

Operations capability, productivity and business performance: The moderating effect of environmental dynamism

Abstract

Purpose – The purpose of this study is to investigate the relationships between operations capability, productivity and business performance in the context of environmental dynamism.

Design/methodology/approach – A proposed conceptual framework grounded in the resource-based view (RBV) and dynamic capability view (DCV) is analysed using archival data from 193 automakers in the UK.

Findings – The results show that operations capability, as an important dynamic capability, has a significant positive effect on productivity, which in turn leads to improved business performance. The results also suggest that productivity fully mediates the relationship between operations capability and business performance, and that environmental dynamism significantly moderates the relationship between operations capability and productivity.

Practical implications – The research findings provide practical insights that will help managers develop operations capability to gain greater productivity and business performance in a dynamic environment.

Original/value – Addressing the two important issues of moderation (i.e. environmental dynamism) and mediation (i.e. productivity), this study makes important contributions to the field of operations management by applying the RBV and DCV.

Keywords Operations capability; Productivity; Environmental dynamism; Dynamic capability; Data envelopment analysis (DEA); UK automotive industry

Paper type Research paper

1. Introduction

A firm's survival depends on its ability to create, access and utilize new resources, build on its capabilities platform, and make the capabilities more inimitable to achieve competitive advantage (Peteraf, 1993; Yu *et al.*, 2014; Barrales-Molina *et al.*, 2015; Yu and Ramanathan, 2016). The resource-based view (RBV) of the firm further suggests that heterogeneity in firm performance is due to ownership of resources that have differential productivity (Makadok, 2001; Phusavat *et al.*, 2009). Although it has been argued that the productivity and efficiency gains from organisational capabilities such as operations are critical in ensuring that firms maintain their competitive advantage (Krasnikov and Jayachandran, 2008; Phusavat *et al.*, 2009), our understanding of the association between operations capability, productivity, and performance is still very limited. There are still two important issues that have not been addressed in the literature.

First, despite increasing research interest in productivity gains and the factors that lead to higher productivity, there has been comparatively little empirical study in this area, especially the mediating role of productivity in the relationship between capability and performance (Lieberman *et al.*, 1990; Smith and Reece, 1999; Talluri *et al.*, 2003). Productivity is a measure of “the efficiency with which physical inputs are converted to physical outputs” (Lieberman *et al.*, 1990, p.1195). Productivity has been gradually introduced into efficiency analysis (Huang *et al.*, 2016), and productivity analysis plays an important role in strategic planning and competitive analysis, which can provide a useful tool for improving the quality of operations and production management (Lieberman *et al.*, 1990; Sudit, 1995). Several scholars have focused on the impact of productivity on business performance, especially in the service industry (e.g. Schefczyk, 1993; Smith and Reece, 1999; Tsikriktsis, 2007), but they investigated the impact of productivity on business performance without examining the potential role of organisational capabilities. Capabilities have been broadly defined as “complex bundles of skills and accumulated knowledge that enable firms to coordinate activities and make use of their assets” (Day, 1990, p.38). Operations capability is focused on performing organizational activities efficiently and flexibly, with the minimum wastage of resources (Krasnikov and Jayachandran, 2008). The role of superior operations capability as a source of competitive advantage has long been widely recognized (e.g. Skinner, 1969; White, 1996), and investigated in previous empirical studies (e.g. Nath *et al.*, 2010; Terjesena *et al.*, 2011; Yu *et al.*, 2014; Chavez *et al.*, 2017). However, none of

these studies examined the effect of operations capability on productivity. With these deficiencies in mind, this study employs financial measures to indicate business performance and seeks to investigate both the direct effect of productivity on performance (Smith and Reece, 1999), as well as its indirect effect with operations capability.

Second, as an alternative explanation, consideration of environmental context is also important to the analysis of firm resources and performance, since different environments imply different valuations of resources (Miller and Shamsie, 1996; Priem and Butler, 2001; Terjesen *et al.*, 2011). Firms' resources and capabilities have value only in the industry environment context (Lieberman and Dhawan, 2005). The success associated with the possession of operations capability can be affected by the various environmental factors within which the firm operates (Terjesen *et al.*, 2011). Environmental dynamism, which refers to the rate and unpredictability of change in a firm's external environment (Dess and Beard, 1984), has been identified as a contextual factor which may affect the effectiveness and productivity of a best practice (Miller and Friesen, 1983; Venkatraman, 1989). Furthermore, the salience of the environmental factors that may influence the effectiveness of operations capability is demonstrated through the case of automakers. The automobile industry was hit hard by the global financial crisis of 2008-2009 (Oliveira *et al.*, 2015), and is increasingly becoming one of the most dynamic and competitive markets in the UK (Holweg *et al.*, 2009). Therefore, there is a need to empirically test the moderating role of environmental dynamism to account for potential changes to productivity of operations from changes in operations capability valuations.

By addressing the two important issues that have not been explored in previous research, our study contributes to the advancement of both theory and practice. From a theoretical perspective, we draw upon the dynamic capability view (DCV) (Teece *et al.*, 1997; Eisenhardt and Martin, 2000) to develop a hypothesis regarding the moderating effect of environmental dynamism. According to the DCV, operations capability is regarded as an important dynamic capability of a firm operating in dynamic environments (Winter, 2003; Terjesen *et al.*, 2011). The DCV helps to highlight the most critical capabilities management needs to sustain for competitive advantage (Cetindamar *et al.*, 2009; Rungi, 2014; Barrales-Molina *et al.*, 2015). Since traditional RBV misidentifies the locus of long-term competitive advantage in dynamic markets (Eisenhardt and Martin, 2000), scholars have extended the RBV to dynamic markets (Teece *et al.*, 1997). The DCV could enhance the understanding of the benefits of operations

capability, because this perspective aims to explain how the firms can strengthen their operations systems and processes to survive in a highly dynamic environment. In line with this perspective, we aim to develop a profound understanding of the complex dynamic processes underlying the development of operations capability. This is an important question because in the traditions of the RBV (Wernerfelt, 1984; Barney, 1991) and the DCV (Teece *et al.*, 1997; Eisenhardt and Martin, 2000) operations capability can be interpreted as a critical dynamic capability, which (in combination with productivity of operations) has the potential to lead to superior performance in an increasingly demanding environment.

From a practical perspective, our study provides valuable insights and guidelines for managers to better understand the importance of productivity in achieving superior performance in a dynamic environment. The nature of the business environments requires the productivity-driven firm to be aware of the importance of productivity gains. Increasing productivity has been a determinant of competitive positions in the automotive industry. In order to assess the competitive success and failure of automobile manufacturers, it is essential to understand the nature of interfirm differences in productivity (Lieberman *et al.*, 1990). Due to the increasingly dynamic and competitive environments, productivity improvement has become an important driver for managers to strengthen their operations systems and processes.

2. Theoretical background and research hypotheses

2.1. Resource-based view (RBV) and capability

The most common perspective on competitive advantage according to performance related to firm resources and capabilities is RBV (Wernerfelt, 1984; Corbett and Claridge, 2002). Capability relate to firm ability to utilize organizational processes effectively for goal achievement (Amit and Schoemaker, 1993), whereby capabilities are as defined by Makadok (2001, p.389): “organizationally embedded non-transferable firm specific resources whose purpose is to improve the productivity of the other resources possessed by the firm”. Numerous studies (e.g. Nath *et al.*, 2010; Yu *et al.*, 2014; Ramanathan *et al.*, 2016) have employed RBV and found a significant relationship between firm performance and organisational (e.g. operations) capabilities, but they have not identified how to achieve sustainable competitive advantage, with RBV’s preoccupation with competitive advantage often being unrealistic in the context of highly dynamic business environments, thus there is a need for more research on RBV

in highly volatile and dynamic market contexts with dynamic capability view (DCV) (Teece *et al.*, 1997; Eisenhardt and Martin, 2000).

2.2. Dynamic capability view (DCV)

DCV attempts to build on RBV for the sophisticated issues surrounding the utilization of firm capabilities to achieve sustainable competitive advantage in dynamic business environments (Teece *et al.*, 1997; Eisenhardt and Martin, 2000; Teece, 2007). Dynamic capability is “the firm’s ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments” (Teece *et al.*, 1997, p.516). Strategic capabilities must be developed to identify and respond to emergent business opportunities to achieve long-term, sustainable competitive advantage (Jarvenpaa and Leidner, 1998; Teece, 2007). Operations capability is a key dynamic capability in both RBV and DCV in this regard.

Figure 1 represents the study’s conceptual model, which is grounded in the RBV and DCV. Operations capability and productivity directly affect firm performance. Operations productivity is a mediating variable between business performance and operations capability, while environmental dynamism is a moderator between productivity and operations capability. We draw upon the RBV and DCV to develop hypotheses regarding the mediating and moderating effects.

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2.3. Research hypotheses

It has been established by empirical investigations that business performance is significantly and positively related to operations capabilities (e.g. Rosenzweig *et al.*, 2003; Nath *et al.*, 2010; Terjesena *et al.*, 2011; Yu *et al.*, 2014). Based on RBV, this study defines operations capability in terms of the synergy of tasks to enhance firm output (e.g. services and products) with the most efficient deployment of its production technology and process, including material and information flows (Hayes *et al.*, 1988; Dutta *et al.*, 1999; Slack *et al.*, 2016). Most studies understand the impact of operations capability on firm performance in terms of production-related objectives (White, 1996; Swink and Hegarty, 1998; Boyer and Lewis, 2002; Terjesena *et al.*, 2011), thus it has been deeply studied in terms of its importance with regard to business performance (mainly competitive advantage) in dynamic and intensively competitive market

contexts (Vickery *et al.*, 1993; White, 1996; Peng *et al.*, 2008; Terjesena *et al.*, 2011). Both RBV and DCV affirm that sustainable competitive advantage can be achieved by developing operations capabilities, including the efficient management of knowledge acquisition and communication, information and material flows, organisational assets and advanced process technologies (Tan *et al.*, 2007).

Therefore, on the basis of RBV and empirical evidence, we expect a direct and significant relationship exists between operations capability and business performance. Our conceptual framework (Figure 1) suggests that the absence of a significant coefficient for such a relationship would suggest that productivity fully mediates the effect of operations capability on business performance (Hair *et al.*, 2010). Mediation tests specify the existence of a significant intervening mechanism (productivity) between the antecedent variable (operations capability) and the consequent variable (business performance). The mediation analysis is also in line with H2 (operations capability → productivity) and H3 (productivity → business performance) we developed below. Thus, we posit the following hypothesis:

H1: Operations capability has a positive impact on business performance, and the impact is mediated by productivity.

Superior operations capability increases efficiency in the delivery process, reduces the cost of operations and promotes competitive advantage (Day, 1994). Krasnikov and Jayachandran (2008) conducted a meta-analysis of the firm capability–performance relationship using a mixed-effects model and concluded that operations capability primarily drives greater efficiency outcomes. Operations capability is frequently based on processes that have been benchmarked and codified (Krasnikov and Jayachandran, 2008). The increase in productivity is attributable to more use of information technologies, better operating systems and processes and more skilled workers (Gummesson, 1998). For example, many firms have implemented total quality management (TQM) and lean operations to reduce waste and subsequently improve productivity. Similarly, many firms have implemented business process reengineering (BPR) to redesign operating systems and to employ processing technologies to enhance productivity and efficiency (Krasnikov and Jayachandran, 2008). Higher productivity may result from a more flexible workforce as opposed to a more specialized one (Smith and Reece, 1999). Considering the above arguments, it can be suggested that superior operations capability will lead to greater

productivity, i.e. the units of output that can be produced from given quantities of inputs, thus the following hypothesis is posited:

H2: Operations capability has a positive impact on productivity.

It is clear that productivity has the potential to contribute to an increase in business profit (Grifell-Tatjé and Lovell, 1999). Improved productivity becomes an antecedent to business performance indicators, such as profitability (Gummesson, 1998). In an increasingly dynamic and competitive environment, firms must continuously improve their productivity and efficiency to gain long term growth and profitability (Sudit, 1995). Some empirical studies on operations management have examined the impact of productivity on profitability, especially in the service industry (e.g. Schefczyk, 1993; Smith and Reece, 1999; Tsikriktsis, 2007). By investigating the impact of productivity on financial performance in the airline industry using data envelopment analysis (DEA), Schefczyk (1993) identified that productivity is related to return on equity. Using empirical methods of analysis and field-based research, Smith and Reece (1999) found that productivity has a direct and significant effect on business performance (such as adjusted profit after tax percentage). Tsikriktsis (2007) also found that operational performance (productivity and quality) has a significant impact on profitability in the airline industry. However, all these studies investigated the relationship in the service industry. Unlike previous research, we aim to test the relationship between productivity and business performance in the automotive industry. This industry was especially hard hit by the global financial crisis (Oliveira *et al.*, 2015). Previous research has suggested that relative productivity has been a determinant of competitive positions in the automotive industry (Lieberman *et al.*, 1990). Accordingly, in view of the above arguments and the findings of previous empirical studies, we offer the following hypothesis:

H3: Productivity has a positive impact on business performance.

The environment consists of a large number of non-controllable variables posing both threats and opportunities for companies in pursuit of their objectives (Sanderson and Luffman, 1988). The external business environment in which a firm competes is in constant flux, thus organizations need to continually adapt to that environment (Roth and Van der Velde, 1991; Wong *et al.*, 2011). With increasing competition and advances in technology, firms are facing

environments that are extremely dynamic. Environmental dynamism refers to the extent of volatility or the unpredictability of change within an industry (Dess and Beard, 1984). Industry developments can arise from many sources, including the rate of change and innovation in the company's principal operations, the introduction of new products and services, and the uncertainty or unpredictability of competitors' actions and customers' preferences (Lawrence and Lorsch, 1967; Miller and Friesen, 1983). Companies operating in dynamic environments must contend with rapid changes in technology, customer needs and preferences, in addition to competition (Miller and Friesen, 1983; Mintzberg, 1994).

According to the DCV, uncertain and turbulent environments help firms achieve competitive advantages through increasing causal ambiguity, which in turn impairs competitors' ability to imitate resources or resource combinations (Eisenhardt and Martin, 2000; Noda and Collis, 2001). The fit between the firm's operations capability and the environmental demands will positively affect the firm's competitive position (Venkatraman, 1989). Operations capability (such as new product development) has been generally viewed as a key dynamic capability (Winter, 2003). Operations capability has a varied impact on competitive advantages and performance, depending on the way in which firms align themselves with their business environments (Song *et al.*, 2005; Terjesena *et al.*, 2011). Operations capability that senses the market changes and respond to shifts will be more valuable for firms to improve their productivity of operations in a dynamic environment. Drawing upon the DCV, it can be argued that operations capability appears to have a stronger positive impact on the productivity of operations when there are greater environmental changes. The relationship between operations capability and productivity in a highly dynamic environment will be greater than in a low-turbulence environment. Thus, we draw upon the DCV to hypothesize that firms possessing superior operations capability will achieve greater benefits such as productivity gains in a dynamic industry (such as the automotive industry), as stated in the following hypothesis:

H4: The greater the degree of environmental dynamism, the stronger the positive impact of operations capability on productivity.

3. Methodology

3.1. Data

The UK automotive industry was chosen for this study to test our conceptual model for several main reasons. First, the automotive industry is particularly important because it is the single largest industrial sector in the world economy, which is also true of the UK automotive industry; it represents the biggest single source of manufacturing output in the UK, despite a massive rationalization of productive capacity in recent years (BBC, 2015; Turnbull *et al.*, 1992). Second, the UK automotive manufacturing industry is becoming increasingly dynamic and competitive. Due to the competitive nature of the industry, automakers are under tremendous pressure to optimize their operations and production process and increase productivity gains (Holweg *et al.*, 2009; Oliveira *et al.*, 2015). Thus, the automotive industry provides a good example of how automakers improve operations capability and productivity when they are put under economic and technological pressure (Cousins and Crone, 2003; Lieberman and Dhawan, 2005), which is the purpose of our study.

The data for this study were obtained from the Financial Analysis Made Easy (FAME) database. Initially, there were a total of 371 motor vehicle manufacturers in 2010 in the FAME database, out of which 178 firms were discarded because of missing data. Thus, the final sample consisted of 193 automakers in the UK. The firms were classified into six different sub-sectors in the automotive industry according to the Standard Industrial Classification (SIC) at the five-digit level. A profile of the automakers is reported in Table 1.

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3.2. Data envelopment analysis (DEA)

The RBV posits that organizations use resources available at their disposal (inputs) to deliver high quality products and services (outputs) to customers. Thus, according to the RBV, this study applies the data envelopment analysis (DEA) approach to evaluate operations capability and productivity (Charnes *et al.*, 1978; Banker *et al.*, 1984; Cooper *et al.*, 2007). DEA is a mathematical programming technique for assessing the relative efficiency of decision making units (e.g. carmakers) that employ multiple inputs to produce multiple outputs (Charnes *et al.*, 1978; Banker *et al.*, 1984). A brief description of DEA is presented in Appendix A. A more detailed exposition of DEA can be found in Cooper *et al.* (2007).

3.3. Measures

The measures used in this study for operations capability, productivity, business performance, and environmental dynamism are reported in Table 2. All measures were adopted from prior research, and described in more detail below.

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3.3.1. Measures of operations capability

In line with previous studies (e.g. Nath *et al.*, 2010; Yu *et al.*, 2014; Ramanathan *et al.*, 2016; Yu and Ramanathan, 2016), we used a DEA framework to measure operations capability in terms of a firm's efficiency in transforming operations resources (inputs) to operations objectives (outputs). The output measure was the cost of operations – for which cost of sales was used as a proxy, including all the costs incurred by the automobile manufacture to produce and deliver products and services to its customers (Nath *et al.*, 2010) – while the input measures included cost of capital and cost of labour. With regard to the inputs (i.e. cost of capital and labour), the automobile industry is characterised by relatively high capital and labour intensity. Thus, tangible assets (such as land and buildings, plant and equipment, and vehicles) were used as a proxy for cost of capital, and remuneration of employees (such as salaries and wages, pension costs, social security costs, and other staff costs) as a proxy for cost of labour (Nath *et al.*, 2010).

3.3.2. Measures of productivity

We employed DEA as a tool to measure productivity (Nath *et al.*, 2010; Yu *et al.*, 2014; Ramanathan *et al.*, 2016). As shown in Table 2, we used three inputs in this study, namely total assets, shareholder funds, and number of employees (Yu and Ramanathan, 2008, 2009; Nath *et al.*, 2010; Yu *et al.*, 2014). Previous studies using DEA (e.g. Yu and Ramanathan, 2008, 2009) proposed different measures of output in monetary units (such as sales revenue, profit volume and value added). We used two outputs in this study, sales and profit before taxation, which reflect how well an automaker is able to use its input resources to achieve sales and profit objectives (Yu and Ramanathan, 2008, 2009).

3.3.3. Measures of business performance

The performance of automakers in this study was measured financially; specifically, business performance was operationalized as return on capital employed (ROCE), which is generally defined as the ratio between the earnings before interest and taxation to the net assets (i.e. total assets less current liabilities) for the period (Pendlebury and Groves, 1999; Richard *et al.*, 2009). All 193 selected firms in this study have positive ROCE; if ROCE is positive it is a suitable measure of performance as it reflects gains in capital turnover and profit margin (Smith and Reece, 1999). ROCE essentially assays the efficiency with which capital is employed and the ultimate profitability reflected in income (Hafeez *et al.*, 2002; Wagner *et al.*, 2002; Richard *et al.*, 2009). Previous studies of operations management have used ROCE as an index of financial performance (e.g. Hafeez *et al.*, 2002).

3.3.4. Measures of environmental dynamism

Following the methods of previous studies (e.g. Dess and Beard, 1984; Goll and Rasheed, 1997; Heeley *et al.*, 2006; Terjesena *et al.*, 2011), we measured environmental dynamism by averaging the regression coefficients of the automotive industry's operating income over a five-year period (2006-2010). Operating income has been used as measure in previous studies (e.g. Heeley *et al.*, 2006; Terjesena *et al.*, 2011). We regressed operating income data over the five years for each subsector in the automotive industry at a five-digit SIC level against time. In the regression analysis, the independent variable was time, and the dependent variable was operating income. We then divided the standard error of the regression slope coefficient by the average annual operating income of each subsector to obtain the index of environmental dynamism for each subsector in the automotive industry.

3.3.5. Control variables

We used firm age and industry type as control variables. Firm age is the number of years since firm formation. Firm age was controlled in the current analysis because older automakers may possess more fully developed operations capability and productivity (Terjesena *et al.*, 2011). Older firms will be more likely to overcome performance threatening liabilities. Industry type (based on a five-digit sub-class level in the UK automotive industry) was controlled in our analysis because of its possible effect on operations capability and productivity gains. Operations capability and productivity of operations are different among automakers (e.g.

manufacture of motor vehicles vs. manufacture of electrical and electronic equipment for motor vehicles) under various environmental conditions. In the present study, firm size was not controlled in our regressions because the most commonly used measures of firm size (such as number of employees and sales) were used to measure operations capability and productivity. Table 3 shows the correlations among the variables.

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4. Results

To test the hypothesised relationships presented in our conceptual model, we used the procedures suggested by Cohen and Cohen (1983) and Li *et al.* (2010). We entered the variables into our models using a four-stage process: (1) control variables, (2) main effect variables, (3) mediating variables, and (3) moderating variables (Li *et al.*, 2010).

In all models, variance inflation factor (VIF) values were less than 10, which indicates that multicollinearity did not exist among the independent variables (Mason and Perreault, 1991). As depicted in Table 4, the result of Model 2 indicates that operations capability significantly affects business performance ($\beta = 0.231, p \leq 0.001$). Hence, H1 is supported. The result of Model 3 shows that productivity is positively and significantly related to business performance ($\beta = 0.638, p \leq 0.001$), which provides support for H3. However, Model 3 shows that the effect of operations capability on business performance becomes insignificant ($\beta = 0.072, n.s.$) when productivity is added. Furthermore, Model 5 reveals a significant positive relationship between operations capability and productivity ($\beta = 0.248, p \leq 0.001$), which lends support for H2. Thus, the full set of the results provide additional support for H1, i.e. the fully mediating effect of productivity on the relationship between operations capability and business performance (Baron and Kenny, 1986).

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In Model 6, productivity is the dependent variable. To minimize the threat of multicollinearity, we orthogonalised the interaction terms by regressing each interaction term on its composing variables and using the residuals in the main regression (Brock *et al.*, 2006; Dawande *et al.*, 2008; Liu and Yang, 2009). The coefficient of interaction term (operations capability \times environmental dynamism) is significant ($\beta = 0.144, p < 0.05$), indicating that environmental dynamism is a moderator of the relationship between operations capability and

productivity, thus H4 is supported. Furthermore, we plotted a figure to demonstrate the moderating effect of environmental dynamism using the simple slope analysis (Aiken and West, 1991). Figure 2 shows that there is a significant positive relationship between operations capability and productivity, which is strengthened by environmental dynamism.

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5. Discussion and implications

5.1. Discussion

Drawing upon the RBV and DCV, we developed a conceptual model that examines the relationships among operations capability, productivity and business performance in the context of dynamic UK automotive industry. Overall, our analysis reveals a significant positive effect of operations capability on productivity, which is significantly moderated by environmental dynamism. The relationship between operations capability and business performance is fully mediated by the productivity of operations.

The findings of positive effects of operations capability on productivity and performance are consistent with the key principles of the RBV, which posit that operations capabilities are key determinants of a firm's competitive advantage and productivity gains (Barney, 1991; Day, 1994). The results are also consistent with previous studies showing the important role of operations capability in improving business performance (e.g. Nath *et al.*, 2010; Terjesena *et al.*, 2011; Chavez *et al.*, 2017). Operations capability has been described as focusing on flexibility, cost reduction, fast and reliable delivery of high quality products/services (White, 1996; Swink and Hegarty, 1998; Boyer and Lewis, 2002). According to the RBV, operations capability comprises the skills and knowledge that enable automakers to be efficient and flexible producers that use resources efficiently, which leads to greater productivity and performance. Productivity gains are attributable to more efficient utilization of skilled labour and effective implementation of processing technologies, TQM and lean and just-in-time (JIT). For example, automakers such as Toyota implement business process reengineering (BPR), as manifest in Toyota Production System (TPS), to redesign operating systems for enhanced productivity and efficiency. Our results also reveal that productivity has a direct and significant effect on the business performance of automakers, which are consistent with several previous empirical studies on the service industry (e.g. Schefczyk, 1993; Smith and Reece, 1999; Tsiriktsis, 2007).

It can be concluded that much of the conceptual work in the productivity–business performance relationship may be applicable to both service operations and manufacturing.

Another important contribution of our research is the confirmation of the mediating role of productivity, which can be viewed as a refinement and extension of operations management research. Although there has been increasing research interest in productivity gains and the factors affecting higher productivity, to date, there are very few empirical studies that have investigated the mediating role of productivity, especially in the automotive industry (Talluri *et al.*, 2003). Our findings indicate that the productivity of operations fully mediates the relationship between operations capability (as the antecedent of productivity) and business performance (as the consequence of productivity) among UK motor vehicle manufacturers. Superior operations capability is essential for automakers to achieve maximum business performance such as ROCE; however, the effect is fully mediated by productivity of operations. The impact of operations capability and business performance becomes insignificant in the presence of productivity, which provides support of the full mediation (Baron and Kenny, 1986). The findings corroborate previous studies (e.g. Lieberman *et al.*, 1990) highlighting that productivity is a determinant of competitive position in the automotive industry. Smith and Reece (1999) developed a similar a conceptual model of business performance using productivity as a mediator between business strategy and external fit and business performance. They found that a customer service strategy indirectly impacts business performance through its significant effect on productivity. To survive in an increasingly dynamic and competitive environment, a productivity-driven firm must respond with its own improvements in productivity and efficiency (Theodorou and Florou, 2008; Samoilenko and Osei-Bryson, 2013). However, as an antecedent of productivity, operations capability should not be ignored. Thus, it is important for motor vehicle manufacturers to understand the relationships among operations capability, productivity of operations and business performance.

A further regression analysis suggests that the relationship between operations capability and productivity is significantly moderated by environmental dynamism, which adds further support to the growing body of literature espousing the DCV (Eisenhardt and Martin, 2000). Our study provides an even stronger argument for DCV as a way to explain the moderating effect of environmental dynamism. The theory is supported in suggesting that the greater the degree of environmental dynamism, the stronger the positive effect of operations

capability on productivity. This finding is consistent with the fundamental principles of the DCV (Eisenhardt and Martin, 2000; Winter, 2003), which posits that operations capability allow automakers to gain competitive advantage in highly dynamic markets. Motor vehicle manufacturers in the UK can expect environments to become more unpredictable and dynamic due to increasing consumer awareness, rapid innovation of new operations processes, and rapid changes in technology (Turnbull *et al.*, 1992; Holweg *et al.*, 2009). The dynamic and competitive environments require carmakers to invest more in improving their dynamic capabilities such as operations capability, which in turn leads to greater productivity. Overall, as a functional dynamic capability, operations capability plays the important role in helping automakers survive in an increasingly dynamic and competitive marketplace.

5.2. Theoretical implications

There are some important theoretical implications that can be gleaned from this study. First, to the best of our knowledge, this is the first attempt to generalize findings in the relationships among operations capability, productivity and business performance in various environmental conditions. Although the direct effect of operations capability on business performance has been commonly studied (Nath *et al.*, 2010; Terjesena *et al.*, 2011; Chavez *et al.*, 2017), the antecedent of productivity of operations (such as operations capability) has been largely ignored. Drawing upon the RBV, our study illustrates that a high level of operations capability seems to lead to higher productivity. Furthermore, our analysis also reveals that the productivity of operations is significantly related to improved business performance. This finding lends support to the data collection and measurement methods, and adds some degree of confidence to those studies that use productivity as a surrogate measure for business performance (Lieberman *et al.*, 1990; Smith and Reece, 1999). Overall, our findings support the RBV and DCV perspectives.

Second, since representatives of the dynamic capability theory (Teece *et al.*, 1997; Eisenhardt and Martin, 2000) do not specify precisely what kind of dynamic capabilities exist in the context of operations management, this study offers theoretical insights and strong empirical evidence of the important role of operations capability in improving productivity in highly dynamic environments. Our findings are consistent with the fundamental principles of the RBV and DCV that suggest the importance of operations capability in gaining competitive advantage

(Eisenhardt and Martin, 2000). Third, as noted above, there have been very few empirical studies that have investigated the mediating role of productivity. Our results reveal that productivity fully mediates the relationship between operations capability and business performance. This finding reinforces the earlier work of Smith and Reece (1999) on the mediating effect of productivity on the relationship between business strategy (such as customer service strategy) and business performance. Fourth, our finding of moderating role of environmental dynamism also has implications for the DCV theory, which suggests that operations capability is a key dynamic capability for companies to achieve sustainable competitive advantage in dynamic business environments.

5.3. Managerial implications

From a practical perspective, the key findings of our research (such as mediation and moderation) provide a number of managerial implications that could prove to be valuable insights for motor vehicle manufacturers. First, the findings of the moderating role of environmental dynamisms and the importance of operations capability in gaining productivity and superior performance provide strategic direction to automakers. According to the DCV, operations capability, as an important dynamic capability, becomes crucial for the success of manufacturing. In order to survive in an increasingly dynamic and competitive environment, it is important for productivity-driven automakers to deploy efforts and resources to improve their operations capability, such as more efficient utilization of labour and adaptation of processing technologies (e.g. ERP, RFID etc.), JIT and lean operations, and TQM. Such operations activities will enable motor vehicle producers to improve productivity and business performance. Firms that can rapidly integrate and reconfigure their operations systems and processes can adapt to rapid environmental changes and thus enhance their competitive advantage.

Second, our results suggest that productivity of operations fully mediates the operations capability–business performance relationship. Since 2002, the UK automotive industry has seen a series of further plant closures, while some automakers have experienced order-of-magnitude productivity gains (Holweg *et al.*, 2009). The competitive nature of the business environment requires productivity-driven carmakers to improve their productivity and efficiency. Automakers should place greater emphasis on productivity improvement, which directly influences business

performance. But, operations capability should not be ignored as such dynamic capability is an important antecedent of productivity.

6. Conclusions and suggestions for future research

In conclusion, this study conceptually argues and empirically confirms the relationships among operations capability, productivity and business performance. Our analysis shows that operations capability, as a key dynamic capability, has a significant impact on productivity of operations, which in turn leads to improved business performance. More specifically, we find that a positive influence (i.e. benefits) of operations capability (as the antecedent of productivity) on business performance (as the consequence of productivity) is mediated through productivity of operations. Environmental dynamism significantly moderates the relationship between operations capability and productivity. As an important functional dynamic capability, operations capability can influence productivity more strongly in high dynamic environments. Addressing the two important issues of moderation and mediation, this study makes important contributions to the field of operations management by applying the RBV and DCV. The findings of this study also provide practical insights that will help managers develop operations capability to gain greater productivity and business performance in a highly dynamic environment.

While this study makes contributions to the operations management literature and has important implications for practice, there are some limitations and opportunities for future research. First, the present study focuses only on operations capability and examines its impact on productivity and business performance, however the RBV suggests that each firm has a distinctive set of resources and capabilities (Day, 1990; Song *et al.*, 2007). Future study may identify more relevant organizational capabilities (such as marketing capability, R&D capability, IT capability, or supply chain capability) and examine their important effects on firm performance. Second, the environmental dimension explored in this study (environmental dynamism) is not exhaustive. Most notably, future efforts should include measures which capture environmental complexity and munificence (Miller and Friesen, 1983; Dess and Beard, 1984) and examine their effects on operations capability improvement and productivity gains. Third, this study focuses on a single industry sample. Although the focus of a single industry has its own advantages, omitting other industries may bias the sample and limit generalizability of the results (Wong *et al.*, 2011). Thus, it is recommended that further cross-sectional research should

be undertaken to investigate the value of dynamic capabilities in various degrees of environmental change.

Appendix A. Data Envelopment Analysis (DEA)

DEA is a mathematical programming technique that calculates the relative efficiencies of organizations (usually refers to a decision-making units (DMU)) based on multiple inputs and outputs (Charnes *et al.*, 1978). The efficiency of any DMU is computed as the maximum of ratio of the sum of weighted outputs to that of the sum of weighted inputs, subjected to the condition that similar ratios, using the same weights, for all other DMUs be less than or equal to one (Charnes *et al.*, 1978). Thus, the fractional form of a DEA mathematical programming model is given as follows:

$$\max E_m = \frac{\sum_{j=1}^J V_{mj} Y_{mj}}{\sum_{i=1}^I U_{mi} X_{mi}}$$

subject to:

(Model 1)

$$0 \leq \frac{\sum_{j=1}^J V_{mj} Y_{nj}}{\sum_{i=1}^I U_{mi} X_{ni}} \leq 1, \quad n = 1, 2, \dots, N$$

$$U_{mi}, V_{mj} \geq 0, \quad i = 1, 2, \dots, I; \quad j = 1, 2, \dots, J$$

The objective function of model (1) seeks to maximize the efficiency score of a DMU by choosing a set of weights for all inputs and outputs. The optimal value of the objective function is the DEA efficiency score assigned to the m th DMU. If the objective function of the associated equation (1) results in efficiency score of 1, a DMU is considered efficient and is located on efficiency frontier. Here, relative means that efficiency is a comparative measure based on the set of DMUs used in the model (1). On the contrary, a DMU is considered relatively inefficient if its efficiency index is less than 1.

Model (1) represents a fractional linear programming model. This can be transformed into a simple linear program, as follows:

$$\text{Max} E_m = \sum_{j=1}^J V_{mj} Y_{mj}$$

subject to:

(Model 2)

$$\begin{aligned} \sum_{i=1}^I U_{mi} X_{mi} &= 1 \\ &; \\ \sum_{j=1}^J V_{mj} Y_{mj} - \sum_{i=1}^I U_{mi} X_{mi} &\leq 0 \quad ; \quad n = 1, 2, \dots, N \\ U_{mi}, V_{mj} &\geq 0 \quad ; \quad i = 1, 2, \dots, I; \quad j = 1, 2, \dots, J \end{aligned}$$

The linear programming problem is achieved by setting the denominator or numerator of the ratio (Model (2)) to an arbitrarily selected constant. A similar manipulation of model (2) is possible to produce an input minimization oriented liner programming problem. In each program, the first constraints are changed but the rest constraints are still the same.

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Table 1: Profile of 193 automakers

	Number of firms	Percent (%)
Sub-sectors in the automotive industry (SIC29)		
Manufacture of motor vehicles (SIC29100)	33	17.1
Manufacture of bodies (coachwork) for motor vehicles (except caravans) (SIC29201)	22	11.4
Manufacture of trailers and semi-trailers (SIC29202)	14	7.3
Manufacture of caravans (SIC29203)	13	6.7
Manufacture of electrical and electronic equipment for motor vehicles (SIC29310)	13	6.7
Manufacture of other parts and accessories for motor vehicles (SIC29320)	98	50.8
Firm age (year)		
1-20	95	49.2
21-50	76	39.4
51-100	20	10.4
More than 100	2	1.0

Table 2: Variables and measures

	Variables	Measures	Mean	S.D.
Operations Capability				
<i>Inputs</i>	Cost of capital	Tangible assets ^a	14282.694	47591.705
	Cost of labour	Remuneration ^a	12337.798	25887.606
<i>Outputs</i>	Cost of operations	Cost of sales ^a	95048.295	362999.122
Productivity				
<i>Inputs</i>	Assets	Total assets ^a	64322.896	172243.582
	Shareholder funds	Actual value ^a	26043.829	84217.824
	Number of employees	Actual value	416.969	1175.332
<i>Outputs</i>	Sales	Turnover ^a	108750.202	388080.108
	Profit (Loss) before taxation	Actual value ^a	4667.503	10983.189
Business Performance	Return on capital employed (ROCE)	Actual value (%)	22.703	22.872

Note: ^a value in thousands of GBP

Table 3: Correlation matrix

	Mean	S.D.	1	2	3	4
1. Environmental dynamism	-0.666	0.949	1.000			
2. Operations capability	0.018	0.076	-0.085	1.000		
3. Productivity	0.511	0.233	-0.034	0.247**	1.000	
4. Business performance	22.703	22.872	-0.138	0.236**	0.662**	1.000

** $p < 0.01$. (2-tailed).

Table 4: The results of regression analysis (n = 193)

	Dependent variable			Mediator		
	Business performance (ROCE)			Productivity		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Industry type	0.151*	0.136 [†]	0.117**	0.046	0.029	0.132
Firm age	0.047	0.062	0.024	0.043	0.059	0.068
Operations capability (OC)		0.231***	0.072		0.248***	0.251***
Productivity			0.638***			
Environmental dynamism (ED)						0.106
OC × ED						0.144*
R^2	0.025	0.078	0.458	0.004	0.065	0.086
Adjust R^2	0.015	0.063	0.447	-0.007	0.050	0.062
F -value	2.440 [†]	5.324**	39.757***	0.378	4.392**	3.539**

*** $p \leq 0.001$; ** $p < 0.01$; * $p < 0.05$; [†] $p < 0.10$.

Figure 1: Conceptual model

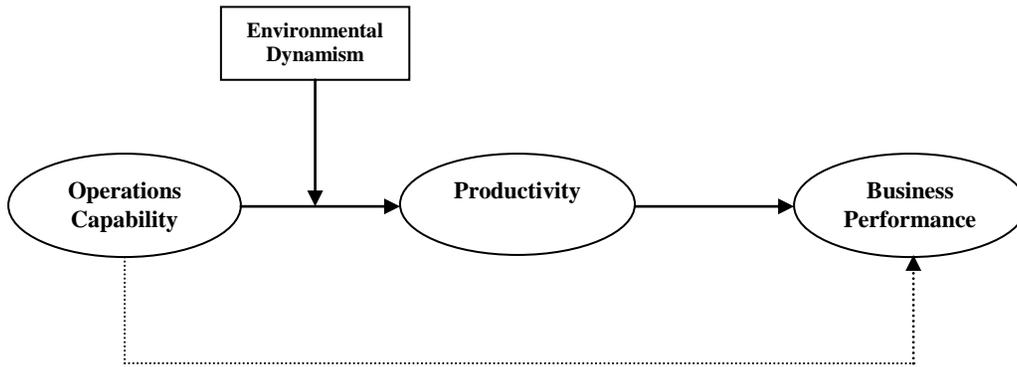


Figure 2: Moderating effect of environmental dynamism on the relationship between operations capability and productivity

