

## Dynamic supply chain capabilities: how market sensing, supply chain agility and adaptability affect supply chain ambidexterity

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**Dynamic supply chain capabilities:  
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ambidexterity**

**Abstract:**

**Purpose:** This paper positions market sensing, supply chain agility and supply chain adaptability as a coherent cluster of dynamic supply chain capabilities. The purpose of the paper is to understand how dynamic supply chain capabilities interrelate and their effect on supply chain ambidexterity.

**Design/methodology/approach:** Based on a survey of Pakistani manufacturing firms, a theoretically-derived model was tested in a structural equation model.

**Findings:** The results of the study show that a market-sensing capability is an antecedent of supply chain agility and supply chain adaptability. Furthermore, supply chain agility, directly, and supply chain adaptability, indirectly, affect supply chain ambidexterity. Supply chain agility therefore mediates the relationship between supply chain adaptability and supply chain ambidexterity.

**Originality/value:** The contribution of this study lies in: (1) identifying dynamic capability clusters relevant for achieving supply chain ambidexterity;(2) evaluating performance implications of dynamic capabilities in the supply chain, specifically supply chain agility and adaptability; and (3) proposing a unique measurement of supply chain ambidexterity in the light supply chain theory, and empirically evaluating the relationship between dynamic capabilities and supply chain ambidexterity.

**Keywords:** Market sensing, supply chain agility, supply chain adaptability, supply chain ambidexterity, dynamic capabilities view, survey

## 1. INTRODUCTION

Today's companies compete in an increasingly volatile and unpredictable marketplace (Christopher and Holweg, 2011, Dubey et al., 2018). To remain competitive, companies need to explore for new market opportunities and exploit existing efficiencies within their operations (March, 1991, Wu et al., 2017). Exploration includes the search for new possibilities, the discovery of innovative ideas, and the flexibility to respond to new opportunities as they arise (March, 1991). Exploitation refers to selecting, refining and implementing standardized procedures to achieve efficiencies in a firm's operations (ibid).

For a long time, scholars have argued that operations managers are faced with a trade-off between flexibility and efficiency – where prioritizing one is often to the detriment of the other (De Meyer et al., 1989, Kannan, 1998, Hayes and Wheelwright, 1984, Skinner, 1985, Skinner, 1969, Hill, 1993). The argument goes that companies should pursue either a low cost competitive strategy supported by efficient operational processes, or a strategy of differentiation supported by more flexible processes (Hill, 1993, Markides, 2006, Porter, 1996, 1980). According to this group of scholars, attempting to reconcile efficiency and flexibility results in the operation becoming stuck in-between, leading to high switching costs (Porter, 1980, 1996, Markides, 2006).

Yet, another group of scholars argues that organisations can be simultaneously flexible and efficient by developing an ambidexterity capability (Duncan, 1976, Adler et al., 1999, Gibson and Birkinshaw, 2004, Tushman and O'Reilly III, 1996). Ambidextrous organisations are ones that are aligned and efficient in the management of today's business demands, while also adaptive enough to changes in the environment so they will be around tomorrow (Gibson and Birkinshaw, 2004 p. 209). For example, Adler et al. (1999) found that by partitioning its operation, a Toyota subsidiary could exploit the cost advantages associated with repetitive tasks whilst simultaneously exploring for new flexible manufacturing systems during non-routine

work. Other OM scholars have found that companies with operational ambidexterity capabilities are able to explore new, and exploit existing, processes simultaneously – leading to enhanced operational performance (Kortmann et al., 2014, Patel et al., 2012, Tamayo-Torres et al., 2017).

The notion of operational ambidexterity has since been extended beyond the boundaries of the firm – to the supply chain (Blome et al., 2013a; Im and Rai, 2008; Kristal et al., 2010; Lee and Rha, 2016; Rojo et al., 2016). Kristal et al. (2010) define supply chain ambidexterity as a firm’s strategic choice to simultaneously pursue both supply chain exploitation (efficiency) and exploration (flexibility) practices (Kristal et al., 2010 p. 415). The notion of supply chain ambidexterity runs counter to those scholars that suggest companies should select the right supply chain for their product; with primarily functional products using efficient supply chains and primarily innovative products relying on flexible supply chains (i.e. Fisher, 1997). Instead, supply chain ambidexterity means managers are not faced with an either/or decision, but can simultaneously have a flexible AND efficient supply chain for a particular product (Lee and Rha, 2016; Rojo et al., 2016).

To achieve such an ambitious goal, Lee (2004) argues that successful companies require supply chains that can rapidly respond to short-term changes in demand (agility) and adjust to long-term market changes by restructuring the supply chain (adaptability). Supply chain agility (SAG) is defined as the firm’s ability to respond to market changes such as variation in demand patterns, in terms of quality, quantity, and variety, as well as to supply patterns, in terms of shortages and disruptions (Blome et al., 2013b). Supply chain adaptability is defined as the ability of the firm to make supply chain design changes– that are far more radical and long-term than changes pursued under the notion of supply chain agility – in the wake of sensed opportunities (Eckstein et al., 2015, Ketchen and Hult, 2007).

Because supply chain agility and adaptability are developed and renewed in response to changes in customer demand, these two constructs have been positioned as dynamic capabilities (see Eckstein et al., 2015; Whitten et al., 2012). Dynamic capabilities are higher-order capabilities that refer to a firm's ability to *sense* opportunities and threats in the marketplace, to *seize* opportunities as they arise and to *transform* assets and organisational structures as the organisation grows and market requirements change (Teece, 2007). Supply chain agility is positioned as a *seizing* dynamic capability because it allows the firm to identify opportunities and threats in the marketplace and to provide an agile supply chain response (Eckstein et al., 2015). Supply chain adaptability is positioned as a *transforming* dynamic capability, because the resource base and structure of the supply chain is transformed over the longer term in response to changes in the marketplace (Eckstein et al., 2015). As agility and adaptability are integrated and coordinated with supply chain partners, a complex adaptive system forms which is able to sense changes in the marketplace, seize new opportunities and transform the supply chain to satisfy customer demand (Whitten et al., 2012).

Importantly, we argue a firm's supply chain would have difficulty seizing opportunities in the marketplace and reconfiguring its operations in response, without the capability to sense these opportunities in the first place. Market sensing reflects the firm's routines related to actively learning about customers, competitors, supply chain members and the business environment that allows for understanding of market conditions as well as for prediction purposes (Morgan, 2012). Recent studies have investigated the direct and indirect effects of supply chain agility and adaptability on different measures of firm performance (Dubey et al., 2018, Eckstein et al., 2015). But despite these laudable efforts, the role of market-sensing capabilities has been largely ignored (Teece et al., 2016). To fill this gap in our understanding, this paper attempts to answer the following research question: *how do market sensing, supply chain agility and supply chain adaptability affect supply chain ambidexterity.*

We answer our research question by examining survey data collected from 277 manufacturing firms in Pakistan. Empirical research findings on companies in Pakistan are limited as a result of the difficulty of data collection; however, due to the uncertainty of the economic system, dynamic supply chain capabilities play an important role in firm survival. We therefore believe that Pakistan, like other dynamic markets, is an excellent context within which to investigate dynamic supply chain capabilities in comparison to more mature markets where firms adjust to significant changes less often. Data is analysed by means of structural equation modelling.

This study contributes to theory and practice in the area of dynamic capabilities in supply chains. According to Teece (2007), dynamic capabilities exist in the form of capability clusters consisting of sensing, seizing, and transforming/reconfiguration capabilities. Like Teece (2007), we position market sensing, supply chain agility and adaptability as a coherent cluster of dynamic supply chain capabilities that should be considered in conjunction rather than in isolation. We empirically show that supply chain agility has a significant short-term effect on supply chain ambidexterity, that supply chain adaptability has a significant long-term effect on supply chain ambidexterity and that market sensing acts as a key antecedent for both variables. Combined, this dynamic supply chain capability cluster allows organisations to modify their products, services and supply chain structures according to market requirements over both the short and long-term. In making this argument, we respond to the call by supply chain theorists to identify dynamic capabilities relevant to the supply chain environment (Beske et al., 2014). Finally, we provide a new measurement of supply chain ambidexterity developed based on extant scales to better explain short and long-term performance versus traditional performance measures.

The remainder of the paper is organised as follows. Section 2 discusses the studies theoretical foundations, reviews the relevant literature and develops a hypothetical model of

the relationship between market sensing, supply chain agility, adaptability and ambidexterity. Section 3 provides a justification of the research design. Section 4 presents the study's findings and section 5 discusses the results. The studies implications for theory and management, along with its limitations, are discussed in Section 6.

## **2. LITERATURE REVIEW AND HYPOTHETICAL MODEL**

### ***2.1. Dynamic Supply Chain Capabilities***

We ground this study in the dynamic capabilities view of the firm. Dynamic capabilities are the organisation's ability 'to sense and then seize new opportunities, and to reconfigure and protect knowledge assets, competencies, and complementary assets with the aim of achieving a sustained competitive advantage'(Augier and Teece, 2009 , p. 412). Dynamic capabilities depict the firm's ability to modify its distinctive and co-specialised resources in order to respond to changing environmental conditions (Augier and Teece, 2009). They manifest in firms through the transformation of business processes, resource allocations and reallocations, and operations (Teece, 2007). Dynamic capabilities can lead to differences in the performance of firms, even if firms are similar in terms of resources and capability endowments (Easterby-Smith et al., 2009). Yet at their core, these capabilities are similar in the sense that they enable knowledge creation and dissemination, and continuous modification of organisational processes in response to environmental changes (Easterby-Smith et al., 2009).

The application of the dynamic capabilities view to strategic decisions in supply chain management is becoming increasingly common (Witcher et al., 2008, Allred et al., 2011, Fawcett et al., 2011, Blome et al., 2013b, Defee and Fugate, 2010). Dynamic capabilities in the supply chain emerge when firms engage their employees in understanding customer requirements and translate these requirements so that they are effectively communicated

throughout the supply chain (Handfield et al., 2015). Indeed, scholars have begun challenging the conceptualization that dynamic capabilities are bounded by the firm, and have extended our understanding beyond firm boundaries to acknowledge the presence of ‘dynamic supply chain capabilities’ (Dubey et al., 2018, Eckstein et al., 2015, Swafford et al., 2006).

For example, Swafford et al. (2006) argue that supply chain agility is a capability that allows the supply chain to *seize* opportunities once they are sensed. Supply chain agility is positioned by other authors as a fundamental capability needed to endure and flourish in volatile environments (Gligor and Holcomb, 2014, Braunscheidel and Suresh, 2009), as it allows for a flexible supply chain response (Gligor and Holcomb, 2012). Building on this argument, Blome et al. (2013b) put forward the idea that supply chain agility is a dynamic capability able to positively influence the operational performance of the firm. Supply chain agility can also be regarded as an extension of agile manufacturing which focuses mainly the firm (Yusuf et al., 1999, Brown and Bessant, 2003). Furthermore, supply chain agility is typically considered to extend the narrower concept of supply chain flexibility (Stevenson and Spring, 2007, Gligor and Holcomb, 2012).

Supply chain adaptability refers to a firm’s ability to *reconfigure and transform* supply chain design according to expected market changes (Lee, 2004). Ketchen and Hult (2007) explain that supply chain adaptability is the willingness to reshape the supply chain when necessary, without ties to legacy issues or the way the chain has been operated previously. Stevenson and Spring (2007) suggest that supply chain adaptability is the property of a supply chain which allows the members to cope with dynamics associated with the supply chain. Eckstein et al. (2015) draw together this line of reasoning and suggest that supply chain agility and adaptability can be considered dynamic capabilities that result from the firm’s ability to reconfigure firm-level and supply chain-level resources.



Interestingly, many of these studies examine the effects of supply chain agility and adaptability, either individually or combined, on firm performance (Blome et al., 2013b, Dubey et al., 2018, Eckstein et al., 2015, Lee, 2004, Lee and Rha, 2016), however the role of market sensing is largely ignored. This is a curious omission as it stands to reason that supply chain managers would need the ability to sense opportunities and threats in the marketplace in the first instance, in order to provide a flexible response (supply chain agility) and to restructure the supply chain over the longer-term (supply chain adaptability). Indeed, Day (1992; 1994) argues that firms involved in developing a better understanding of the market situation (market sensing) have a better chance of understanding and acting on uncertainties and market trends (Day, 1992, Day, 1994). Bharadwaj and Dong (2014) reaffirm that systematically undertaking market sensing activities to remain synchronized with market changes can facilitate the provision of superior value propositions.

It thus stands to reason that, like the dynamic capabilities of the firm (Teece, 2007), dynamic supply chain capabilities including market sensing, supply chain agility and supply chain adaptability exist in cluster. It follows that dynamic supply chain capabilities are interrelated and need to exist in combination to prove beneficial to the firm. We now turn our attention to understanding how market sensing, supply chain agility and adaptability interrelate and the resulting effects on supply chain ambidexterity.

## ***2.2. Supply Chain Ambidexterity***

To become ambidextrous, firms need to harmonise the contradictory demands imposed by the environment (Raisch and Birkinshaw, 2008). These demands include balancing efficiency in exploiting current resource positions versus exploring and responding to future market conditions through search and experimentation activities (He and Wong, 2004). This simultaneous pursuit of seemingly conflicting goals has been termed organisational ambidexterity (Weber and Tarba, 2014).

Operations management scholars have acknowledge that a firm's internal operation can be both flexible and efficient if the right structures are in place (Adler et al., 1999, Kortmann et al., 2014, Patel et al., 2012, Tamayo-Torres et al., 2017). For example, Patel et al. (2012) found that firms with greater operational ambidexterity capabilities are able to respond to demand and competitive uncertainty by pursuing efficient and flexible manufacturing strategies. Tamayo-Torres et al. (2017) found that ambidexterity acts as an enabler across quality, speed, flexibility and cost dimensions, therefore driving manufacturing performance.

The concept of ambidexterity has since been applied within a supply chain context (Blome et al., 2013a; Im and Rai, 2008; Kristal et al., 2010; Lee and Rha, 2016; Rojo et al., 2016). For example, Kristal et al. (2010) explains that supply chains encompass a variety of sub-systems which can simultaneously pursue either efficiency or responsiveness objectives. Im and Rai (2008) found that knowledge sharing leads to relationship performance gains and that such sharing is enabled by the ambidextrous management of buyer-supplier relationships. Rojo et al. (2016) identify that building a supply chain ambidexterity capability can help firms to achieve an optimal level of supply chain flexibility. Likewise, Lee and Rha (2016) find that supply chain ambidexterity is important as firms mitigate the negative impact of supply chain disruptions, thereby enhancing business performance. To build an ambidextrous supply chain, Blome et al. (2013a) suggest that buyers can gain synergistic advantages by pursuing both contractual supplier relationships to achieve cost efficiencies, and relational collaborations to realize flexibility benefits.

Unfortunately however, the majority of these studies examine the relationship between supply chain ambidexterity and firm performance without acknowledging the antecedents of supply chain ambidexterity.

### ***2.3. The relationship between market sensing, supply chain agility and adaptability***

We suggest that supply chain ambidexterity requires a firm's supply chain to be simultaneously agile, so it can quickly respond to short term market changes, and adaptable so the resource base and structure of the supply chain can be reconfigured to achieve longer term efficiency gains. We stress there would be no need for an agile or adaptive response if, in the first instance, supply chain managers are unable to sense opportunities and threats in the marketplace.

Based on this line of reasoning, we hypothesise that market sensing acts as an antecedent of supply chain agility and adaptability. Support for this relationship can be found in the dynamic capabilities view, which suggests that the ability to sense market opportunities accurately is a pre-requisite of the development and deployment of other dynamic capabilities (Teece, 2007). Firms with well-developed market-sensing capabilities are more likely to be agile because they have a better understanding of supply chain partner activities allowing for proactive response to market uncertainty (Tse et al., 2016). Indeed, market sensing allows firms to become well prepared and to develop structures, technologies and policies to respond to market changes in an efficient manner (Ngai et al., 2011).

In fact, Eckstein et al. (2015) argues that the ability to sense marketplace changes is an important dimension of supply chain agility. Supply chain agility necessitates that firms respond promptly and adequately to unexpected changes in the market situation (Tippins and Sohi, 2003). This is not possible unless the firm has a clear understanding of the future implications of market opportunities (Teece et al., 2016). Faster and more accurate responses to business opportunities (i.e. supply chain agility) that thwarts competition and retains customers, is the outcome of the ability to better sense and disseminate market information (Day, 1992). Drawing together this line of reasoning, we hypothesize that:

*H1: Market sensing has a positive effect on supply chain agility.*

We go on to suggest that a firm's ability to understand and adjust quickly to marketplace changes depends on its adaptive capabilities (Day, 2014). Market sensing positively affects supply chain adaptability because understanding the magnitude of change or variability in the business environment is the first step towards building flexibility and efficiency into supply chain design (Christopher and Holweg, 2011). This argument is supported by Schoenherr and Swink (2015) who suggest that supply chain adaptability reduces the constraints on the firm's response to changing product or service requirements, by spotting new resources (e.g. raw materials) and problem solving (e.g. product commercialisation and launching).

An important contribution made by Lee (2004) highlights how supply chain adaptability transforms supply chain design in response to the 'structural shift' in the market. However, in order to achieve this transformation, Lee argues that this structural shift has to be perceived *ahead of time* so that long-term supply chain design decisions can be adjusted (Lee, 2004). This is achieved by sensing changes in the market through activities such as capturing market data, separating noise, and identifying key patterns. Based on this information, the firm decides on facility relocation, supply source changes, and relevant outsource manufacturing (Lee, 2004). It can thus be argued that a supply chain manager's ability to scan the marketplace, interpret and respond to the signals of change acts as a key trigger of supply chain adaptability (Reeves and Deimler, 2011). We therefore hypothesize the following:

*H2: Market sensing has a positive effect on supply chain adaptability.*

#### ***2.4. The relationship between supply chain agility, adaptability and ambidexterity***

We have argued that supply chain agility is the firm's ability to respond quickly to market changes and disruptions, both internally as well as with the support of its suppliers and customers (Braunscheidel and Suresh, 2009). By possessing a supply chain agility capability, firms are able to modify their routines according to changing market conditions, and seize

market opportunities in a timely manner (Swafford et al., 2006) without modifying the inherent structure of a supply chain's design (Eckstein et al., 2015). Becoming agile requires the ability to cater to sometimes conflicting requirements, such as innovation versus efficiency and meeting global versus local demand, etc. (Lewis et al., 2014). Supply chain agility improves the firm's responsiveness by integrating sensitivity to market changes, with the capability of using resources in response to these changes in a flexible and timely manner (Li et al., 2008).

In a somewhat counter-intuitive way, supply chain agility also makes a firm more cost efficient. Although both are somewhat conflicting objectives, such contradictions, as suggested by Adler et al. (1999), are embraced in the knowledge age. For example, Yang (2014) notes that in order to match supply with demand, firms make investments in the ability to customise products, make adjustments in production volumes, and produce a wide range of products. The collaboration between supply chain partners that results from the pursuit of these goals allows transaction costs and total resource inputs to decrease, leading to the reduction of supply chain costs. Supply chain agility also drives down costs through inventory reduction and effective integration with suppliers, while increasing responsiveness through rapid adaptation to demand (Mason et al., 2002). Therefore, it can be argued that supply chain agility provides the agile and efficiency gains of an ambidextrous supply chain. Thus, we propose:

*H3: Supply chain agility has a positive effect on supply chain ambidexterity.*

Importantly however, supply chain agility cannot be thought to positively affect the ambidexterity of a supply chain in isolation. In contrast to supply chain agility, which centres on short-term responses, supply chain adaptability requires longer-term changes to the structure and resource base of a firm's supply chain (Lee, 2004 , p. 4). Supply chain adaptability helps firms cope with longer-term challenges such as changes in product range and mix, markets served, service levels, and profit margins (McCullen et al., 2006).

In this study, we hypothesise that supply chain adaptability has a longer-term, positive impact on supply chain ambidexterity. Moreover, we suggest that supply chain adaptability affects both dimensions of supply chain ambidexterity positively. Firstly, supply chain adaptability influences efficiency because the flexibility built into the supply chain (by outsourcing, using flexible labour arrangements, etc.) requires that fixed costs be changed into variable costs, which over a period of time can reduce total supply chain costs (Christopher and Holweg, 2011). Furthermore, designing product ranges with higher levels of component commonality also reduces inventory carrying costs (Lee, 2004).

Secondly, supply chain adaptability positively influences responsiveness, as developing alternative supply bases through facility relocation helps to maintain quality levels and to guarantee steady service in times of changing markets and economies (Eckstein et al., 2015). Diversification in sourcing also helps to improve service levels and delivery performance (Christopher and Holweg, 2011). Similarly, innovativeness supports reduction in development lead times, design cycles and flexible design capabilities (Eckstein et al., 2015).

Like with supply chain agility, supply chain adaptability positively influences the efficiency and flexibility of the supply chain; it is just that the former is oriented towards short-term response, while the latter is focused on longer-term restructuring. Indeed, this line of reasoning supports our argument that having an ambidextrous supply chain means managers are not faced with an either/or decision, but can have a flexible and efficient supply chain for the same product (Lee and Rha, 2016, Rojo et al., 2016). We therefore hypothesize the following:

*H4: Supply chain adaptability has a positive effect on supply chain ambidexterity.*

## ***2.5. Mediating Role of Supply Chain Agility***

Dynamic capabilities theory suggests that capabilities do not remain infinitely competitive (Protogerou et al., 2012). Over time, the processes underlying dynamic capabilities become imitable and require transformation (Teece, 2014). It follows that, in order to sustain competitive advantage in the long run, certain short-term changes have to be made. Based on this reasoning, we suggest that supply chain adaptability is the capability that influences the long-term sustainability of a firm's competitive advantage, while the influence of supply chain agility is shorter-term.

This argument is supported by Eckstein et al. (2015) who suggest that supply chain adaptability acts as an enabler of supply chain agility. Specifically, they state that the ability to reconfigure the supply chain according to market requirement (supply chain adaptability) acts as the basis for the firm to develop a supply chain agility capability (Eckstein et al. 2015). Supply chain agility requires the ability to quickly deal with demand-side changes, such as changing customer preferences, and supply-side changes, such as delivery failures (Blome et al., 2013b). A firm is able to cope with delivery failures if it has been involved in the continuous development of its supplier and logistics infrastructure (Lee, 2004). Similarly, a firm is able to deal with changing customer preferences if it has been monitoring these changes overtime (Lee, 2004). Accordingly, the long-term structural changes (supply chain adaptability) needed to achieve the dual motivations of efficiency and flexibility necessitate a series of short-term supply chain interventions (supply chain agility). Based on this line of reasoning, supply chain agility plays a mediating role in the relationship between supply chain adaptability and ambidexterity. Therefore, we posit:

*H5: Supply chain agility mediates the relationship between supply chain adaptability and supply chain ambidexterity.*

Drawing together these arguments, we advance the following hypothetical model (See Figure 1).

---Insert Figure 1 here---

### **3. RESEARCH METHODS**

#### ***3.1. Research Design***

We follow a positivistic ontology believing that the major constructs of our works (e.g. supply chain agility and supply chain adaptability) are real and not subject to social construction. The underlying epistemology predicts that these constructs can be measured with quantitative methods which we do with the help of a survey. Therefore, we adopted a deductive research approach, as we are testing hypotheses that are underpinned by existing theories (dynamic capabilities) (Ketchen and Shook, 1996). In addition, related studies on dynamic capabilities and supply chain ambidexterity from a supply chain perspective have used the same methodology enabling generalisability of results (Blome et al., 2013b, Eckstein et al., 2015, Kristal et al., 2010). The unit of analysis for the study is the firm. The context of the study is the developing economy of Pakistan; a country experiencing an intense period of political and economic change (World Bank, 2017). A recent study showed that Pakistan is expected to grow at a rate of 5.97 per cent over the next ten years (Zahid, 2017). The country also faces challenges from Chinese firms that are expected to join the competition in Pakistani markets under the upcoming China-Pakistan Economic Corridor (CPEC).

#### ***3.2 Data Collection***

As an emerging economy, Pakistan presented several challenges with regards to data collection. Hoskisson et al. (2000) highlights some of the issues faced by strategy researchers in emerging countries such as: difficulty in collecting random and representative samples; lack



of reliability of the postal system; lack of trust between the respondent and researcher;; difficulty in gaining access to top management, and a lack of understanding of common management issues among practicing managers. Indeed, many studies conducted in emerging economies like Pakistan and India have reported similar issues (Ryan and Tipu, 2013, Jeswani et al., 2008, Ali et al., 2012; Malik and Kotabe, 2009). For example, Malik and Kotabe (2009) collected data from seven cities in India and Pakistan using convenience sampling, and cited that there were no updated or complete lists of firms available in either of the countries. Many other studies, in both these countries, have not used probability sampling methods (e.g. Ryan and Tipu, 2013, Jeswani et al., 2008, Ali et al., 2012) due to similar reasons.

Similar problems were also faced in this study. For example, there was no comprehensive database for identifying manufacturing organisations in the country. Instead, we constructed the list of organisations to be included in the sampling frame using various sources such as: manufacturing organisations listed on the Pakistan Stock Exchange; lists of managers available from Quality and Productivity Society of Pakistan; yellow pages and websites of associations for the leading industries. We made sure that no duplicate entries of firms were included, so that a comprehensive database of manufacturing firms in Pakistan was constructed. Email addresses from all these sources were combined, and multiple waves of emails were sent between February and July 2016. All surveys were accompanied by a cover letter that briefly introduced the research and highlighted the importance of the respondent's cooperation. Discounting the emails that remained undelivered, 3,375 emails were sent in total. In total, 277 usable responses (8.2 per cent response rate) were received, which, for email data collection in an emerging country is a decent figure, even though it comes with non-response bias issues.

We tested non-response bias using the methodology suggested by Armstrong and Overton (1977), comparing early and late respondents, with late respondents acting as a proxy

for non-respondents (Schoenherr and Swink, 2015). Comparison between early and late respondents was made based on three demographic variables: 1) years of existence of the respondent's firm; 2) sales of the respondent's firm; and 3) experience of the respondent using independent sample t-tests. The results showed that there was no significant difference between the two groups. The industry and respondent profiles are provided in Tables 1 and 2. The distribution of the firms in the sample closely resembles the distribution of local industry (Pakistan Bureau of Statistics, 2005-06). For example, 25.5 per cent of the respondents belonged to the textile sector, versus 26.2 per cent contribution in terms of output in the national economy. Similarly, 17 per cent of respondents were from FMCGs (versus 16.5 per cent); 4.3 per cent of respondents were from auto and auto-part manufacturing (versus 5.4 per cent); 10.8 per cent of respondents belonged to chemical manufacturing (versus 12 per cent); and 2.9 per cent were from the electronics industry (versus 1.8 per cent).

--- Insert Table 1 & 2 about here ---

### **3.3 Measures**

Following the advice of Schminke (2004), extant measures were used to develop survey instruments. A thorough literature review was conducted to identify scales from the previous studies, demonstrating suitable reliability and validity. Given the fact that the variables of interest in this study cannot be typically obtained from a firm's financial statements, perceptual measures were instead used to collect data from respondents. Perceptual measures were found to be adequate because the literature indicates a high correlation between subjective and objective measures of variables (Protogerou et al., 2012). The following section provides the details about these scales and their sources.

***Market Sensing Capability (MSC):*** relates to the ability of the firm to sense opportunities and threats in the market (Teece, 2007). The scale is adopted from Morgan et al. (2009) and consists

of five items measured on the scale of 1 (strongly disagree) to 7 (strongly agree). The scale elicited data on the efforts of the firm, and aimed at learning about customer needs, competitor strategies, distribution channels, market trends, and the broader market environment.

***Supply Chain Agility (SAG):*** identifies the firm practices that capitalise on market opportunities. This scale is based on the supply chain agility scale developed by Blome et al. (2013b) and is measured on the scale of 1 (strongly disagree) to 7 (strongly agree). It measures the firm's ability to adapt its offering quickly according to changing customer needs, the ability to cope with the changing demands and requirements to modify product portfolios, and the ability to cope with supply side problems.

***Supply Chain Adaptability (SAD):*** operationalised in this study as the ability to modify supply chain design. The construct is based on the supply chain adaptability construct from Lee's (2004) Triple-A supply chain. It consists of a 5-item scale developed in the Whitten et al. (2012) study, and is measured on the scale of 1 (strongly disagree) to 7 (strongly agree). As per the assertions of Lee (2004), the scale measures the ability of the firm to: spot new suppliers in developing countries; develop suppliers and logistics infrastructure; understand ultimate customers; develop flexible product designs; and understand the firm's product standing in the technology and product life cycles.

***Supply Chain Ambidexterity (SAM):*** Ambidexterity in organisation research is measured in various ways. The constructs have been formed as second-order reflective (Kristal et al., 2010) and second-order formative (Tamayo-Torres et al., 2017), by multiplying (Gibson and Birkinshaw, 2004), adding (Lubatkin et al., 2006), or subtracting (He and Wong, 2004) the two sub-dimensions. However, multiplying two dimensions has been by far the most used method of forming the construct (see Junni et al., 2013 for a detailed review). We measure SAM as an interaction of supply chain efficiency (SCE) and supply chain responsiveness (SCR). Both

scales are measured on the scale of 1 (far worse than competitor) to 7 (far better than competitor). The details about the items of the two scales are provided in the following.

- ***Supply Chain Efficiency:*** SCE measures the cost-based performance of the supply chain. The scale consists of five items adopted from Sezen (2008), who adopted it from Beamon (1999). The items ask the respondents to rate their firm's performance in comparison to their closest competitors, in terms of total costs of resources, distribution, transportation and handling, as well as the costs of manufacturing, inventory holding, and return on investment.
- ***Supply Chain Responsiveness:*** The SCR scale consists of five items adopted from Rajaguru and Matanda(2013). The items ask the respondents to rate their firm's performance in comparison to their closest competitors in terms of the ability to respond quickly and effectively to customer requirements, respond quickly and effectively to competitor tactics, and quickly develop new products.

### **3.4. Common Method Bias**

Common method bias occurs due to resemblances in measurement methods resulting in biased reliability and validity estimates, and imprecise estimation of relationships between variables of interest (Podsakoff et al., 2003). Pre-emptive procedural remedies were taken in this study to avoid the problem of common method bias, as prior research has shown such measures to be more effective (Green et al., 2016). Guidelines suggested by Conway and Lance (2010), Podsakoff and Organ (1986), and Podsakoff et al.(2003) were followed in this respect. In terms of procedural remedies, dependent and independent variables appear in different sections of the survey and with different Likert-type scales; for example, strongly disagree–strongly agree versus far better–far worse. Furthermore, respondents were ensured that their responses will remain completely anonymous. Respondents were also given the choice of submitting the

survey without filling in their name and company name. The survey instrument was refined through two rounds of pilot surveys and opinions from experts, in order to remove any ambiguity in the questionnaire items that could bias the respondents in any way. Following the above guidelines, exploratory factor analysis was performed without a rotation. Three factors emerged from the solution, with the first factor accounting for less than 50 per cent of the variation. In the next step, all the variables in the research model were loaded on a single factor in a confirmatory factor analysis. This showed considerably poor results compared to the research model ( $\chi^2=3.75$ , CFI=0.817, RMSEA=0.1) and did not achieve the basic threshold levels. Thus, it was concluded that common method bias is not a major concern in this study.

### **3.5. Assessment of Psychometric Properties**

Confirmatory factor analysis (CFA) was used to establish the validity and unidimensionality of the constructs. Separate CFA was performed for dependent and independent variables. Model fit indices for both independent variable CFA ( $\chi^2=1.39$ ,  $p>0.05$ , GFI=0.969, CFI=0.992 and RMSEA= 0.034) and dependent variable CFA ( $\chi^2=1.77$ ,  $p>0.05$ , GFI=0.983, CFI=0.992 and RMSEA=0.053) were found to be adequate (Hu and Bentler, 1999). Factor loadings for all the constructs were either close to or above 0.7. Combined with significant p-values, this provides the evidence for convergent validity. Reliability of the constructs was established using Cronbach's alpha coefficients. Reliability coefficients for all the constructs were greater than 0.7, indicating reliability of the constructs. Table 3 provides the information about factor loadings and reliability measures for the constructs in the study.

--- Insert Table 3 about here ---

In order to establish discriminant validity, we compared the bi-variate correlations with the square root of AVE extracted (Fornell and Larcker, 1981). According to this criterion, if the correlation between a pair of constructs is less than AVE, discriminant validity is

established. It is evident from Table 4 below that correlations between all pairs of constructs are lesser than associated AVEs, indicating discriminant validity. Table 4 also provides means and standard deviations for the constructs in the study.

--- Insert Table 4 about here ---

#### **4. RESEARCH FINDINGS**

In this study, we developed a hypothesised model to identify the underpinning constructs of supply chain ambidexterity. To do so, we positioned market sensing, supply chain agility and supply chain adaptability as three dynamic supply chain capabilities. We then considered the interrelationship between these three constructs and their impact on supply chain ambidexterity. Furthermore, we considered the mediating role of supply chain agility in the relationship between adaptability and ambidexterity.

Before we tested our hypotheses using structural equation modelling, indicators were tested for the assumptions of constant variance, the existence of outliers, and normality by using plots of residuals by predicted values, rankit plot of residuals, and statistics of skewness and kurtosis. Multivariate outliers were assessed based on Mahalanobis distances of predicted variables. As the maximum absolute values of skewness and kurtosis were well within the limitations of past research (0.75 and 0.50, respectively) (Curran et al., 1996). In addition, also the above-mentioned plots did not show any concerning deviations. Finally, we also checked whether multicollinearity of variables was a problem, but as variance inflation factors were less than 1.97 (the recommended threshold is 10.0) we concluded that multi-collinearity was not a problem (Hair et al., 2014).

Figure 2 provides the results of the structural model. Path coefficients with solid lines indicate significant relationships ( $p < 0.01$ ), while the ones with dotted lines indicate insignificant relationships. Model fit was found to be adequate ( $\chi^2 = 1.35$ ,  $p > 0.05$ , GFI = 0.96,

CFI=0.99, and RMSEA= 0.036). Based on the results of the structural model, H1, H2, and H3 were significant, whereas support could not be found for H4. In order to test the mediation relationship posited in hypothesis 5, a bootstrapping technique (Hayes, 2013) was used. In order to test the hypotheses, indirect effect coefficients were generated using 5,000 bootstrap samples, along with a 95 per cent biased corrected confidence interval. Results showed that SAG significantly mediated the relationship between SAD and SAM ( $\beta=4.41, p<0.01$ ). Results of the mediation test showed that indirect coefficient was significant ( $p<0.01$ ). Therefore, H5 was supported.

--- Insert Figure 2---

## 5. DISCUSSION

Meta-analytic studies have called for more empirical studies investigating the implications of dynamic capabilities (Wilden et al., 2016). Even though there seems to be a consensus that dynamic capabilities should have a positive relationship with performance outcomes, Pezeshkan et al. (2016) suggest that empirical evidence regarding this relationship is mixed, at best. Given the popularity of dynamic capabilities as a research area, there is significant criticism surrounding this debate (Schilke, 2014). In support of earlier arguments by Teece (2007), we have gathered empirical data to show that, like firm-level dynamic capabilities, dynamic supply chain capabilities exist in clusters of sensing, seizing and transforming capabilities. Specifically, supply chain agility allows firm's to seize opportunities in the marketplace by providing a short-term supply chain response. Supply chain adaptability allows firms to provide a longer-term response to marketplace changes by transforming the resource base and structure of the supply chain.

Importantly, we found that supply chain agility and adaptability are only necessary if supply chain managers are able to sense market opportunities and threats in the first place.

After sensing opportunities and threats, managers can respond in two ways. In the short term, firms develop capabilities that allow them to modify their products and services quickly, and according to customer requirements both in terms of quantity and variety (supply chain agility). In the longer term, firms invest in the process of learning about their ultimate customers, understanding the life cycle of their products, and the continuous development of new suppliers (supply chain adaptability). Thus, market sensing not only helps supply chain managers to understand market changes, it also empowers them to improve decision-making regarding execution and reconfiguration of their capabilities.

These findings contribute to the existing literature by empirically showing that market sensing is an antecedent of supply chain agility and adaptability capabilities. This findings resonate with previous studies that have highlighted the importance of market sensing for supply chain agility (Tse et al., 2016) and supply chain adaptability (Aitken et al., 2002, Eckstein et al., 2015). With regard to dynamic capabilities theory (Teece, 2007), these results suggest that a sensing capability is the pre-requisite for seizing and reconfiguration capabilities.

We further identified a significant direct impact of supply chain agility, and an indirect impact of adaptability on supply chain ambidexterity. These results highlight the central role played by these dynamic capabilities in changing the market situation. Supply chain agility provides increased responsiveness and yields higher profitability, if exploited properly, and is thus a resource to fall back upon in turbulent times (Blome et al., 2013b). The ability to respond to changing market requirements is significant with regards to achieving market success. Conversely, the ability to sense market opportunities correctly, but the lack of capability to capitalise on them, would not improve performance and the opportunities would thus be lost (Roberts and Grover, 2012). Similarly, an insignificant direct relationship, and a significant indirect relationship, between supply chain adaptability and ambidexterity highlights the importance of successfully transforming supply chain design into short-term responses that can



bring immediate results. In accordance with Eckstein et al. (2015), our findings suggest that supply chain agility allows the firms to transform supply chain adaptability capabilities into superior performance levels.

## **6. CONTRIBUTION AND FUTURE RESEARCH DIRECTIONS**

### ***6.1 Theoretical and Managerial contribution***

While ambidexterity has become an important element in the wider supply chain discourse (e.g. Blome et al., 2013a, Kristal et al., 2010, Matthews et al., 2015), no consensus on how to measure supply chain ambidexterity exists. For example, Kristal et al. (2010) measures the ambidextrous supply chain strategy as a dichotomy between exploration- and exploitation-based practices. Blome et al. (2013a), on the other hand, base their ambidextrous supply chain governance construct on a contractual-relational governance dichotomy. Im and Rai (2008) base their construct of contextual ambidexterity on the adaptability-alignment dichotomy.

In this paper, we introduce a new way of measuring supply chain ambidexterity, including traditional measures of responsiveness and efficiency, and combine them in a multiplicative way in-line with prior research in the area (see Gibson and Birkinshaw, 2004, Hill and Birkinshaw, 2014). We believe that by integrating responsiveness and efficiency as measures, we capture the major trade-off that has been discussed in the supply chain context, allowing a unique and suitable supply chain specific contribution to theory. Also, instead of measuring ambidexterity based on classical performance measures, we provide a theoretical angle that captures the essence of dynamic supply chain capabilities, providing insights on how firms can achieve sustained competitive advantage in a supply chain context.

Finally, we challenge the common assumption that only one supply chain type (efficient/ responsive) is suitable for a particular product (e.g. Fisher, 1997, Lee, 2002). Instead, we suggest to managers that a product can have both a flexible and efficient supply chain if

underpinned by the dynamic supply chain capabilities of market sensing, supply chain agility and adaptability. The results of this study suggest to managers that dynamic supply chain capabilities exist in clusters that need to be invested in simultaneously to capitalize on efficiency and flexibility gains.

## ***6.2. Limitations and Future Research Directions***

The findings of this study should be interpreted in light of its limitations. These limitations may also point out some avenues for future research. First, this study used self-reported perceptual data in order to measure both independent and dependent variables. While this is the dominant practice in most management research, and substantial efforts were made to achieve the highest possible level of data quality during the process of data collection and construct validation, self-reporting bias cannot be totally ruled out. Second, the study used a cross-sectional research design, thus the usual caveats of this design apply to this study. Findings of this study cannot be taken as conclusive evidence of the underlying causal relationships. Conclusive evidence can only be generated through longitudinal research.

Future research in the area may employ a longitudinal research design, or employ secondary (panel) data. However, as emphasised by Protogerou et al.(2012), these limitations do not invalidate the results. A single study is never enough to provide the final argument related to underlying relationships in the model being tested. Given that this study takes into consideration a fairly large dataset, it provides the basis for the logic of the dynamic supply chain capabilities- supply chain ambidexterity relationship. Models based on a cross-sectional design need to be developed in order to evaluate the pertinence of the research model before longitudinal designs can be used. Better understanding of this logic, however, will require these relationships to be studied using diverse types of evidence (qualitative/quantitative). Finally, we considered the interplay between various dynamic supply chain capabilities in terms of how these capabilities affect the overall performance of the supply chain. We found that a market

sensing capability positively and directly affects supply chain agility and adaptability. Combined, these dynamic supply chain capability clusters allow organisations to modify their products, services and supply chain structures according to market requirements both over the short and long-term. Therefore, future research should consider market sensing, supply chain agility and adaptability in conjunction rather than in isolation.

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