to the Covid crisis. This application was the basis for determining the final indicator for evidence of firm BMC in response to the Covid crisis. The final distribution of BMC indicator variables in response to the Covid crisis are detailed in Table 9. The data in Table 9 evidenced that most firms in the population had evidenced BMC in response to the crisis. From the firms that evidenced BMC in response to the Covid crisis, Table 9 further shows that the single BM dimension change indicator was the most frequent trigger for BMC.

Table 8

Extract of dependent variable datafile illustrating the researcher's interpretational logic for determining BMC

Unique company identifier	BMC indicator (overall)	Count of BM dimensions changed	Change in VP	Change in CoTC	Change in VDS	Change in VCM	Researchers interpretation applied for identifying BMC changes in response to Covid
6	No	0	No	No	No	No	There was no evidence of changes to VP, CoTC, VDS or VCM in response to Covid. Although there was evidence of strengthening supplier networks, this was however part of their ongoing risk management practices, to mitigate the risk of suppliers selling directly to customers over time. Hence this was not seen as a VDS change in response to Covid. While there was evidence of passing through improved customer pricing, this was a result of internal efficiencies and scale, rather than a new pricing strategy in response to Covid. Therefore, there was no evidence of BMC in response to Covid.
40	Yes	3	No	Yes	Yes	Yes	There was evidence of changes to CoTC in response to Covid. This came through in the case of ElJosa bus service, whereby the company was seeking opportunities to operate in the inter-city and luxury coach segments, in recognition of industry changes from Covid. There was also evidence of changes in the VDS. This was from trimming operating expenses to realign with reduced revenue expectations, as well as undertaking a retrenchment process for one of the companies that was subject to reduced service demand. There was also evidence of a change to VCM. This was through the stated intent to engage with contracting authorities to renegotiate service contracts to compensate for Covid uncertainties. This therefore indicated an intent to reprice their services. There was no evidence of changes to VP in response to Covid. Therefore, there was evidence of BMC in response to Covid through CoTC, VDS and VDM.

Unique company identifier	BMC indicator (overall)	Count of BM dimensions changed	Change in VP	Change in CoTC	Change in VDS	Change in VCM	Researchers interpretation applied for identifying BMC changes in response to Covid
48	Yes	4	Yes	Yes	Yes	Yes	There was evidence of changes to VP in response to Covid. This was through the stated intention to develop and launch new products, as well as the expansion of product offering as a strategic imperative to mitigate the impact of Covid on revenues. There was evidence of changes to CoTC in response to Covid. This was positioned through the expansion of new markets (domestic and international) as a strategic imperative to mitigate the impact of Covid on revenues. There was evidence of changes to VDS in response to Covid. This was through remuneration cuts and reductions of overhead costs. There was evidence of changes to VCM in response to Covid. This was through adjustments to pricing in response to weaker consumer demand. Also, an expansion of distribution channels and focus on expanding their e-commerce channel. Therefore, there was evidence of BMC in response to Covid through VP, CoTC, VDS & VCM.
82	No	0	No	No	No	No	There was no evidence of changes to VP, CoTC, VDS or VCM in response to Covid. The company stated that the Covid pandemic had not had a material impact on the company. There were some references to new services, however these emerged first from the reporting for the period to 31 December 2019 and continued into the reporting period to 30 June 2020. Therefore, this was not evidence of a Covid response towards a change in VP. Therefore, there was no evidence of BMC in response to Covid.
87	Yes	2	Yes	No	Yes	No	There was evidence of changes in VP in response to Covid. This was in developing an array of services specifically to help companies respond to the Covid pandemic. There was also evidence of changes to the VDS in response to Covid. This was through a focus on reducing operating costs, through both temporary and permanent measures. There was no evidence of changes to CoTC or VCM in response to Covid. Therefore, there was evidence of BMC in response to Covid through VP and VDS.

Source: By Author

Table 9

Final dataset indicators for overall BMC and BM dimension change in response to the Covid crisis

BMC evident	Count	% of total	Count of firms that changed none of their BM dimensions in response to the Covid Crisis	% of total*	Count of firms that changed only one BM dimension in response to the Covid Crisis	% of total*	Count of firms that changed multiple BM dimensions in response to the Covid Crisis	% of total*
Yes	68	77.3%	0		37		31	
No	20	22.7%	20		0		0	
Total	88	100.0%	20	22.7%	37	42.0%	31	35.2%

* Percentages did not sum to 100.0% due to rounding at one decimal place

Source: By Author

5.1.2 Process for developing the persistence of shock dataset

The first independent variable (persistence of shock) measured the duration of the exogenous shock. The data for determining the duration of the economic lockdowns and the impacted sectors was sourced from the South African government coronavirus information website (Department of Health, 2020). Economic sector specific restrictions (duration of lockdown in days) were noted, ensuring that variations in the independent variable emerged. The researcher found that the economic sector categories per the South African government Covid website included compound categories. The challenge encountered was that the economic lockdown regulations were very specific, especially in respect to business areas that could operate during the lockdown. As an example, in the 'Financial and business services' category - banks, payment system operators and insurance companies could operate, affected only by the social distancing workplace requirements, whereas other business services companies were significantly restrained in their operations (Department of Health, 2020). As a means of ensuring that the variations in operating restrictions for the different sectors were clearly identifiable, the researcher therefore implemented a sector classification system that allocated the affected compound economic categories from the SA Covid website into granular sectors that could be directly mapped to the Moneyweb economic sector identifiers (see Table B1 in **Appendix B** for the affected categories).

Based on the researcher's review of the Covid lockdown regulations detailed on the SA Covid website, the researcher assigned impact labels to each economic category (see Table B2 in **Appendix B** for the assigned labels). The labels provided a description of the level of operational activity that industries were allowed to operate at. Due to the earlier described nature of the economic sector categorisation in the regulations, a label of 'Partial operations' was included as well. These was assigned to industries that could operate, but not at full capacity and subject to regulatory restrictions.

For the purposes of determining the duration that the lockdown regulations prevented an industry from operating at full capacity, the researcher first calculated the number of days that each of the five phases of the regulatory lockdown were in place for, over the period 26th March 2020 to 30th September 2020 (South African Government, 2020a, 2020b, 2020c, 2020d, 2020e). This calculation yielded the duration per phase, measured as the number of days that each phase of restriction lasted. Over the period 26th March 2020 to 30th September 2020, there were a total of 184 days of legislated lockdowns in place that impacted firms to varying degrees. The lockdown levels ranged from 35 days of the strictest level five restrictions to nine days of the least restrictive level one restrictions (see Table B3 in **Appendix B** for the duration per phase of lockdown).

The durations per lockdown phase were then applied to each of the economic categories, based on the rule that any industry labelled as either partially or fully restricted from operating during the lockdown period, were flagged as impacted for the entire duration of the relevant lockdown phase. As an example, a sector that was impacted by the regulatory lockdown levels five, four and three would have been assigned the value of 142 days, indicating the cumulative period that the sector was unable to operate at full capacity. The Moneyweb sector identifier was then utilised to map the sector impact duration back to the firm level population (see Table B4 in **Appendix B** for the number of days of lockdown experienced by each industry). This data gathering process resulted in a categorical dataset with ordinal properties.

5.1.3 Process for developing the reduction in income of primary customer during the Covid crisis dataset

The second independent variable (reduction in income of primary customers during the Covid crisis) was measured using data sourced from the Statistics South Africa website (<http://www.statssa.gov.za/>). The researcher first determined the primary customers for each firm in the population, through a multi-stepped approach.

For all companies in the population that had annual reports released during the period 01st March 2020 to 30th September 2020, the annual reports were used to identify either a description of the company activities or a clear description of their clients. This method was utilised for 53 firms. For the remaining companies, the researcher accessed the relevant company website and extracted the company or activities description for determining a primary client category label. This method was utilised for 28 firms. For the remaining seven firms, the researcher reviewed the documents that were collected for the dependent variable for information that provided an indication of the company activities or clients. Based on this analysis, Table 10 highlights the customer category labels assigned and the frequency of occurrences within the population.

Table 10*Customer category labels and population frequency*

Label number	Customer base category label	Number of occurrences in population ^a	Percentage change between first two quarters of 2020 ^b
1	Consumer	23	-15.0%
2	Business - SME	1	-12.8%
3	Business - Large	10	-18.7%
4 ^c	Business – Mixed	37	-16.5%
5 ^d	Mixed - Business and Consumer	17	-15.7%

^a N = 88. ^b Percentage change between Q2 2020 (April to June) and Q1 2020 (January to March). ^c Average of label numbers 2 and 3. ^d Average of label numbers 1, 2 and 3.

Source: By Author

Thereafter, the level of negative impact on primary customers during the Covid crisis was determined. This was done by analysing survey results from Statistics South Africa. The quarterly labour force survey (QLFS) from Statistics South Africa was utilised to estimate the impact on individual incomes during the Covid lockdowns (Statistics South Africa, 2020c). The QLFS was conducted at a household level and “includes agricultural workers, self-employed workers whose businesses are unincorporated, unpaid family workers, and private household workers” (Statistics South Africa, 2020c, p. 18). The QLFS also collected income tax information and evidenced a total decrease in income taxes paid for the period April 2020 to June 2020 of 15.0% (Statistics South Africa, 2020c). Income taxes were calculated based on income earned, therefore the decrease in income tax was used as a proxy for the reduction in individual incomes during the Covid crisis.

For the impact on revenues for businesses, Statistics South Africa’s quarterly financial statistics (QFS) reports for June 2020 and March 2020 were utilised to measure the total revenues for small, medium and large companies (Statistics South Africa, 2020d, 2020e). These enabled the researcher to calculate the relative percentage change in business revenues of the three months to June 2020, versus the three months to March 2020, per business size category. Based on this process as well as the additional categories defined for mixes of customer bases, the calculated percentage changes per customer base category were presented in Table 10 (see Table C1 in **Appendix C** for the details of the percentage change calculations).

5.1.4 Process for determining the increase in inventory levels dataset

The pre-Covid increase in inventory levels variable to indicate SCR investment was determined using firm level public non-human data over the prior three reporting periods. This period was selected so that pre-shock company investments to increase inventory levels could be determined. From the Osiris database, the 'Stock' line item was extracted from company balance sheets for the prior and the third from prior reporting periods, for the 88 firms in the population. The 'Stock' lined item represented the net inventory of a firm and included finished goods as well as raw materials purchased for the production of goods and services.

The researcher then calculated the percentage change in inventory between the prior and third from prior period (so covered the three prior reporting periods). The process yielded a range of calculated values that indicated whether firms had increased inventory levels in the pre-Covid period. Based on this calculation, the researcher was unable to calculate the value for 34 firms, due to no datapoint being available for either the prior reporting period or the third from prior reporting period. Excluding these firms resulted in a population of 54 firms for testing the hypotheses related to this variable. The researcher assigned category labels that enabled the grouping of similar ranged values and resulted in an ordinal dataset for the percentage change in pre-Covid firm inventory levels.

This section described the preparation of the dependent and independent variables for data analysis. Prior to the statistical testing of the research hypotheses, an overview of the descriptive statistics of the population has been provided.

5.2 Descriptive statistics

Descriptive statistics enabled researchers to “concisely understand a data set of any size using a handful of figures and simple graphs that serve to summarize the contents of a variable” (Knapp, 2018a, pg. 4). Before providing the descriptive statistics for each variable, Table 11 provides an overview of the population characteristics using market capitalisation (see Table B4 in **Appendix B** for the spread of firms across economic sectors).

The population utilised for testing hypothesis 1, hypothesis 2 and hypothesis 4 in this research effort comprised 88 companies. For testing hypothesis 3 and hypothesis 5, the population reduced to 54 companies, as outlined in Section 5.1.3. All rules utilised to develop the datasets for the dependent and independent variables were outlined in Chapter 4 of this research report.

Table 11*Population firm size characteristics using market capitalisation in ZAR million*

Measure	Population for hypothesis 1, hypothesis 2 and hypothesis 4 (88 firms)	Population for hypothesis 3 and hypothesis 5 (54 firms)
Min	9	19
Max	20 621	15 781
Average	2 413	2 195
Median	974	664
Total market capitalisation	212 380	118 517

Note. Market capitalisation data was sourced from Refinitiv (previously Thompsons Reuters)

Source: By Author

Table 11 shows that there was a significant spread of firm sizes by market capitalisation in the population. There was also a diverse spread of economic sectors represented across the population, noting that the ‘Real Estate Investment Trusts’ sector contributed approximately 27% of companies in the final population (see Table B4 in **Appendix B** for the spread of firms across economic sectors). Notwithstanding this, the 88 firms in the population were spread across 26 economic sectors.

Knapp (2018a) noted that the count and relative percentages could be used to characterise categorical data. As the variables utilised in this research effort were all categorical, the descriptive statistics for the variables presented the mode as the central tendency measure (Allen, 2017; Knapp, 2018a) and the range as the measure of variability where possible.

5.2.1 Dependent variable (BMC): Descriptive statistics

The descriptive statistics for the BMC variable are provided in Table 12 and Table 13. Table 12 provides the descriptive statistics of the population for testing hypothesis 1, hypothesis 2 and hypothesis 4. Table 13 provides the descriptive statistics of the population for testing hypothesis 3 and hypothesis 5.

Table 12

Frequency distribution of dependent variable (BMC) for hypothesis 1, hypothesis 2 and hypothesis 4

Category	Coded Value	Frequency	Percent	Cumulative Percent
No BMC in response to Covid	0	20	22.7%	22.7%
BMC in response to Covid evident	1	68	77.3%	100.0%

Note. N = 88.

Source: SPSS

Table 13

Frequency distribution of dependent variable (BMC) for hypothesis 3 and hypothesis 5

Category	Coded Value	Frequency	Percent	Cumulative Percent
No BMC in response to Covid	0	11	20.4%	20.4%
BMC in response to Covid evident	1	43	79.6%	100.0%

Note. N = 54.

Source: SPSS

For categorical variables, the appropriate measure of central tendency was the mode as it was the measure that best represented the centrality of qualitative categorisations (Allen, 2017; Knapp, 2018a). As the mode measured the most frequently occurring category, it provided a measure that was unaffected by the range of the population (Allen, 2017). For the BMC dependent variable, the data evidenced that evidence of BMC in response to the Covid crisis was the most frequently occurring value of the categorical dependent variable and therefore represented the mode. Dispersion metrics provide an indication of the degree of spread within the data (Allen, 2017). In term of measures of dispersion, it was not appropriate to utilise any measures for this variable, as it was a coded binary variable.

5.2.2 Persistence of shock (DUR)

The descriptive statistics for the persistence of shock (DUR) variable are provided in Table 14. The data in Table 14 provides a tabulated frequency distribution of the DUR variable and highlighted that approximately 70% of the population were prevented from operating at full capacity for more than 142 days by the lockdown regulations, which was almost five calendar months.

Table 14*Frequency distribution of DUR independent variable*

Number of days (DUR)	Frequency	Percent	Cumulative Percent
0	15	17.0%	17.0%
35	6	6.8%	23.9%
65	3	3.4%	27.3%
142	45	51.1%	78.4%
175	15	17.0%	95.5%
184	4	4.5%	100.0%

Note. N = 88.

Source: SPSS

The DUR variable was a discrete variable as it could only assume limited integer values. In terms of central tendency measures, the mode for the DUR variable was 142 days. On the measures of variance, from the discussion earlier in Section 5.1.2, it was confirmed that the range of the DUR variable was 184 days.

5.2.3 *Change in primary customer income or revenue (IMP)*

The descriptive statistics for change in primary customer income or revenue (IMP) variable are provided in Table 15. Table 15 provides a tabulated frequency distribution of the IMP variable and highlighted that more than 50% of the population had customer bases that had lost revenues or income of at least 16.5% during the Covid crisis.

Table 15*Frequency distribution of IMP independent variable*

Change in customer income / revenue (IMP)	Frequency	Percent	Cumulative Percent
-18.7%	10	11.4%	11.4%
-16.5%	37	42.0%	53.4%
-15.7%	17	19.3%	72.7%
-15.0%	23	26.1%	98.9%
-12.8%	1	1.1%	100.0%

Note. N = 88.

Source: SPSS

The IMP variable was a discrete variable as it could only assume a limited range of values based on the calculations outlined in Chapter 4 earlier. In terms of central

tendency measures, the mode for the IMP variable was -16.5%. On the measures of variance, the range of the IMP variable was 5.9%.

5.2.4 Change in firm reported inventory levels over last three reporting periods (INVPERCHG)

Data gathered for the change in firm inventory levels prior to the Covid crisis was originally gathered as a continuous variable. For the purposes of the research effort, the researcher applied ranged categories to the dataset that then yielded an ordinal data set for the INVPERCHG variable. The frequency statistics for the INVPERCHG variable were provided in Table 16 and showed that more than a third of the population had increased their inventory levels by at least 25% over the three-year period prior to the Covid crisis.

Table 16

Frequency distribution of INVPERCHG independent variable

Range of percentage change in inventory levels over last three reporting periods ^a	Coded value	Frequency	Percentage	Cumulative Percentage
(-75%; -50%]	0	3	5.6%	5.6%
(-50%; -25%]	1	8	14.8%	20.4%
(-25%; 0%]	2	9	16.7%	37.0%
(0%; 25%]	3	14	25.9%	63.0%
(25%; 50%]	4	11	20.4%	83.3%
> 50%	5	9	16.7%	100.0%

Note. N = 54.

^a (A: B] notation indicates that the lower bound is up to but excluding A and the upper bound is up to and including B.

Source: SPSS

5.3 Data transformations

Overall, the researcher collected data for one dependent and three independent variables. Table 5 in Section 4.7 earlier described the variables as originally collected. Table 17 provides an overview of the variables gathered and coded for analysis, prior to applying any data transformations.

Table 17*Summary of research variables and initial transformations applied*

Variable	Original numerical measurement recorded	Data transformation applied	Coded value
BMC (outcome variable)	Descriptive (nominal) data with three ordinal categories: No BMC, BMC - Single dimension, BMC – Multiple dimensions	Binomial data: No BMC in response to Covid, BMC in response to Covid evident (incorporates single and multiple dimensions)	No BMC in response to Covid = 0 BMC in response to Covid evident = 1
DUR (predictor)	Discrete data with six ordinal categories: 0, 35, 65, 142, 175, 184	No data transformations applied	0, 35, 65, 142, 175, 184
IMP (predictor)	Discrete data with five ordinal categories: -18.7%, -16.5%, -15.7%, -15.0%, -12.8%	No data transformations applied	-18.7%, -16.5%, -15.7%, -15.0%, -12.8%
INVPERCHG (predictor)	Continuous data	Data arranged into buckets to yield an ordinal dataset with six categories	(-75%; -50%] = 0 (-50%; -25%] = 1 (-25%; 0%] = 2 (0%; 25%] = 3 (25%; 50%] = 4 >75% = 5

Source: By Author

Prior to testing the hypotheses, the researcher employed a cross tabulation to review the spread of the dependent variable across the categories of the predictor variables. This step was carried out to assess whether further data transformations were necessary.

5.3.1 Cross tabulation checking and subsequent data transformations

The initial cross tabulation results are shown in Table 18, Table 19 and Table 20. The results showed that there were more than 25% of cells with observations that were less than five, for the DUR (50.0%), IMP (50.0%) and INVPERCHG (58.0%) variables.

Table 18*Cross tabulation of BMC and DUR*

BMC ^a	DUR						Total
	0	35	65	142	175	184	
0	7	3	1	5	3	1	20
1	8	3	2	40	12	3	68
Total	15	6	3	45	15	4	88

^a BMC = 0 (no evidence of BMC), BMC = 1 (evidence of BMC).

Source: SPSS

Table 19*Cross tabulation of BMC and IMP*

BMC	IMP					Total
	-18.7%	-16.5%	-15.7%	-15.0%	-12.8%	
0	3	10	3	3	1	20
1	7	27	14	20	0	68
Total	10	37	17	23	1	88

^a BMC = 0 (no evidence of BMC), BMC = 1 (evidence of BMC).

Source: SPSS

Table 20*Cross tabulation of BMC and INVPERCHG*

BMC ^a	INVPERCHG						Total
	0	1	2	3	4	5	
0	1	2	1	3	2	2	11
1	2	6	8	11	9	7	43
Total	3	8	9	14	11	9	54

^a BMC = 0 (no evidence of BMC), BMC = 1 (evidence of BMC).

Source: SPSS

Saunders et al. (2009) guided that when this phenomenon is observed, the researcher should examine the data and consider where adjacent categories could reasonably be grouped. The researcher therefore combined existing categories of each independent variable to yield regrouped independent variable categories as detailed in Table 21. Importantly, the groupings maintained the ordinal rankings of the categories. The cross

tabulation was re-conducted using the regrouped predictor variable categories. The cross tabulation results are outlined in Table 22, Table 23 and Table 24 and evidence that each variable had at most 25% of categorised cells with a count of less than five.

Table 21

Regrouping of independent variables

Old category (DUR)	New category (DUR2)	Old category (IMP)	New category (IMP2)	Old category (INVPERCHG)	New category (INVPERCHG2)
0, 35, 65	65	-12.8%, -15.0%, -15.7%	-15.7%	0,1,2	0
142	142	-16.5%	-16.5%	3,4,5	1
175, 184	175	-18.7%	-18.7%		

Source: By Author

Table 22

Cross tabulation of BMC and DUR2

BMC ^a	DUR2			Total
	65	142	175	
0	11	5	4	20
1	13	40	15	68
Total	24	45	19	88

^a BMC = 0 (No evidence of BMC), BMC = 1 (Evidence of BMC).

Source: SPSS

Table 23

Cross tabulation of BMC and IMP2

BMC ^a	IMP2			Total
	-18.7%	-16.5%	-15.7%	
0	3	10	7	20
1	7	27	34	68
Total	10	37	41	88

^a BMC = 0 (No evidence of BMC), BMC = 1 (Evidence of BMC).

Source: SPSS

Table 24*Cross tabulation of BMC and INVPERCHG2*

BMC ^a	INVPERCHG2 ^b		Total
	0	1	
0	4	7	11
1	16	27	43
Total	20	34	54

^a BMC = 0 (No evidence of BMC), BMC = 1 (Evidence of BMC). ^b INVPERCHG2 = 0 (Firms did not increase pre-Covid inventory), INVPERVCHG2 = 1 (Firms increased pre-Covid inventory).

Source: SPSS

Following the regrouping of categories for the predictor variables, Table 25 provides the final view of the outcome and predictor variables. Table 25 represents the concise view of the variables and their categories after all data transformations were applied.

Table 25*Summary of categorised variables for hypothesis testing*

Variable notation	Type	Final categories
BMC (outcome)	Categorical	0 = No BMC in response to Covid 1 = BMC in response to Covid evident
DUR2 (predictor)	Categorical	65 = Covid lockdowns restricted industry company from full operations for 65 days 142 = Covid lockdowns restricted industry company from full operations for 142 days 175 = Covid lockdowns restricted industry company from full operations for at least 175 days
IMP2 (predictor)	Categorical	-18.7% = Primary customer base income or revenue reduced by 18.7% -16.5% = Primary customer base income or revenue reduced by 16.5% -15.7% = Primary customer base income or revenue reduced by 15.7%
INVPERCHG2 (predictor)	Categorical	0 = Firms that had not increased pre-Covid inventory levels 1 = Firms that increased pre-Covid inventory levels

Source: By Author

5.4 Assumption checking prior to testing

5.4.1 Logistic regression pre-checks

Knapp (2018c) provided three checklist items for researchers to check prior to running a logistic regression. These were (a) the required sample size, (b) normality of continuous variables, and (c) multicollinearity. Knapp (2018c) also noted that researchers could proceed with using a logistic regression process even when some of the criteria were not met, conditional on the researcher clearly articulating this as a limitation. This research effort contained only categorical variables, hence the test for normality and multicollinearity were not warranted. The absence of continuous variables was not considered a material issue as Knapp (2018c) further positioned that logistic regression models were also viable when using categorical variables.

When using only a single categorical variable, the minimum number of required observations was calculated by counting the number of categories of the independent variable, then subtracting one, and multiplying the result by 10 (Knapp, 2018c). The same process was followed for the two-variable models, noting that the number of required observations across the independent variables could be summed (Knapp, 2018c). Based on this method, 20 observations were required for both hypothesis 1 and hypothesis 2, 40 observations were required for hypothesis 4 and 30 observations were required for hypothesis 5. The population for hypothesis 1, hypothesis 2 and hypothesis 4 contained 88 observations and therefore was well above the minimum number of required observations. The population for hypothesis 5 contained 54 observations and was also well above the minimum number of required observations. The population therefore met the logistic regression pre-check condition for the number of required observations.

5.4.2 Chi-square pre-check

Knapp (2018b) positioned that the only criterion for a chi-square test was that the number of observations per cell in the cross-tabulation be greater than five. From Table 24 earlier, the researcher observed that one of the cells in the BMC and INVPERCHG2 cross tabulation was less than five. Aligned to the chi-square criterion guidance from Knapp (2018b), the researcher proceeded with the chi-square analysis having noted the inability of the data to meet the pre-check criterion in the limitations section of the research report. Fisher's exact test was further used to supplement the chi-square test (Frey, 2018).

5.5 Hypothesis testing

5.5.1 Hypothesis 1 test outcome

The researcher utilised a logistic regression with the single DUR2 predictor variable in order to test hypothesis 1 (the longer that an exogenous shock persists, the greater the likelihood of BMC). The significance level of the model was reviewed at the 95% significance level using the p-value. Table 26 outlines the summary of the model outputs. As the model had a significance level of less than 0.05 and noting that there was a single predictor variable in the model, this indicated that the DUR2 variable was statistically significant at the 95% level of confidence. The null hypothesis was therefore rejected.

Table 26

Omnibus tests of model coefficients - DUR2 predictor variable

Step	Chi-square	df	Sig.
Step 1	10.273	2	0.006

Source: SPSS

Table 27 provides the detailed variable outputs of the logistic regression. The p-values and confidence intervals at the 95% level of confidence are also provided in Table 27.

Table 27

SPSS output from logistic regression - DUR2 predictor variable

Step 1 ^a	B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I. for EXP(B)	
							Lower	Upper
DUR2 [=65]			9.586	2	0.01			
DUR2(1) [=142]	1.912	0.627	9.310	1	0.00	6.769	1.982	23.123
DUR2(2) [=175]	1.155	0.696	2.752	1	0.10	3.173	0.811	12.416
Constant	0.167	0.410	0.166	1	0.68	1.182		

^a Variable(s) entered on step 1: DUR2.

Source: SPSS

The logistic regression method utilised a reference category (Knapp, 2018c) and '65 days' was used as the reference category. The reference category was statistically significant with a p-value less than 0.05. Firms that experienced Covid lockdown restrictions of 142 days had 6.769 times the odds of evidencing BMC compared to firms that experienced Covid lockdown restrictions of 65 days ($p \leq 0.05$). Firms that experienced Covid lockdown restrictions of 175 days had 3.173 times the odds of

evidencing BMC compared to firms that experienced Covid lockdown restrictions of 65 days ($p > 0.05$).

Knapp (2018c) noted that “there remains some debate regarding the wisdom of reporting the R^2 for logistic regression” (p. 22) as the statistic was not as clearly interpreted relative to multiple regression models. However, Knapp (2018c) further noted that the Nagelkerke R^2 statistic was useful for logistic regressions. Table 28 provides the summary statistics of the model. The Nagelkerke R^2 indicated that 16.8% of the BMC variability was accounted for by the model.

Table 28

Model summary statistics output - DUR2 predictor variable

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
Step 1	84.056 ^a	0.110	0.168

^a Estimation terminated at iteration number 5 because parameter estimates changed by less than 0.001.

Source: SPSS

5.5.2 Hypothesis 2 test outcome

A logistic regression with the single IMP2 predictor variable was utilised to test hypothesis 2 (a reduction in revenues or incomes of a firm’s primary customer base will lead to BMC). The significance level of the model was reviewed at the 95% significance level using the p-value. Table 29 outlines the summary of the model outputs. As the model had a p-value greater than 0.05 and noting that there was a single predictor variable in the model, this indicated that the IMP2 variable was not statistically significant at the 95% level of confidence. The null hypothesis was therefore not rejected.

Table 29

Omnibus tests of model coefficients - IMP2 predictor variable

Step	Chi-square	df	Sig.
Step 1	1.453	2	0.484

Source: SPSS

Table 30 provides the detailed variable outputs of the logistic regression. The p-values and confidence intervals at the 95% level of confidence are also provided in Table 30.

Table 30*SPSS output from logistic regression - IMP2 predictor variable*

Step 1 ^a	B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I. for EXP(B)	
							Lower	Upper
IMP2 [= -15.7%]			1.413	2	0.493			
IMP2(2) [= -16.5%]	-0.587	0.556	1.115	1	0.291	0.556	0.187	1.653
IMP2(1) [= -18.7%]	-0.733	0.805	0.829	1	0.363	0.480	0.099	2.328
Constant	1.580	0.415	14.500	1	0.000	4.857		

^a Variable(s) entered on step 1: IMP2.

Source: SPSS

The logistic regression method utilised a reference category (Knapp, 2018c) and '-15.7%' was used as the reference category for the percentage decline in primary customer income or revenue during the Covid crisis. Neither the reference category ($p = 0.493$) nor the other IMP2 categories ($p\text{-value} > 0.05$) were statistically significant at the 95% confidence level.

Table 31*Model summary statistics output - IMP2 predictor variable*

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
Step 1	92.876 ^a	0.016	0.025

^a Estimation terminated at iteration number 4 because parameter estimates changed by less than 0.001.

Source: SPSS

Table 31 provides the model summary statistics of the model. The Nagelkerke R^2 indicated that only 2.5% of the BMC variability was accounted for by the model.

5.5.3 Hypothesis 3 test outcome

The researcher utilised a lower number of observations from the population for testing hypothesis 3 (firms that increased inventory levels prior to the Covid crisis were less likely to evidence BMC). This approach was outlined earlier in Section 5.1.3 and was due to cases where companies had not reported inventory, thereby not enabling the researcher to calculate the percentage change in inventory levels over the last three reporting periods.

The researcher utilised a chi-square test to check for a statistically significant association between changes in pre-Covid inventory levels and firm BMC. Table 32 outlines the summary of the chi-square test outputs from SPSS. The Pearson chi-square test statistic value of 0.003 was not significant at the 95% level of confidence and the null hypothesis could therefore not be rejected. Fisher's exact test also yielded a result that was not significant at the 95% level of significance. The null hypothesis was therefore not rejected.

Table 32

SPSS output of chi-square test - INVPERCHG2 variable

Measure	Value	df	Asymptotic significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	0.003 ^a	1	0.959	1.000	0.623
Fisher's Exact Test				1.000	0.623

^a 1 cell (25.0%) has expected count less than 5. The minimum expected count is 4.07.

Source: SPSS

When the spread of the INVPERCHG2 observations across the BMC categories was examined in Figure 5, it was evident that there was no material difference in the proportional representation of INVPERCHG2 across both BMC variable categories. Of the firms that did not evidence BMC, 63.6% had increased pre-Covid inventory levels. Of the firms that did evidence BMC, 62.8% had increased pre-Covid inventory levels. This therefore further supported the chi-square test statistic findings.

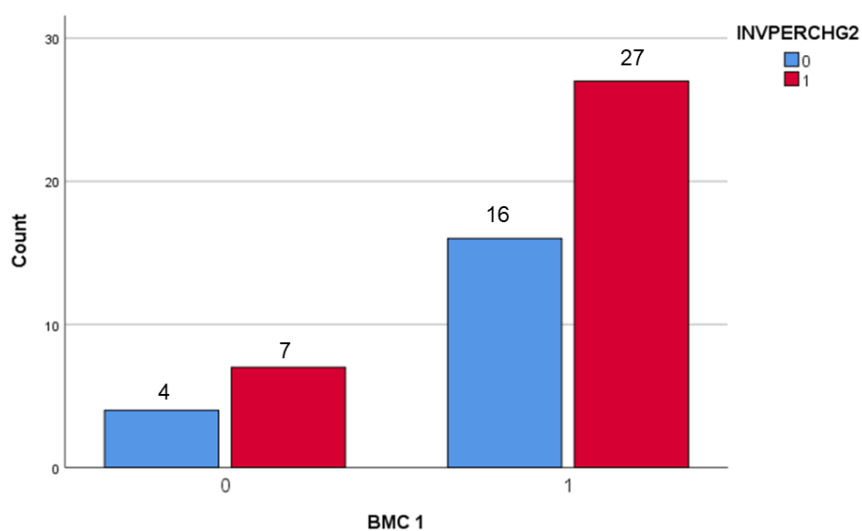


Figure 5: Spread of INVPERCHG2 across BMC categories

Source: SPSS

5.5.4 Hypothesis 4 test outcome

A logistic regression was utilised to test hypothesis 4 (exogenous shock persistence and reduction in incomes of a firm's primary customer base will increase the likelihood of BMC). The model included persistence of shock (DUR2) and reduction in income of primary customers (IMP2) as the two explanatory variables. The significance level of the model was reviewed at the 95% significance level using the p-value. Table 33 outlines the summary of the model outputs from SPSS. The model had a p-value of less than 0.05 and was therefore statistically significant at the 95% level of confidence. At least one of the model's predictor variables was therefore predicting the outcome variable with statistical significance (Knapp, 2018c). The null hypothesis was therefore rejected.

Table 33

Omnibus tests of model coefficients - DUR2 and IMP2 predictor variables

Step	Chi-square	df	Sig.
Step 1	12.842	4	0.012

Source: SPSS

Table 34 provides the detailed variable outputs of the logistic regression. The p-values and confidence intervals at the 95% level of confidence are also provided in Table 34. The outputs showed that the persistence of shock (DUR2) variable was the variable with statistically significant predictive power for the outcome variable. For the DUR2 variable, it was noted that the odds of firm BMC had increased relative to the standalone odds from Table 27. Conversely, for the IMP2 variable, the odds of firm BMC had decreased relative to the standalone odds from Table 30.

Table 34*SPSS output from logistic regression - DUR2 and IMP2 predictor variables*

Step 1 ^a	B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I. for EXP(B)	
							Lower	Upper
DUR2 [= 65]			10.327	2	0.006			
DUR2(1) [= 142]	2.088	0.661	9.987	1	0.002	8.069	2.210	29.461
DUR2(2) [= 175]	1.302	0.723	3.243	1	0.072	3.675	0.891	15.152
IMP2 [=-15.7%]			2.422	2	0.298			
IMP2(2) [=-16.5%]	-0.945	0.620	2.323	1	0.127	0.389	0.115	1.310
IMP2(1) [=-18.7%]	-0.761	0.877	0.754	1	0.385	0.467	0.084	2.603
Constant	0.584	0.503	1.349	1	0.245	1.794		

^a Variable(s) entered on step 1: DUR2, IMP2.

Source: SPSS

Table 35*Model summary statistics output - DUR2 and IMP2 predictor variables*

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
Step 1	81.487 ^a	0.136	0.206

a. Estimation terminated at iteration number 5 because parameter estimates changed by less than 0.001.

Source: SPSS

The Nagelkerke R^2 in Table 35 indicates that 20.6% of the BMC variability was accounted for by the model. It was observed that this model explained more of the BMC variability than either of the DUR2 (hypothesis 1) or IMP2 (hypothesis 2) single variable models.

5.5.5 Hypothesis 5 test outcome

A logistic regression was utilised to test hypothesis 5 (increases in pre-Covid inventory levels and the duration of the exogenous shock influence BMC). The model included persistence of shock (DUR2) and percentage change in inventory levels (INVPERCHG2) as the two explanatory variables. The significance level of the model was reviewed at

the 95% significance level using the p-value. Table 36 outlines the summary of the model outputs. The model had a significance level greater than 0.05 and was therefore not statistically significant at the 95% level of confidence. None of the model's predictor variables were therefore predicting the outcome variable with statistical significance (Knapp, 2018c). The null hypothesis could therefore not be rejected.

Table 36

Omnibus tests of model coefficients - INVPERCHG2 and DUR2 predictor variables

Step	Chi-square	df	Sig.
Step 1	6.420	3	0.093

Source: SPSS

Table 37 provides the detailed variable outputs of the logistic regression. The p-values and confidence intervals at the 95% level of confidence are also provided in Table 37. The outputs showed that the persistence of shock (DUR2) variable was the variable with statistically significant predictive power for the outcome variable, although this was not sufficient to make the overall model significant. Similar to the observation from the hypothesis 4 result, it was noted for the DUR2 variable that the odds of firm BMC had increased relative to the standalone odds from Table 27.

Table 37

SPSS output from logistic regression - INVPERCHG2 and DUR2 predictor variables

Step 1 ^a	B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I. for EXP(B)	
							Lower	Upper
INVPERCHG2(1) [= 1]	0.163	0.760	0.046	1	0.830	1.177	0.265	5.224
DUR2 [= 65]			5.922	2	0.052			
DUR2(1) [= 142]	1.959	0.894	4.806	1	0.028	7.095	1.231	40.894
DUR2(2) [= 175]	1.545	0.918	2.833	1	0.092	4.689	0.775	28.354
Constant	0.242	0.726	0.111	1	0.739	1.274		

^a Variable(s) entered on step 1: INVPERCHG2, DUR2.

Source: SPSS

The Nagelkerke R² in Table 38 indicates that 17.6% of the BMC variability was accounted for by the model. It was observed that this model explained more of the BMC variability than the standalone DUR2 model (hypothesis 1).

Table 38

Model summary statistics output - INVPERCHG2 and DUR2 predictor variables

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
Step 1	48.173 ^a	0.112	0.176

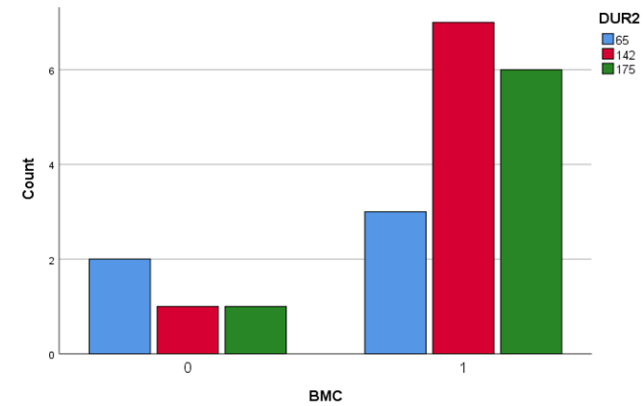
^a Estimation terminated at iteration number 5 because parameter estimates changed by less than 0.001.

Source: SPSS

Following the results of the logistic regression for testing hypothesis 5, the researcher attempted to enhance the understanding of the results by visually examining the spread of the DUR2 and BMC variables across firms that had either increased pre-Covid inventory levels or not. The results of this analysis are provided in Figure 6. The proportions of firms that evidenced BMC was approximately the same across the DUR2 categories and on an overall basis, regardless of whether there had been pre-Covid increases in inventory levels, as shown in Figure 6. This added to the understanding of the logistic regression results and enhanced the understanding of the data.

Spread for duration of exposure to shock (DUR2) across BMC categories

Firms that did not increase pre-Covid inventory levels (INVPERCHG2 = 0) (N = 20)



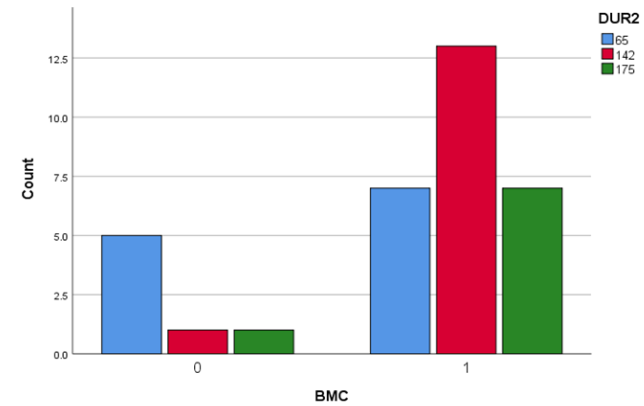
Two-way frequency spreads for DUR2 and BMC

BMC	DUR2			Total
	65	142	175	
0	40%	13%	14%	20%
1	60%	88%	86%	80%

Two-way frequency spreads for DUR2 and BMC (Grouped DUR2)

BMC	DUR2		Percentage of '>65' to row total
	≤65	>65	
0	2	2	50%
1	3	13	81%

Firms that did increase pre-Covid inventory levels (INVPERCHG2 = 1) (N = 34)



BMC	DUR2			Total
	65	142	175	
0	42%	7%	13%	21%
1	58%	93%	88%	79%

BMC	DUR2		Percentage of '>65' to row total
	≤65	>65	
0	5	2	29%
1	7	20	74%

Figure 6: Spread of DUR2 versus BMC for different INVPERCHG2 categories

Source: By Author using SPSS outputs

5.6 Summary of analysis results

The research effort positioned five hypotheses that sought to test the predictive or influencing ability of a set of variables for firm BMC in response to the Covid crisis. Table 39 summarises the results of the hypothesis tests conducted in this research effort.

Table 39

Summary of hypothesis testing results

Hypothesis	Significance at the 95% confidence level	Hypothesis decision
Hypothesis 1: The longer that an exogenous shock persists, the greater the likelihood of BMC	Significant	Supported
Hypothesis 2: A reduction in revenues or incomes of a firm's primary customer base will lead to BMC	Not significant	Not supported
Hypothesis 3: Firms that increased inventory levels prior to the Covid crisis were less likely to evidence BMC	Not significant	Not supported
Hypothesis 4: Exogenous shock persistence and reduction in incomes of a firm's primary customer base will increase the likelihood of BMC	Significant	Supported
Hypothesis 5: Increases in pre-Covid inventory levels and the duration of the exogenous shock influence BMC	Not significant	Not supported

Source: By Author

At the 95% level of significance, hypothesis 1 and hypothesis 4 were supported (null hypothesis rejected) while hypothesis 2, hypothesis 3 and hypothesis 5 were not supported (null hypotheses failed to be rejected). Having presented the results of the statistical analyses conducted, Chapter 6 provides a discussion of the research analysis results relative to the expected results from the literature reviewed.

6. CHAPTER 6: DISCUSSION

6.1 Introduction

This chapter presents a unified discussion of the detailed findings from Chapter 5 with the literature reviewed in Chapter 2. A brief contextual review of the population analysed for BMC changes in response to the exogenous supply-side shock of the Covid crisis is presented. Thereafter the research findings for each hypothesis are presented and discussed. The research findings offered insights into the occurrence and drivers of BMC for exogenous supply-side shocks within the research setting. In doing so, it supported the existing literature and added insights into a novel driver of BMC in response to an exogenous supply-side shock.

6.2 Reviewing the research population

The population consisted of firms listed on the South African JSE. The research effort sought to test for explanatory factors in firm BMC decisions in response to the Covid crisis and having noted that country coronavirus containment responses varied, the choice of population was deliberate to study the phenomenon of interest. This research effort utilised a census approach to gather relevant data for the population of interest. The population approach was also relevant as a direct response to the call of Wirtz et al. (2016) for further empirical studies on BM dynamics.

The analysis specifically excluded firms that had multiple listings, firms that were designated as holding companies, banks, firms that were facing regulatory issues as well as firms that were in the process of delisting from the JSE. The reasons for these exclusions were documented in Section 4.2 and had the effect of significantly reducing the chance that BMC decisions taken by firms in the final population were influenced by (a) factors outside of South Africa, or (b) by regulators for non-Covid related reasons. In this manner, it was possible to test for possible explanatory factors in a research setting where the population was exposed to the same exogenous shock factor and were subjected to the same economic lockdown legislations.

Teece (2018) noted that firms could have had access to similar resources but developed unique practices and inter-connections of practices that would have led to fundamentally different BMs. The firms in the final population ranged across economic size (as measured by average market capitalisation) and economic sectors (see Table B4 in **Appendix B**). In the population, 77.3% of the firms evidenced BMC in response to the Covid crisis and the data showed that 35.2% of the population had engaged in multiple-dimension BMC in response to the Covid crisis. This was supportive of the work of

Schoemaker et al. (2018) where it was noted that adjusting elements of the existing BM, rather than embarking on a complex overall BM change, allowed for firm-specific emergent solutions.

Having reflected on the research population, the discussion of the results for each hypothesis tested are presented. The presentation considers the expected result from the literature reviewed, followed by a discussion of the test results and implied research findings.

6.3. Hypothesis 1: The longer that an exogenous shock persists, the greater the likelihood of BMC

6.3.1 Expectations for hypothesis 1 from the literature reviewed

Firm BMC responses to conditions of uncertainty had been a focal area in extant literature. Fjeldstad and Snow (2018) as well as Broekhuizen, Bakker, and Postma (2018) had noted that changing a firm BM in response to disruption was often a challenge for firms. Similarly, Brenk, Lüttgens, Diener, and Piller (2019) had noted that firms facing threat conditions generally evidenced increased information centralisation and an affinity to rely on past experience to preserve the existing BM, such that BMC efforts could be limited.

The extant literature further noted that firms were required to develop the capability for BMC to accommodate expected shifts in their operating environment (Pati et al., 2018; Saebi et al., 2017), notwithstanding the complexity associated with transforming extant BMs (Mehrizi & Lashkarbolouki, 2016; Osiyevskyy & Dewald, 2018; Saebi et al., 2017; Snihur & Wiklund, 2019) even when conditions were stable (Broekhuizen et al., 2018). Saebi et al. (2017) utilised prospect and threat-rigidity theories to find that threats rather than opportunities in the business environment were more likely to drive changes in a firm's BM. Osiyevskyy and Dewald (2018) had noted that firms facing a crisis were likely to actively take on the risk of BMC as means of avoiding losses, even though the BMC responses would be non-uniform. Firms changed their BMs in response to conditions of threat (Saebi, et al., 2017) and there had been evidence of financial and economic risk driving BMC in firms (Kaulio et al., 2017; Snihur & Zott, 2020).

The majority of firms in the population (77.3%) evidenced BMC in response to the Covid crisis, where BMC indicated a change in at least one of the four BM dimensions. Hence, in the research setting, did the persistence of the exogenous supply-side shock, as represented by the Covid crisis associated lockdowns, drive firm BMC? Statistics South Africa (2020a) highlighted that 75.7% of surveyed businesses considered the economic impact of the Covid crisis to be more severe than the GFC. In that context, firms that

were unable to operate at full capacity due to lockdown conditions would have had to rely on cash reserves and balance sheet strength to endure. However, all firms were likely to have a finite limit of available resources, and time was likely to be an influencing factor in determining whether BMC was required. The expectation therefore followed from the literature reviewed that firms would have evidenced BMC if a shock, and therefore the threat to the business, persisted for a period of time.

6.3.2. Research results achieved for hypothesis 1

Hypothesis 1 (the longer that an exogenous shock persists, the greater the likelihood of BMC) sought to test for the positive relationship between the duration of the shock and firm BMC responses. A logistic regression model with a single independent variable was utilised for the test. The model returned a statistically significant result at the 95% level of confidence, providing evidence that increased duration of the exogenous supply-side shock increased the odds of BMC in firms.

Having controlled for non-Covid crisis related BMC through the data gathering and review process, the research found that an extended exposure to a shock (the lockdown limitations from operating at full capacity in this research setting) was more likely to drive firm BMC as a response mechanism. A discussion of the research results and possible implications follows.

6.3.3 Discussion of research findings for hypothesis 1

The BMC evidence from the population supported observations and expectations that crisis conditions were a catalyst for firms to engage in BMC (Schoemaker et al., 2018; Snihur & Wiklund, 2019; Snihur & Zott, 2018). The prevalence of firms engaging in BMC in response to the Covid crisis appeared to be behaviour that was aligned with the findings of Saebi et al. (2017), that firms were more likely to change their BMs when facing conditions of threat. However, it was noted earlier that some researchers had found that firm BMC was less likely during conditions of crisis (Brenk et al., 2019; Broekhuizen et al., 2018; Fjeldstad & Snow, 2018).

A reason for this contrast could have been the effect of the shock duration, as well as the research design utilised to gather data on BMC. As the duration of the legislated lockdowns persisted, there were increased conversations on a new normal for businesses and society. However, uncertainty persisted on what the new normal would be, when it would be in place, or what transformations would be required from firms. Firms may well have sought to continue with their extant BMs. However, the research design guided the collection of firm documents that were released over the period 01st March 2020 to 30th September 2020. This covered half of a typical listed-firm annual

financial reporting period. Firm BMC in response to Covid could thus have been flagged either from documents released early within the research window or later on. Therefore, even if firms had actively chosen not to engage in BMC during the early part of the crisis, which would have aligned with Fjeldstad and Snow (2018) as well as Broekhuizen et al. (2018), the protracted extent of the legislated lockdowns in South Africa and the designed data collection method, were likely a factor in the population yielding significant evidence of BMC in response to the Covid crisis.

This research effort also provided empirical population data that supported the Saebi et al. (2017) as well as Osiyevskyy and Dewald (2018) positions on firm likelihood to engage in BMC during periods of crisis. While the firm's inward focus (Brenk et al., 2019) may well have been true for a short period, the persistence of the shock influenced firms to make responding BMC decisions over a longer period. The BMC data also evidenced a range of firm BMC responses across the four BM dimensions (see Table 9 in Section 5.1.1 and see Table A1 in **Appendix A**), offering support to the positioning of non-uniform BM responses to crisis conditions (Osiyevskyy & Dewald, 2018). The Saebi et al. (2017) and Osiyevskyy and Dewald (2018) observations were therefore further supported in that the firms in the population exhibited a range of BMC decisions when faced with the same exogenous shock. The most common BM dimension that was adjusted was the 'value delivery structure', at 41.7% of all BM dimension changes (see Table A1 in **Appendix A**). This dimension covered cost and expense optimisation as well as restructuring. In conditions of crisis or uncertainty, firms tended to focus on the elements that they had the most control over (Brenk et al., 2019) and therefore cost and expense management in response to the Covid crisis was an action taken by many firms.

6.3.4 Conclusion on the research findings for hypothesis 1

This research effort focussed on whether firm's responded through BMC to the Covid crisis during a defined research window that covered the period 01st March 2020 to 30th September 2020. This period covered the material implementation of South African economic lockdown legislations that sought to curb the societal spread of Covid. The intent of the research was not to measure the impact of financial or economic risk on firm BMC decisions, and therefore the research design deliberately avoided gathering firm data on financial performance or general industry economic indicators. The context of the research setting was in the midst of the Covid crisis and detailed firm level financial data was unlikely to be uniformly or readily available.

In testing for and finding empirical support for the statistical significance in the relationship of the duration of a shock on firm BMC responses, the research also

developed a BMC dataset that offered insights into other findings from the extant BM literature. The research design and supporting data gathering process enabled the development of a dataset that modelled BMC decisions in response to the Covid crisis. The data supported views of crisis conditions catalysing BMC, as well as evidence of non-uniform BMC actions taken in response to the same exogenous shock. The key additional insight that has been presented, was the finding on the role of time in BMC responses to an exogenous supply-side crisis.

This therefore evidenced that duration of shock may indeed have influenced the proportion of firms engaging in Covid-driven BMC. This supported the academic findings for BMC in response to conditions of threat but did not negate the observations of Broekhuizen et al. (2018) or Fjeldstad and Snow (2018). Rather, it provided a connecting factor between the two prevalent academic views – the duration of the shock. This highlighted the positive relationship of shock persistence on firm BMC decisions.

6.4. Hypothesis 2: A reduction in revenues or incomes of a firm's primary customer base will lead to BMC

6.4.1 Expectations for hypothesis 2 from the literature reviewed

Although Laasch (2018) provided a value logic framework that allowed the BM concept to extend to part-commercial or non-profit firms, the consensus amongst academics in the BM research area had been that the customer dynamic was a crucial element of the BM construct (Wirtz et al., 2016). As a general business model construct, it was reasonable to assume that firms would have customer bases that were either consumers, businesses or varied combinations of both. Statistics South Africa (2020a) reported that 43.8% of surveyed businesses were unable to operate during level four lockdowns, meaning that firm revenue sources were under pressure. Similarly, Statistics South Africa (2020b) indicated that 15.4% of surveyed consumers were reporting no income six weeks into the lockdown, while 25.8% were earning lower income than before the lockdowns were implemented.

There had been general agreement in the extant BM literature that BMs represented the firm's efforts to capture value from identified customer pools of value (Chesbrough, 2002, 2007a; McDonald & Eisenhardt, 2019; Spieth et al., 2019; Teece, 2018; Wirtz et al., 2016), although Markides and Sosa (2013) and Teece (2018) had indicated that firms could have different BMs even when they have access to similar resources. Therefore, it followed from the literature that firms that had developed extant BMs on value assumptions for underlying customer bases, would have had to review their BMs in

response to the significant negative impact on the income or revenue levels of their customer bases during the Covid crisis.

6.4.2 Research results achieved for hypothesis 2

Hypothesis 2 (a reduction in revenues or incomes of a firm's primary customer base will lead to BMC) sought to test for the positive relationship between the drop in customer base income and revenues and firm BMC responses. A logistic regression model with a single independent variable was utilised for testing this hypothesis. The model yielded a result that was not statistically significant at the 95% level of confidence, and there was therefore no empirical evidence of a statistically valid relationship between the drop in primary customer incomes and firm BMC responses during the Covid crisis.

The logistic regression model that tested for the customer-base income reduction during the Covid crisis and firm BMC had a very low explanatory power (Nagelkerke R^2 of 2.5%) and therefore indicated that while BMC was evident in the population, it was not explained by the deterioration in customer income levels. In discussing the results, the extant literature and the research design and approach were considered.

6.4.3 Discussion of research findings for hypothesis 2

The results of the logistic regression in Table 30 showed that relative to the reference category, the larger decreases in customer income were associated with lower odds (< 1.00) of BMC. Even though the regression parameters were not statistically significant, the directional results achieved were unexpected as it was because it was reasonable to have expected the inverse relationship to hold. This was based on the understanding of how BMs were conceptualised; to effectively organise inter-connected firm activities that enabled the delivery of solutions to targeted customers such that the firm was able to capture value. Listed firms regularly communicated their business cases to the investment community, usually articulating both where their targeted value pools are located in the economy and their anticipated actions to extract the targeted value better than their competitors. This should therefore have indicated that firm BMs were based on assumptions on the underlying value drivers of the targeted value pools, and by association, have been sensitive to the levels of underlying customer incomes.

The 'value proposition' and 'value capture mechanism' dimensions of the firm BM were expected to be the most sensitive to changes in customer income, as these dealt with new products and services as well as product and service pricing. While the data had shown that 46.3% of the identified BM component changes were from the value proposition and value capture mechanism dimensions (see Table A1 in **Appendix A**), the model was unable to evidence a statistically significant relationship. Accounting for

the fact that there was evidence of BMC in response to the Covid crisis across the population, the researcher examined the underlying data that was used to measure the drop in customer income levels during the Covid crisis. Two areas were highlighted that offered possible explanations for the model results.

Firstly, the process relied on a manual allocation of customer base descriptions. The method utilised descriptions of firm activities and their customers to allocate the customer base descriptions, and there was the possibility that the actual customer bases were more diversified than the assigned labels in Table 10. Secondly, the researcher utilised Statistics South Africa data to estimate the reduction in income levels during the Covid crisis for individuals and business enterprises. While this was considered a good proxy for the general drop in incomes and revenues during the Covid crisis, it may have been that firms had more nuanced target customer bases, such that a general application of income or revenue level changes did not fully capture or estimate the underlying impact on the actual customer bases. The data from Statistics South Africa (2020c, 2020d, 2020e) also compared the second quarter of 2020 to the first quarter of 2020 and thus covered the six months of 2020 to the end of June 2020 (see Table C1 in **Appendix C** for the calculations). Based on the data accessible to the researcher the data utilised was the most recent available. However, it was possible that firms were accessing data that indicated a pick-up in customer value pools. Therefore, it was possible that the method and data used to estimate the independent variable had not fully captured the most recent changes in income levels of the customer base.

Beyond the research design, the results may have pointed to resilient firm balance sheets or financial strength going into the lockdown period, such that firms were able to financially weather the stress of lowered customer income levels. Another possible reason may have been actions taken by firms to defer expenses to creditors and extend repayment terms of debtors, thereby extending the profile of expected liability and revenue streams. The result of these actions would have been to mitigate the impact of the drop in customer income levels during the Covid crisis and delay BMC actions, such that the independent variable in isolation would not explain the BMC decision.

An interesting further dimension in the extant literature for antecedents of BM innovations had been industry value migration (Hacklin et al., 2018). In particular, Hacklin et al. (2018) found that adjusting the extant firm BM was effective for firms facing high industry value migration. The onset of the Covid lockdowns in South Africa transformed business operating conditions in a very short period of time. One of the fundamental shifts experienced was the shift to increased utilisation of digital channels across society for a wider range of uses (McKinsey & Company, 2020). This could have indicated that many

industries faced conditions of relative value migration, away from traditional channels of customer engagement. In firms adjusting their BMs to align with shifting external operating contexts (Fjeldstad & Snow, 2018) they may have found a structurally cheaper method of delivering goods and services. Therefore, the change in customer income levels would not have been as large a driving force as expected, because the firm cost structure had adjusted to the change in the operating business context. This could have explained why the population evidenced high levels of BMC in response to Covid, but no statistically significant relationship with the drop in customer income levels during the Covid crisis.

There was also a consideration for the complexity of BMs. There was consensus in the extant literature that an integrated BM was complex due to the interconnectedness of components across (a) strategic, (b) customers and markets, and (c) value creation dimensions (Wirtz et al., 2016). It could thus be that firm BMs in the research setting were so complex, that the customer income effect had not yet filtered into the BMC consideration. Therefore, it could have indicated that due to the complexity of BMs, changes in income levels of the customer bases and therefore the targeted value pools, had a significant lag before it impacted strategic or operational decision making of firms.

The final consideration was the acknowledgement that the BM literature was in need of cumulative theory development (Foss & Saebi, 2018; Wirtz et al., 2016). The results therefore could also have indicated that the theorised relationship between targeted customer value pools and BMs was not as clear as expected in the conceptualisation of the BM. Ritter and Pedersen (2020) found that business-to-business firms had diversified value propositions across their customer base, such that they demonstrated resilience to the stress of the Covid crisis. In essence, firms thus had different and diversified demand curves such that they benefited from rising demand for certain value propositions even as demand fell for others (Ritter & Pedersen, 2020). The data in Table 10 highlighted that 65 firms in the population (74.0%) were business-to-business or a combination of business-to-business and business-to-consumer firms. Therefore, the observations from Ritter and Pedersen (2020) also provided a possible reason that explained why the reduction in customer income levels during the Covid crisis had not exhibited a significant relation with firm BMC responses to the Covid crisis.

6.4.4 Conclusion on the research findings for hypothesis 2

This research effort attempted to empirically demonstrate that the drop in customer income levels during the Covid crisis was an explanatory factor in firm's BMC responses to Covid. However, the tested model did not provide a statistically significant result. It

therefore raised observations on the resilience of firms to changes in the income levels of the customer bases that their BMs were developed to focus on. It also raised questions around BM complexity inducing a possible lag effects for change in customer base characteristics impacting firm's BM considerations.

6.5. Hypothesis 3: Firms that increased inventory levels prior to the Covid crisis were less likely to evidence BMC

6.5.1 Expectations for hypothesis 3 from the literature reviewed

Shashi, Centobelli, Cerchione, and Ertz (2020) found that strategic stockpiling was a strategy that would evidence a firm's investment in redundancy-based SCR. With the material impact of the Covid crisis on global supply chains (Euromonitor International, 2020; Seric & Winkler, 2020) it was of academic interest to assess if there were differences in firm BMC responses to the Covid crisis, based on whether they had invested in increasing inventory levels prior to the Covid crisis. Academic research into SCR had positioned that SCR investments were important in the context of increasingly global value chains (Azadegan et al., 2020; Namdar et al., 2018), especially as Shashi et al. (2020) noted that globally, many firms had suffered at least one disruption to their supply chain. Therefore, in the research setting, had firms that had made pre-Covid investments towards an inventory-based SCR strategy by increasing inventory levels, evidenced differentiated BMC responses to the Covid crisis?

Kamalahmadi and Parast (2016) as well as Linnenluecke (2017) had also observed that many firms designed their supply chains specifically to be both efficient and robust. SCR investments were generally classified as either flexibility or redundancy strategies (Kamalahmadi & Parast, 2016; Shashi et al., 2020) with Azadegan et al. (2020) having noted that both options could have been effective in conditions of uncertainty. Macdonald, Zobel, Melnyk, and Griffis (2018) had found that the extant SCR literature evidenced a relationship between SCR investments and firm survival when faced with periods of crisis. Hence, in the context of the Covid exogenous supply-side shock, it followed from the literature that there would be a differentiable firm-level relationship between pre-Covid increases in inventory levels and BMC responses to Covid.

6.5.2 Research results achieved for hypothesis 3

Hypothesis 3 (firms that increased inventory levels prior to the Covid crisis were less likely to evidence BMC) sought to test for differences in BMC responses to the Covid crisis. The chi-square test was utilised to test this hypothesis. At the 95% level of confidence, there was no evidence of a statistically significant relationship and the hypothesis was therefore not supported. Hence, it could not be inferred that pre-Covid

investments that increased inventory levels had impacted firm BMC responses to the Covid crisis.

The proportion of firms that had increased their pre-Covid inventory levels was approximately 63% (see Table 16) and it was expected that a statistically significant relationship between the variables of interest would be found. However, from a purely statistical observation, the result of the chi-square test was understandable when Figure 5 was reviewed. Figure 5 showed the split of BMC response across firms that had or had not increased their pre-Covid inventory levels. For each of the two BMC categories, the relative proportion of firms that had increased their pre-Covid inventory levels compared to those that had not, were very similar (62.8% and 63.6% respectively). In considering possible reasons for the research findings, the extant literature on SCR, research setting, and research design were reviewed.

6.5.3 Discussion of research findings for hypothesis 3

An inventory-based redundancy SCR strategy should have been a competitive advantage when all firms faced the exogenous supply-side shock of the Covid crisis. With global supply chains either disrupted or stopped, firms that had increased levels of inventory relative to others should have had a competitive advantage, if only for a limited period of time. However, there were further effects of the South African lockdowns that challenged this assumption. Firstly, the South African Covid lockdowns were applied across society, with the exception of services (such as medical services) that were deemed essential. Especially in the early stages, many of the customer markets were also closed. Businesses and consumers were restricted on what goods and services could be sold and purchased, and the list of allowed goods and services only broadened later into the lockdown. Therefore, it was not necessarily true that firms with additional stock on hand had an advantage, as there was not a consistent market to access consumers. Secondly, firms were also subjected to additional Covid legislation that discouraged behaviour that was deemed anti-competitive within the Covid context, especially around the pricing of goods and services that were allowed to be sold. Thus, while firms that had an inventory stockpile advantage to peers may have been able to extract extra-normal profits during a supply chain disruption with regular market trading conditions, the additional legislations acted to limit the strategic options available to firms. Therefore, these factors were likely at play and could have influenced the lack of empirical support for the hypothesis.

A further consideration was the swiftness and breadth of the South African Covid lockdown. Within a very short space of time, the lockdown closed all ports and therefore

stopped supply chains. Hence, rather than a disruption that could be planned for and worked around, this served to actually prevent the overall movement of goods. Shashi et al. (2020) had positioned that SCR was effectively about policies and procedures that allowed a firm to swiftly adapt and enabled their supply chains to resume. The fact that the lockdown was across the economy served to limit the ability of firms to find means of restarting their supply chains. The issue was legislative rather than operational, such that firms were completely dependent on the South African government's legislated guidelines to determine when and to what degree they could operate. Therefore, an investment in SCR, regardless of the type, would likely have faced significant challenges for implementation as planned.

The researcher also considered Knight's (1921) differentiation between risk and uncertainty. Knight (1921) positioned risk as a known construct with a quantifiable dimension while uncertainty was largely unknown and unquantifiable. Much of the extant SCR literature discussed SCR in the context of design, towards supply chain efficiency and resilience to disruptions, usually built from knowledge of prior supply chain disruptions (Azadegan et al., 2020; Kamalahmadi & Parast, 2016; Namdar et al., 2018). Therefore, they were usually working in the context of risk, rather than uncertainty. Investing in developing a resilient supply chain was usually about managing the known and quantifiable elements across the supply chain and it could reasonably be positioned that SCR was about risk management. The Covid crisis gave rise to conditions of Knightian uncertainty in supply chain disruption, and it was possible that the investments in SCR strategies were not able to provide a differentiable advantage to firms in their BMC responses to the Covid crisis. This would have been because the SCR investments had been designed for responding to risk, rather than uncertainty.

Support for this emerged from Pournader et al. (2020) where it was posited that there was confusion in the use of the term disruption within the supply chain resilience context. The extant consideration in the SCR literature considered operational supply chain breakdowns and events like the Covid pandemic similarly, without considering the relative probability and severity imbalances (Pournader et al., 2020). In the context of the South African Covid lockdowns, the early phases were characterised by confusion around regulation details and it was probable that investments into SCR were unable to be effective because all of the actors in the supply chain were facing conditions of uncertainty. Therefore, the expected relationship between planned actions and responses was likely affected by the uncertainty as all actors sought to understand the change in context.

The researcher also considered the impact of the choice of statistical test. The chi-square test was appropriate for testing for differences between samples when using categorical variables (Knapp, 2018b). The independent variable for this test was originally continuous in nature and was developed into a categorical variable to enable the testing for differences. There could be an argument for using the logistic regression methodology to test the hypothesis, however the researcher was guided by the research intent. As the intent was to test for differences in populations (firms that engaged in BMC in response to the Covid crisis versus firms that did not) based on the presence or absence of a characteristic (the evidence of increased pre-Covid inventory levels), the chi-square test was deemed the appropriate test statistic.

6.5.4 Conclusion on the research findings for hypothesis 3

The statistical testing conducted did not find support for hypothesis 3. While firms that had evidenced increased pre-Covid inventory levels did not evidence a differentiated BMC response during the Covid crisis, the discussion for the seemingly counter-intuitive results allowed for insights into the possible contributing factors. The breadth of legislated restrictions and the differentiation between risk and uncertainty emerged as material factors that may have contributed to the results achieved.

6.6. Hypothesis 4: Exogenous shock persistence and reduction in incomes of a firm's primary customer base will increase the likelihood of BMC

6.6.1 Expectations for hypothesis 4 from the literature reviewed

Hsu et al. (2019) and Wirtz et al. (2016) noted that firms needed to be aware of shifts in their broad business environment and have the capability for BMC, either in anticipation or in response. From the discussions in Section 6.3 and Section 6.4, the expectation from the extant BM literature was that firm BMC would be individually sensitive to the persistence of the shock and to negative changes of income levels of primary customers. Section 2.6.2.1 and Section 2.6.2.2 outlined that both of these factors were present in the research setting. The expected result from the literature thus followed that the combination of these independent variables would increase the likelihood of BMC relative to the standalone factors.

6.6.2 Research results achieved for hypothesis 4

At the 95% level of confidence, the two-variable model was statistically significant with a p-value less than 0.05 (see Table 33) and the null hypothesis was rejected. Therefore, the combination of persistence of shock (DUR2) and decrease in primary customer income levels (IMP2) variables were predictive of BMC. Of the two variables in the model, Table 36 indicated that DUR2 was statistically significant whereas IMP2 was not.

Relative to the standalone odds from Table 27, it was noted that the odds of firm BMC due to the DUR2 variable increased in the two-variable model, as evidenced by the higher relative odds for the DUR2 variable categories. The same was not observed for the IMP2 variable, which demonstrated lower odds of BMC when compared to the standalone odds from Table 30. The two-factor model also had a higher Nagelkerke R^2 value than the single factor models, indicating that it was explaining more of the BMC variability than either of the standalone models.

The combination of the DUR2 and IMP2 independent variables therefore provided a statistically significant predictive model for BMC. The model explained more of the variability in BMC than either of the single variable models (for DUR2 and IMP2).

6.6.3 Discussion of research findings for hypothesis 4

Firms evidenced BMC when they were exposed to a prolonged shock and customer income levels were reducing. This was as expected and indicated that the firm's BMs were sensitive to changes to these external factors. However, it appeared that the duration of exposure to the shock was the more significant driver of firm BMC. The reduction in customer income levels during the Covid crisis increased the predictive relationship of shock duration with BMC. Possible reasons for these results were considered and discussed.

Reduction in customer income levels had the effect of making duration of exposure to the shock a more predictive variable. The reduction in customer income levels actually had a lower predictive power in the two-variable model when compared to the standalone model from hypothesis 2. This could have been because firms were hesitant to change their BMs even as they recognised that the underlying customer income pools were shrinking. This could have been due to an expectation that there would be a swift economic reversal that led to an increase in customer income pools. In that scenario, there would have been less need for BMC, especially noting the complexity of changing extant BMs, that had been noted in the extant BM literature (Mehrizi & Lashkarbolouki, 2016; Osiyevskyy & Dewald, 2018; Saebi et al., 2017; Snihur & Wiklund, 2019). This positive outlook bias may have persisted as the lockdown regulations in South Africa gradually eased from the stricter lockdown level five towards the milder lockdown level one.

Businesses therefore may have been overly optimistic in their expectations of an economic recovery, such that the change in the current underlying customer income pools were not a factor in forward looking BMC decisions. In essence, they could have been factoring in the expectation of a swift and firm recovery in customer value pools.

However, the prolonged and broad nature of the exogenous crisis had an impact across society. The expected economic recovery was therefore slower than businesses may have expected, as stressed consumers and small businesses faced income challenges for longer than expected. Therefore, the persistence of the shock may have gradually reduced firm optimism for a swift recovery of the economy and customer income pools. In doing so, firms may then have had to consider BMC even though the primary driver was duration of shock rather than the reduction in customer income levels.

From a research design perspective, the data gathering process may also have contributed to the results for hypothesis 4. The data for BMC and the persistence of shock variables was collected for the period March 2020 to September 2020. The data for the change in customer income levels was based on the changes between the three months to March 2020 and the three months to June 2020. There was therefore greater alignment between the persistence of shock and BMC variables in terms of periodicity. This may explain why the persistence of shock variable was a stronger predictor of BMC than the change in customer income levels, in the two-variable model.

6.6.4 Conclusion on the research findings for hypothesis 4

The testing for hypothesis 4 found that extended exposure to an exogenous shock and changes in underlying customer income levels were collectively predictive of BMC in the research setting. In examining and discussing the result, the researcher concluded that persistent exposure to the shock had the likely effect of decreasing firm optimism for a swift and strong recovery in customer income levels and resulted in BMC. The research design was also considered as a contributing factor for the model results.

6.7. Hypothesis 5: Increases in pre-Covid inventory levels and the duration of the exogenous shock influence BMC

6.7.1 Expectations for hypothesis 5 from the literature reviewed

Ivanov et al. (2017) and Shashi et al. (2020) had noted that increased inventory levels as a SCR strategy could have provided a buffer to supply chain disruptions. It followed that firms that had evidenced pre-Covid increases in inventory levels should have had a lower likelihood of BMC. In contrast, the BM literature indicated that firm BMC was more likely during threat conditions (Saebi et al., 2017). It followed that the joint presence of pre-Covid increases in inventory levels and the persistence of the shock as independent variables may have impacted BMC through their interactions. While the expectation from the literature review was that these variables may have had counteracting effects on BMC, the research hypothesis was structured to assess whether a model with both of these variables had a significant relationship with BMC.

6.7.2 Research results achieved for hypothesis 5

At the 95% level of confidence, the two-variable model was not statistically significant with a p-value greater than 0.05 (Table 36) and the null hypothesis was therefore not rejected. Therefore, the combination of persistence of shock (DUR2) and pre-Covid increase in inventory level (INVPERCHG2) variables were not significantly related to BMC. Relative to the standalone odds from Table 27, the odds of firm BMC due to the DUR2 variable was again higher in the two-variable model. The two-variable model also had a higher Nagelkerke R² value than the single factor DUR2 model, indicating that it was explaining more of the BMC variability when combined with the INVPERCHG2 variable.

The combination of the DUR2 and INVPERCHG2 independent variables therefore did not provide a statistically significant predictive model of BMC. However, the presence of the INVPERCHG2 variable improved the relationship of DUR2 with BMC, as evidenced by the higher relative odds for the DUR2 variable.

6.7.3 Discussion of research findings for hypothesis 5

The results for hypothesis 1 from Section 6.3 and hypothesis 3 from Section 6.5 were also relevant for this discussion. The persistence of shock variable would have been expected to increase the likelihood of BMC for larger DUR2 values, as confirmed by the results for hypothesis 1. Firms that had increased their pre-Covid inventory levels would have been expected to have had a buffer to the Covid shock and therefore have evidenced different BMC behaviour to firms that had not. However, this was not supported by the results of hypothesis 3. In combination, there should therefore have been evidence of the interaction of these variables with BMC.

The evidence in Figure 6 supported this when considering the DUR2 variable as either short-term (≤ 65 days) or longer term (>65 days). For the longer-term category, 74% of firms had evidenced BMC and increased their pre-Covid inventory levels. This contrasted with 81% of firms that had evidenced BMC and had not increased their pre-Covid inventory levels. Hence, the visual examination of Figure 6 did support the expectation that an increase in pre-Covid inventory levels had buffered firms against BMC such that there was less evidence of BMC when duration was accounted for. However, there was insufficient statistical evidence to prove this at an acceptable significance level.

Noting that the extant SCR literature had indicated that increases in inventory levels was an effective means of developing SCR (Ivanov et al., 2017; Shashi et al., 2020), Figure 6 provided some insight into the evidenced BMC behaviour of firms when considering whether or not they had increased pre-Covid inventory levels. The overall percentage of

firms that had evidenced BMC in Figure 6 was similar for firms across both categories of INVPERCHG2, thus indicating that pre-Covid changes in inventory levels did not appear to have a material impact on the relationship between DUR2 and BMC. This could point to the complexity of the interrelationships of BM components, such that even if firms had increased inventory levels, the interaction of the BM components were such that the supply chain dimension was not the material driver of the BMC decision. As this was an exogenous supply-side crisis, there was the likelihood that SCR strategies (such as increased inventory levels) were negated by the nature of the crisis.

Collectively, in failing to find statistically significant support for hypothesis 5, there were interesting observations that emerged, when considering the earlier results of hypothesis 1 and hypothesis 3. The combination of duration and increased inventory variables were not influencing BMC in the research setting. This finding was despite the earlier findings from hypothesis 1 that the duration variable was a statistically significant predictor of BMC. Hence, the addition of the increase in inventory variable may have served to dilute the relationship of the duration variable and BMC, to the extent that the overall model was not significantly related to BMC. In doing so, this indicated that the presence of increased inventory levels dampened the BMC response for prolonged exposure to the Covid crisis. This therefore supported the expectation, but there was no statistically significant support in the research setting.

6.7.4 Conclusion on the research findings for hypothesis 5

The testing for hypothesis 5 found that the combination of persistence of shock and pre-Covid increases in inventory levels were not influencing BMC at an acceptable significance level within the research setting. In examining and discussing the result, the researcher concluded that it was likely due to the complexity of BMs, that possibly pointed to the relative importance of supply chains within the interrelated BM components. The possibility of the increased inventory levels likely acting to dilute the impact of the persistence of shock variable was also discussed.

6.8. Conclusion on chapter discussions

There had been an increased interest in the field of dynamic BMs and the antecedents to BMC was noted as an area that would benefit from further empirical studies (Wirtz et al., 2016). This research effort added to the extant BM literature by conducting empirical population-based research into factors that drove or influenced firm BMC decisions in response to exogenous supply-side shocks.

Firm BMC was assessed through the four dimensions that were flagged by the work of Saebi et al. (2017). The work of Saebi et al. (2017) was specifically in the context of the

GFC, which was a uniquely endogenous and demand side driven financial crisis. However, as a deviation from the Saebi et al. (2017) approach, the researcher adjusted the flags for indicating BM dimension changes in response to the Covid crisis to ensure that BMC would only be flagged for Covid crisis related responses. Therefore, the research effort offered an extension to the work of Saebi et al. (2017) for exogenous supply-side shocks.

There was no statistically significant support for hypothesis 2 (reduction in firm's customer income levels), hypothesis 3 (pre-Covid increases in firm inventory levels) and hypothesis 5 (persistence of shock and pre-Covid increases in firm inventory levels). However, there was statistically significant support for hypothesis 1, indicating that firms were more likely to have evidenced BMC as a response to the Covid crisis, the longer the duration of the exogenous supply-side shock persisted. Hypothesis 4 was also statistically significant, indicating that the combination of persistence of shock and changes in customer income levels were predictive of BMC. While extant BM studies had shown that threats provided a catalyst for firms engaging in BMC, this was the first study to the researcher's knowledge that had empirically tested for the duration of the shock as an antecedent to firm BMC.

7. CHAPTER 7: CONCLUSION

The Covid pandemic threatened the survival of firms on a global scale (Wentzel et al., 2020) and disrupted global supply chains (Pournader et al., 2020). This research effort examined factors that may have driven or influenced firm BMC in response to the Covid crisis. The core factors that were considered were persistence of shock, change in customer income levels during the Covid crisis and pre-Covid increases in inventory levels. These factors covered the time dimension of an exogenous stimulus, a key change in the underlying target market, and efforts to embed resilience in the supply chain. The factors therefore addressed dimensions that were considered significant in the BM literature (Wirtz et al., 2016) and that were of academic relevance in the context of the unique characteristics of the Covid crisis. The factors of interest were used to craft five hypotheses for the research effort.

The research findings demonstrated support for hypothesis 1 (the longer that an exogenous shock persists, the greater the likelihood of BMC) and hypothesis 4 (exogenous shock persistence and reduction in incomes of primary customer base will increase the likelihood of BMC). However, the findings did not demonstrate support for hypothesis 2 (a reduction in revenues or incomes of a firm's primary customer base will lead to BMC), hypothesis 3 (firms that increased inventory levels prior to the Covid crisis were less likely to evidence BMC) or hypothesis 5 (increases in pre-Covid inventory levels and the duration of the exogenous shock influence BMC). The implications of the research findings to extant BM theory and the contribution to the BM body of knowledge are discussed, before extrapolating the findings to possible management considerations and noting the limitations and possible areas of future research.

7.1. Theoretical implications

7.1.1 The effect of persistence of a shock on firm BMC

The research supported hypothesis 1 and found a positive relationship between persistence (duration) of an exogenous supply-side shock and firm BMC in response to the threat from the shock. Saebi et al. (2017) had found that firms changed their BMs when faced with perceived threats. The additional implication from this research to the theory of BMC in the context of crisis was to find empirical evidence within the research setting that the persistence or duration of a shock, rather than just the occurrence of a shock event, was a factor in a firm's BMC decisions. Theoretically, this implied that theories on BMC response to threats or crises should consider this dimension in future research. When measuring firm BMC responses immediately after a threat or crisis was experienced, it may have appeared that there was evidence of threat-rigidity in that firms

may not have acted swiftly to engage in BMC. However, there was empirical support in the research setting that demonstrated that firms were more likely to evidence BMC as a response, when the shock persisted.

7.1.2 Decreases in customer income levels did not influence firm BMC

The research findings for hypothesis 2 challenged the extant theoretical positioning of BMs as a construct that was reliant on the underlying customer value pools. Fjeldstad and Snow (2018) noted that BMs should have had the ability to adjust to contextual changes, which included shifts in the underlying value pools upon which they were constructed (Teece, 2010). Indeed, Hsu et al. (2019) also noted that firms that were able to adapt their positioning to changing market preferences were usually the strongest competitors. When considering that BMs essentially connected firm activities to meet customer needs and extract value (Chesbrough, 2002; Laasch, 2018; McDonald & Eisenhardt, 2019; Teece, 2010), it was expected that a material reduction in income levels of a customer base during the Covid crisis would have led to firm BMC. This expectation was however not empirically supported in this research setting.

From a theoretical perspective, this implied that there were a broader set of influencing factors, that may have been related to the multiple demand curve findings of Ritter and Pedersen (2020). It also suggested that the complexity of BMs could have slowed the feedback mechanism for firm management to have acted on changes (Broekhuizen et al., 2018; Fjeldstad & Snow, 2018) to the underlying customer income levels. The research findings therefore raised additional avenues of research on the extant understanding of the interaction of changes in target market dynamics and BMC responses.

7.1.3 Pre-Covid investments into an inventory-based redundancy SCR strategy did not differentiate firm BMC response behaviour

The research findings for hypothesis 3 also implied possible limitations to increasing inventory levels as a means of limiting BMC when faced with an exogenous supply-side crisis. In the research setting, there was no significant difference in BMC activity for firms that had increased pre-Covid inventory levels relative to firms that had not. While Shashi et al. (2020) noted that the intent of firm SCR investments was to protect the integrity of supply chains, in the uniquely exogenous and supply-side oriented context of the Covid crisis, there was no evidence that pre-Covid investments that increased inventory levels had protected firm supply chains and led to differentiated firm BMC responses to. Linking the finding to the SCR literature, there was no support for an inventory-based SCR strategy leading to differentiated BMC responses in a crisis context. Therefore, the

research findings have added to the developing perspective on the need to theoretically clarify what SCR strategies are practically capable of effectively addressing during periods of crisis – operational risks or the uncertainty of disruption (Pournader et al., 2020).

7.1.4 Persistence of shock relationship with BMC in an exogenous supply-side crisis is amplified when coupled with additional explanatory variables

The research findings showed that the persistence of shock variable was a strong predictor of BMC. When combined with the further explanatory factors, the relative odds related to the persistence of shock variable improved, as shown in the results for both hypothesis 4 and hypothesis 5. This finding had implications for BM theory by offering an avenue for considering the evolution of other BMC drivers in crisis conditions, when combined with a temporal lens.

7.2 Research contribution

Noting that the Covid crisis had been a uniquely exogenous supply-side shock and, despite the research setting limitation, these research findings contributed to the developing understanding of firm BMC responses to the Covid crisis. The contributions of the research findings and the research process are presented below.

7.2.1 Extending the range of factors that influence firm BMC decisions in response to threats or crises

This research offered a contribution by finding empirical support within the research setting for the persistence (duration) of a shock influencing a firm's propensity to respond with BMC. It further found that a model that combined persistence of shock with changes in customer income levels was also significant in influencing BMC. In doing so, it enhanced the understanding of external factors or drivers of BMC (Foss & Saebi, 2018), specifically in the context of firm BMC responses to crisis conditions. Through making a contribution that confirmed the ongoing role of time in influencing firm BMC decisions during periods of crises, it further contributed by opening up opportunities for future research on how the effects of other drivers of BMC were also shaped by time during crises.

7.2.2 Extending the work of Saebi et al. (2017) to include exogenous supply-side shock events

Saebi et al. (2017) found that firms were more likely to change their BMs when facing conditions of threat rather than opportunity. However, they noted that their findings were limited by their research setting as well as the nature of the crisis that they used to

represent the threat to firms, namely the GFC – which had been characterised as an endogenous and demand side shock. Saebi et al. (2017) specifically noted uncertainty that their findings would extend to other types of shocks.

In finding support for hypothesis 1, this research made a contribution to the understanding of firm BMC responses to crisis conditions by supporting the Saebi et al. (2017) findings that firms engaged in BMC when facing a threat from an exogenous supply-side shock. It further extended the Saebi et al. (2017) findings to a different research setting and broadened the range of shocks to now include exogenous supply-side shocks.

7.2.3 Adding to the BM body of knowledge through empirical studies with the BM as a dependent variable

This research effort offered a contribution that responded to calls for further empirical studies with the BM as the dependent variable (Foss & Saebi, 2018; Wirtz et al., 2016). This was done through the utilisation of a population-based approach to test the postulated hypotheses.

It further contributed by providing a real-time study into the prevalence of BMC in response to the Covid crisis, through population-based research within the South African JSE-listed company setting. The researcher was not aware of any other real-time research efforts into BMC within the research setting. Apart from the very recent work of Ritter and Pedersen (2020), the researcher was also not aware of any other real-time research into the impact of the Covid crisis on BMs.

Finally, the research process contributed a dependent variable dataset that supported the positioning of Schoemaker et al. (2018), where it was noted that changing a BM during conditions of complexity and uncertainty was a requirement for firms to maintain performance. The data evidenced a high proportion of BM experimentation with 77.8% of the population evidencing Covid-related changes to at least one BM dimension, supporting the theory that firms were experimenting with BM changes during the crisis conditions. When compared to the 22.2% of firms that did not engage in Covid-related BMC, this contrasted with the positioning of other academics who positioned that firms may refrain from engaging in BMC during periods of crisis because of the complexity involved (Broekhuizen et al., 2018; Fjeldstad & Snow, 2018; Mehrizi & Lashkarbolouki, 2016).

7.2.4 Adding empirical insights for the intersection of SCR strategies and BMC

The research findings offered a contribution to the intersection of SCR and BM literature, by offering an empirical study that failed to find a significant difference in firm BMC responses, when testing for the effect of pre-Covid increases in inventory levels. In doing so, it highlighted possible limitations of inventory buffer as a redundancy SCR strategy for an exogenous supply-side crisis. Although this may have been a consequence of the research setting, it pointed to an emerging issue in the review of SCR theories. The need to review the effectiveness of elements of SCR and strategies had been noted by Pournader et al. (2020).

7.3. Implications for management

7.3.1 Time is an ongoing factor when firms engage in crisis-driven BMC

The time factor mattered within the research setting. The research found that there was a positive relationship between duration of the crisis and firm BMC responses. Management of South African listed firms should therefore invest towards understanding the durability of their firm BM when considering conditions of crisis. This understanding would offer management the opportunity to develop firm capabilities for adapting to conditions of uncertainty faster than their peers. As the research showed that firms responded with BMC as the duration of the shock persisted, management that gear firms to be adaptable at short notice could use BMC for leapfrog opportunities during periods of stress. This was also supported by Ritter and Pedersen (2020) who recently considered BM longevity, noting that management awareness of the lifespan of their BM aided them in understanding the time that they had to make strategic decisions, in the face of crisis conditions.

7.3.2 Review assumptions of the relationship of the underlying customer base relative to the firm BM

This research did not find support for a relationship between the reduction in customer income during the Covid crisis and firm BMC. Management should therefore consider reviewing the sensitivity of their BM to their underlying customer bases. The research findings may have pointed to BMs that were more resilient to deteriorations in underlying customer income levels, and this would be valuable for management to understand better. The work of Ritter and Pedersen (2020) offered that business-to-business firms were likely facing multiple demand curves with diverse slopes and may have been a lens that enhanced management understanding of how their BMs responded to conditions of crisis. Management understanding of the true drivers of their BM will likely enhance their

ability to lead their firms through periods of crisis and communicate more effectively with the investment community.

7.3.3 Understanding SCR strategies and how they perform in crises

The research offered a contribution by highlighting opportunities for management to employ tools and techniques that aid in understanding uncertainty (such as scenario planning) in redesigning supply chains. The research did not find significant differences in firm BMC behaviour based on pre-Covid increases in their inventory levels. The discussion of this research finding indicated that a possible reason for this was the risk focus of SCR versus the uncertainty that the Covid crisis gave rise to. The lessons from the Covid impact on supply chains should be used as input into redesigning supply chains, and managers should consider incorporating probability and severity considerations (Pournader et al., 2020).

7.3.4 Examine extant BMs with a complexity lens

Managers should employ complexity theory and tools to understand the interconnections of the various BM components. Complexity in BMs emerged from the various components, the interconnections and the networks across actors that interacted with the different components (Bidmon & Knab, 2018; Wirtz et al., 2016). Utilising tools that assist in better understanding the problem and provide the correct dimensions of risk or uncertainty (Pournader et al., 2020) will be crucial for firms as they consider more resilient BMs for the future. Managers should consider utilising tools such as futures analysis and scenario planning to assist with understanding possible consequences of actions taken in complex systems in crisis conditions.

7.4 Limitations

7.4.1. Theoretical lens

A possible theoretical limitation was due to the choice of BM components that were checked for evidence of BMC. The BM literature noted that there were multiple conceptualisations of the BM components (Foss and Saebi, 2018; Wirtz et al., 2016). As the researcher utilised a keyword search method, a different choice of BM dimensioning may have yielded different BM dimension change data, in terms of granularity. However, noting that the academic literature had highlighted that BM views on BM components had effectively converged on value proposition, creation and capture (Chesbrough, 2002, 2007a; Foss & Saebi, 2018; McDonald & Eisenhardt, 2019; Spieth et al., 2019; Teece, 2010), the researcher would not expect that the overall BMC indicator variable would be significantly different.

A further theoretical limitation was the choice of identifying BMC through a change in at least one BM component, rather than all. Again, the academic literature was divided on approaches (Clauss, 2017), especially when considering BM evolution versus innovation (Saebi et al., 2017). As BMC covered the breadth of changes to BM, the choice made for the research was appropriate for the research intent.

7.4.2 Unit of analysis

A potential limitation emerged from the selected unit of analysis. While the choice of unit of analysis was justified based on the research intent of this research effort, the researcher considered the potential limitations of the choice. The unit of analysis for this research effort was the firm. However, some firms likely had portfolios of businesses that may have operated across various economic sectors. As such, a firm may have had underlying businesses that would have been exposed to different operating restrictions during the lockdowns. Hence, utilising business units of firms as the unit of analysis could have provided further granularity of data to examine the research areas of interest. However, the researcher also considered that access to data for that unit of analysis may have been a significant challenge for researchers.

7.4.3 Methodological choices

The Covid crisis was a unique phenomenon that continued to impact the world. For researchers seeking to deeply understand the underlying factors that were contributing to management thinking in making BMC decisions in the context of the Covid crisis, a qualitative research design using a phenomenological approach could have been useful (Creswell & Creswell, 2018). The particular value of that approach relative to the quantitative approach utilised in this research effort, would have been the ability to get information directly from the perspective of firm management. However, potential sources of researcher and participant bias would have to be managed.

Wirtz et al. (2016) noted that 62% of academics in the BM research arena had indicated that empirical research was increasingly valuable in the development of the BM theoretical body of knowledge. Therefore, notwithstanding the possible limitation of the quantitative approach, this research effort was envisaged to contribute to the BM literature by answering the call for further research into dynamic BMs using the BM as a dependent variable.

7.4.4 General limitation

Beyond the research design, the primary limitation of the research effort related to generalisability of the findings. The nature of global responses to contain or manage the

Covid crisis varied across countries and meant that the nature of the challenges that firms had to face were non-uniform. Hence, even though the nature of the exogenous shock was common globally, the varied nature of the containment responses meant that the findings for BMC responses in the extant research setting may not be generalisable for other settings. Some of the additional factors that varied across countries, thereby inhibiting generalisability, included (a) population demographics, (b) fiscal and monetary policy positions, (c) industrialisation levels, and (d) healthcare sector readiness.

7.5 Suggestions for future research

This research effort sought to test for explanatory relationships. The nature of a new phenomenon will also benefit from explorative research efforts. A qualitative study with firm management would shed light on the factors that were considered in their BMC decisions as they experienced the real-time challenge of the Covid crisis. As an example, a thematic analysis could be useful to develop the understanding of leadership and strategic thinking in the firm BMC decision making process.

This research effort was conducted in real time relative to the Covid crisis, hence there is the opportunity to add a further temporal lens to the research to review whether there is support for the hypotheses when taking a longer research time horizon. As an extension of this, there is also a research opportunity to examine the relationship between firm BMC decisions in response to the Covid crisis and firm performance. This could be through either share price performance (measured through and after the Covid crisis period as well as relative to peer group) or reported profitability (measured after the Covid crisis period and relative to peer group). Would there be evidence of a clear relationship between firms that evidenced Covid-related BMC and relative outperformance? Research into relationships between firm share price performance during the Covid crisis and firm BMC may provide insights into shareholder versus stakeholder bias in management decision making during the crisis.

This research effort conceptualised BMC over the period March 2020 to September 2020, without distinguishing when the BMC decision was flagged during the period. Hence, regardless of whether a firm issued documents that flagged BMC very early or very late in the period, it was still flagged as overall BMC. As outlined in Table 9, the researcher collected data at a BM component view. There exists the potential for further research into the interaction of these two dimensions within the research setting. This could be done by examining the BM components and assessing whether there was a preference for different component changes at different stages of the crisis. This may enhance the understanding of which BM components were favoured by firms during

the early stages of the crisis and lockdowns versus the latter stages. These insights may be of value to academics and practitioners alike, especially as the Covid pandemic persists.

The intersection of SCR strategies and firm BMC choices remains an area that may benefit from future research, especially as businesses consider what BM or supply chain changes may be required in the aftermath of the Covid crisis. Research into how effective various SCR strategies were for firms through the Covid crisis may assist in measuring the value of SCR strategies for disruptions that are exogenous, supply-side oriented and persistent. This would contribute to understanding the relationship between SCR strategies and BM resilience.

The lack of empirical support for hypothesis 2 in this research setting raises questions on whether the nature of the relationship of BMCs with underlying customer bases are evolving. Further research into the relationship of underlying customer bases and supporting BMCs would be valuable. Further qualitative and quantitative research into this area would assist in reviewing BMC understanding following the global disruption of the Covid crisis.

Finally, at the time of writing, the second wave of the Covid crisis was prevalent across the globe. In response, governments were again implementing lockdown measures even as vaccines were being successfully developed. In South Africa, the government moved the country from lockdown level one to lockdown level three in late December 2020. The BMC impact of the second wave of the crisis is of both business (Roubini, 2020) and academic (Pournader et al., 2020; Saebi et al., 2017) interest. Do firms that evidenced BMC during the first wave of the Covid crisis evidence further BMC during the second wave, or do they prove to be more resilient to BMC? Future research could also consider whether firms that evidenced BMC during the first wave of the Covid crisis evidenced relative outperformance during the second wave. Future research could also examine whether firm BMC in response to the Covid crisis were oriented towards sustainable BMCs (Geissdoerfer et al., 2018), and incorporated non-commercial value logics (Laasch, 2018).

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Appendix A

Individual BM component changes in response to the Covid crisis

Table A1

Overall incidents of BM component changes in response to the Covid crisis

BM Dimension	Count	Percentage of Total
VP change	20	18.5%
CoTC change	13	12.0%
VDS change	45	41.7%
VCM change	30	27.8%
Overall count	108	100.0%

Source: By Author

Some firms were flagged as engaging in multiple BM dimension changes in response to the Covid crisis, therefore, the sum of the observations in Table B1 are greater than the 88 firms of the population.

Appendix B

Further details on data gathering for persistence of shock variable

Table B1

Details of the re-categorisation of SA Covid website compound economic categories

SA Covid website category	Researcher divided category into the following
Accommodation and food service activities permitted	Accommodation Food service activities
Financial and business services	Financial services Business services Real Estate
Health, social and personal services	Health services Social services Personal services
Media and entertainment services	Media services Entertainment services
Transport, storage and communication services permitted	Transport services Storage and communication services
Agriculture, hunting, forestry and fishing	Agriculture, hunting and fishing Forestry

Source: By Author

Table B2

Duration of each phase of the Covid lockdown over the research period

Lockdown level	Start	End	Days
Pre-lockdown	02-Jan-20	25-Mar-20	n/a
Level 5	26-Mar-20	30-Apr-20	35
Level 4	01-May-20	31-May-20	30
Level 3	01-Jun-20	17-Aug-20	77
Level 2	18-Aug-20	20-Sep-20	33
Level 1	21-Sep-20	30-Sep-20	9

Source: By Author

Table B3

Impact label description for industries impacted by lockdown regulations

Impact label	Description
No operations	Companies were not allowed to operate
Partial operations	Companies were allowed to operate within regulatory restrictions
Full operations	Specifically permitted to operate within the regulations

Source: By Author

Table B4 shows the mapping of economic categories to duration categories, noting the distribution of the firms that were present in the population. As an example, the 'Automobiles & Parts' sector in Table B4 indicated that this sector was not able to operate at full capacity for 142 days due to the lockdown regulations. This was due to the sector being impacted by the regulatory lockdown levels five, four and three. The cumulative number of days of these three lockdown levels summed to 142 days (see Table B2).

Table B4*Economic sectors in population - Duration of lockdown impact and number of firms*

Moneyweb economic sector identifier	Cumulative days that lockdown regulations prevented full operations	Number of firms in population	Percentage of total firms in population
Automobiles & Parts	142	1	1%
Construction & Materials	175	4	5%
Electronic & Electrical Equipment	184	2	2%
Energy	0	1	1%
Financial Services	0	7	8%
Fixed Line Telecommunications	0	1	1%
Food Producers	35	5	6%
Forestry & Paper	35	1	1%
General Industrials	142	2	2%
General Retailers	142	8	9%
Health Care Equipment & Services	0	2	2%
Industrial Metals & Mining	65	1	1%
Industrial Transportation	184	2	2%
Leisure Goods	142	1	1%
Life Insurance	0	1	1%
Media	0	2	2%
Mining	65	2	2%
Mobile Telecommunications	0	1	1%
Personal Goods	142	1	1%
Pharmaceuticals & Biotechnology	142	3	3%
Real Estate Investment & Services	142	4	5%
Real Estate Investment Trusts	142	24	27%
Software & Computer Services	175	6	7%
Support Services	175	3	3%
Technology Hardware & Equipment	142	1	1%
Travel & Leisure	175	2	2%

Source: By Author

Appendix C

Supporting calculation for percentage change in primary customer income

Table C1

Percentage change in income of primary customer categories

Category label	Number of companies in dataset	Jan 20 to Mar 20	Apr 20 to Jun 20	Percentage change between the periods
Consumer ¹ (R'000s)	23	13 789	11 720	-15.0%
Business - SME ² (R millions)	1	929 629	811 074	-12.8%
Business - Large ³ (R millions)	10	1 546 158	1 257 224	-18.7%
Business - Mixed ⁴ (R millions)	37	2 475 787	2 068 298	-16.5%
Mixed - Business and Consumer ⁵	17	n / a	n / a	-15.7%

¹ Based on income taxes paid by survey sample. ² Based on Turnover figures for small and medium businesses. ³ Based on Turnover figures for large businesses. ⁴ Based on Turnover figures for small, medium and large businesses. ⁵ Average of the growth rates for "consumer" and "Business - mixed".

Source: By Author