Intra-Sector Firm Performance and its Determinants in the UK Construction Industry

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https://doi.org/10.34737/vx4zz

INTRA-SECTOR FIRM PERFORMANCE AND ITS DETERMINANTS IN THE UK CONSTRUCTION INDUSTRY

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A thesis submitted in partial fulfilment of the requirements of the University of Westminster for the degree of Doctor of Philosophy

April 2021

Abstract

This thesis is a detailed quantitative investigation of intra-sector firm performance in the UK construction industry. Using the value-based model and creating a conceptual tool of assessment from it comprising nine determinants, the research applies this tool to the industry. Over two decades of firm performance data in the key sectors are analysed to answer the firm's performance question. By doing so, the thesis for the first time combines the disciplines of strategy, economics and finance to analyse the intra-sector firm performance question in UK construction.

A panel-based ordinary least squares (OLS) regression is the main approach. However, corrections and adjustments are made for a range of likely econometric issues including heteroscedasticity, autocorrelation, multicollinearity and cointegration. A suite of five different advanced regressions including GLS random effects and maximum likelihood estimations are implemented to validate and corroborate the OLS results. In addition, three different regressions are performed in the sample simultaneously namely in the overall industry, the three key sectors in it and in a time-based pre- and post-credit crisis splicing.

Robust evidence is found for each of the nine determinants and their varied influences on profits in the UK construction industry. Among the important findings here are: evidence for a liquidity-orientated business model in large tracts of the industry; a negative leverage impact on profits only among building sector firms; and a purely positive profits function among civil engineering firms. Based on these findings, firm managers in each sector of the industry are given specific recommendations including: to avoid debt in the buildings sector; to invest systematically in technology and capital assets in the civil engineering sector; and to focus on cost leadership in the specialist trades sector. The analysis also yields important policy insights for regulators and policy think tanks. Noteworthy here are tax-based incentives for inventory management in all sectors of the industry, a technology development institute for the firms in the industry and sector-specific regulatory guidelines for the firms in the buildings sector. The thesis expands the repertoire of creative solutions for the difficult intra-sector firm performance questions of this industry.

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Acknowledgements

Frist and foremost, I thank and praise Almighty God for his blessing and guidance throughout this arduous journey which without I would not have been able to succeed.

I would like to express my sincere gratitude and appreciation to my supervisors Dr Gheorghe Multescu, Dr Kristina Vasileva and Dr Mariah Christina Georgiadou for their continuous guidance and assistance at every step towards completing this thesis. I am thankful for all their insightful comments and suggestions which significantly enhanced my skills and abilities as a researcher. They helped me get through every challenge and obstacle along the way and made sure I was on the right track. For that I am grateful to them all.

I would also like to extend my sincere thanks and gratitude to my former supervisors Dr Stephen Gruneberg and Mr Michael Lister for planting the seeds, which have now blossomed into this thesis. I was honoured to have them as my supervisors and lucky to have them help me lay the foundations which this thesis was built on.

Last but not least, all thanks, gratitude and love to my wonderful family starting with my father Samir, who provided me with unlimited support and never spared an expense to see me succeed in my endeavours, and my mother Abeer, who overwhelmed me with her unconditional love and support. I consider myself extremely lucky to have them as parents. I thank them for raising me to be the man I am today. I can never repay them for all they have done for me. All I can hope for is to make them proud.

Special thanks and love to my siblings Mohammed, Ghada, Haya and Ahmed for always being there for me whenever I needed. Having them in my life is the greatest blessing a brother can ask for.

I thank my wife Hadeel, my inspiration and the love of my life, for all the sacrifices she made in supporting me and for sticking by my side through all the difficult times of this challenging journey. She always brings out the best in me and inspires me to reach my highest potential. I am truly blessed to have her as my wife.

A deep heartfelt thank you to my sweet three-year-old son Khaled who has been since the day he was born my main source of motivation to become successful and become the best role model I can be for him. I thank God for blessing me with him in my life.

Declaration

I declare that all the material contained in this thesis is my own work.

Abbreviations

AA	Asset arrangement
CASHTOTA	Cash to total assets
CD	Competitive dynamics
CF	Capital Financing
CV	Coefficients of variation
DBTOTA	Debt to total assets
Entity FE	Entity fixed effects
GLS RE	Generalised least square random effects
GM	Gross margin
INCTECHCAPINVESTOREV	Incremental technology and capital investment to total revenues
INVENTOTA	Inventory to total assets
IPA	Infrastructure and projects authority
IR	Inventory relationships
ISFP	Intra-sector firm performance
ISP	Industry structure perspective
Ln (PAT)	Log of profit after tax
Ln (TOTR)	Log of total revenues
LPFETOTA	Land property/plant furniture equipment to total assets
M	Margins
MLE RE	Maximum likelihood estimation random effects
MP	Market positioning
MS	Marketing spends
MT	Marketing theory
NCATOTA	Net current assets to total assets
OLS	Ordinary Least Square
OM	Operating margin
ONS	Office for national statistics
Pooled OLS	Pooled Ordinary Least Square
RBV	Resource-based view
RG	Revenue growth
RGP	Revenue growth patterns
RICS	Royal institution of chartered surveyors
RM	Resource management
SGATOTA	Selling general and administrative expenses to total assets
SIC	Standard Industrial Classification
TCE	Transaction cost economics
TCI	Technology and capital investments
TCR	Trade creditor relationships
TCTOTA	Trade Creditors to total assets
TDR	Trade debtor relationships
TDTOTA	Trade debtors to total assets
Two-way FE	Two-way fixed effects
VBM	Value-based model
VBMA	Value-based model of assessment

41	Construction of buildings
42	Civil engineering
43	Specialised construction activities

Chapter 1. Introduction

1.1 Research rationale

This thesis is driven by three independent yet interlinked motivations. The first is predominantly derived from the nature and specific peculiarities of the UK construction industry while the second is based largely on a gap in the body of knowledge in strategic performance studies within it. The final motivation is aimed at filling the gap of longitudinal performance studies in the industry. All three motivations feed off one another and provide a rationale for the research question, aims and objectives that follow.

1.1.1 Construction industry-performance-based rationale

There are some peculiar and stylised reasons why the UK construction industry and firm performance in it are particularly in need of detailed scholarly analysis. First is that the industry has been the cynosure of attention in several policy debates across the wider economic literature with its significant performance failures, bankruptcies and insolvencies (Hughes *et al.*, 2015; Department for Business, Innovation and Skills, 2013; Gruneberg and Francis, 2019). A performance determinant study that is strategically wide yet empirically measurable is needed to improve firm performance in the industry and its key sectors. Second, the uniquely fragmented nature of the supply chain of the industry and its highly unequal adversarial relationships combined with the many small and medium enterprises implies that performance failures in this industry have a domino effect that has an exaggerated macroeconomic impact (Morledge and Smith, 2013; McCloughan, 2004; Creedy, 2004; Doloi, 2013; Koushki *et al.*, 2005). A detailed performance study in the industry is therefore vital to avoid such frequent firm performance mishaps. Third is that the UK construction industry is highly diverse with an unusually large variety of firms with varying internal strategic and financial structures (Glenigan, 2011; Enshassi *et al.*, 2009; Sweis *et al.*, 2013; Smyth, 2018). The challenge before the firm manager in this industry is to calibrate these internal structures effectively to improve and sustain performance and this is often without precedent in other industries. Finally, the project site-based complexities of this industry that often make standardisation of operating procedures and protocols difficult and complex imply a unique firm performance environment that needs detailed delineation and analysis (Morledge and Smith, 2013; Kabiri *et al.*, 2012; RICS, 2012; UKCES, 2012;

HM Treasury, 2010). Therefore, these peculiar and stylised industry performance characteristics constitute the first critical rationale for this thesis.

1.1.2 Body of knowledge-based rationale

Firm performance studies in the UK construction industry are at a crossroads. Given the critical nature of the industry as the very basis of the engine of economic growth in the country, there is a need to better assess the performance dynamics of UK firms. Although there have been many types of research undertaken in this industry, there is a dearth of studies that critically evaluate the widest range of measurable and discretionary strategic determinants of firm performance and their impact on such performance (Ive and Murray, 2013; Gruneberg and Francis, 2019; deValence, 2003; Hughes *et al.*, 2015). Policy makers, regulators and firm managers in the industry need real-life insights that can help calibrate their actions to improve the firm's performance. A strategic approach to firm performance using a carefully modified theoretical tool of assessment that captures the widest canvas of performance determinants is the most direct way of generating such insights.

Existing performance studies here have been far too generic and lacking in well-crafted theoretical underpinning. One of the main reasons for this has been a missing unified theoretical framework encompassing the widest possible range of measurable determinants of firm performance in this industry. Existing theoretical work has been largely focused on the firm's internal perspective, the industry-based external perspective or a set of generic potential determinants (Sun *et al.*, 2017; Billal *et al.*, 2016; Harrington *et al.*, 2012; Bemelsmans *et al.*, 2012). This is inadequate in such a unique industry with its singular characteristics. Analysing and improving firm performance in the industry with a wide encompassing theoretical model of performance assessment in the UK construction industry is thus the second key motivation behind this research effort.

Strategic theories of firm performance evaluate it using either an external industry-based perspective or an internal firm-based one. Of the first, the most generic of formulations include the industry structure perspective (Porter, 1985) and marketing theory (Kotler and Armstrong, 2015). In the second it is the resources based view (Barney, 1991) and transaction cost economics (Coase, 1937; Spulber, 2009) that constitute the standard frameworks used in the literature. But all of these formulations share the limitation of being unidimensional and restricted in their vision of firm performance. Given the unique features of firm performance in the UK construction industry, there is a clear need to encompass a wider and holistic theoretical understanding of such performance. The value-based model (VBM, Becerra, 2009) combines and integrates all four aforementioned paradigms and provides a unique overarching basis to interpret firm performance that is topical and relevant to this industry. Using this VBM as the theoretical underpinning this thesis builds a conceptual framework to comprehensively evaluate intra-sector firm performance in the UK construction industry.

1.1.3 The longitudinal rationale

The UK construction industry firm performance needs large sample studies that evaluate it across a significant period. It is worth noting how, in the current environment, policy discussions, recommendations and guidelines have been developed for the UK construction industry that are based largely on either anecdotal practitioner survey-based evidence (Anikeeff and Sriram: 2008; Taroun: 2014; Jaffar *et al.*, 2011; Segerstedt and Olofsson: 2010; Aloini *et al.*, 2012) or small-sample limited time horizon data (Horta *et al.*, 2012; Deng and Smyth, 2014; Ive and Murray, Department for Business, Innovation and Skills. (2013); Horta *et al.*, 2016). There remains a growing gap in terms of studies that critically examine firm performance determinants in a substantial industry sample across a valid length of time in the UK. A longitudinal large sample study in the industry using an academically rigorous theoretical framework is thus the third and final key motivation underpinning this research effort.

This rationale naturally coalesces into the research question, aim and objectives underpinning this thesis.

1.2 Research question

How can a value-based model of assessment (VBMA) be used to improve the intra-sector firm performance in key sectors of the UK construction industry?

1.3 Research aim

The research aims to investigate how and why firm performance varies in three key sectors – the construction of buildings, civil engineering and specialised construction activities – of the UK construction industry and how a VBMA can be used to improve intra-sector firm performance (ISFP) in the UK construction industry.

1.4 Research objectives

- To establish the current determinants of firm performance in the UK construction industry and analyse their overall impact on the construction industry by using a VBMA.
- To analyse ISFP in key sectors of the UK construction industry based on VBMA determinants.
- To assess how VBMA determinants change over time and the implications of these changes for firm performance in the overall UK construction industry and key sectors therein.

The research question, aim and related objectives are deductive in orientation, intending to test and assess how a VBMA helps improve ISFP in the UK construction industry. The idea is to use a longitudinal empirical dataset from 2000 to 2019 comprising a large set of financial metrics of determinants and performances linked by the VBMA in the firms of the UK industry and analyse the results to derive insights to improve performance, regulation and development of the industry. The three separate research objectives identify the three different levels of analysis intended in the research: the overall industry level, the intra-sectoral level and across time. From these three separate levels of analysis, the thesis intends to contribute to the body of knowledge in strategic firm performance in the UK construction industry.

1.5 Summary of methodology

The thesis applies the VBMA to a large sample of 61,897 firm-year observations of determinant performance metrics across 3,096 construction firms (Standard Industrial Classification (SIC) codes 41,42 and 43) and 20 years between 2000 and 2019 using a classical regression method. Five separate regressions are performed at every level of the analysis: the pooled OLS, entity fixed effects, the two-way fixed effects, GLS random effects and the maximum likelihood estimation. This is although tests to rule out the major econometric issues likely in a sample and variable set of this kind – heteroscedasticity, autocorrelation, multicollinearity, endogeneity and cointegration –

are also implemented. The overall intention behind such a wide set of regressions is to ensure that the relationships between determinants and performances identified in the study are not spurious and are robustly substantiated.

In addition, the methodology of the thesis is applied at three separate, yet interlinked levels within the UK construction industry. The first level evaluates the firm's performance determinant associations in the overall UK industry while this is then expanded in the second level across the key sectors within it and the third and final level divides the sample across the business cycles and periods of economic distress. From these three separate yet interlinked explanations, a rich and variegated picture of the industry that answers the three research objectives detailed above is attempted.

1.6 Novel research outcomes

Four different novel research contributions are achieved in this thesis.

1. The thesis expands the theory of ISFP in the UK construction industry. Uniquely, it creates and adapts a comprehensive theoretical tool based on the VBMA. This singular tool combines nine performance determinants conceptually grounded in the large number of strategic paradigms encapsulated in the VBMA.

2. Based on the sample findings, the thesis identifies six specific policy-based recommendations for the government, regulators and other stakeholders in the industry.

3. By identifying the different performance determinants in each of the three key sectors of the industry, the thesis makes the task of firm managers more cogent. It also details a list of 12 specific determinant-based recommendations for such managers in the buildings, civil engineering and specialist trade sectors of UK construction.

4. Three different regressions in the industry, the key sectors and the time comparisons are simultaneously implemented in the sample. Therefore the thesis expands the repertoire of solutions to address the firm's performance question in the industry.

1.7 Research outline

The thesis is structured as follows. Following this introduction, Chapters 2 and 3 are presented which constitute the literature review. In Chapter 2, the UK construction industry, the contextual importance of ISFP in it and the relevance of a conceptual framework based on the VBM encompassing firm strategy theory to assess such performance are evaluated. This is followed by Chapter 3 where the identified determinants of ISFP theoretically delineated in the previous chapter are analysed in the policy and practice literature of industry firm performance. Chapter 4 is the methodology chapter which presents and justifies the main regression model and identifies the dependent and independent variables in it. In Chapter 5, the sample data collated in the UK construction industry is descriptively summarised and analysed. A detailed and theoretically analysed description of the overall UK construction industry regression results is presented in Chapter 6. This is then followed by a similar theoretical analysis of the ISFP regression results in Chapter 7. Chapter 8 presents and analyses the time-based regression results in the sample both in the industry and across the sectors in it. The key insights derived from Chapters 6,7 and 8 are summarised in the conclusions and recommendations in Chapter 9 which answers each of the research objectives of the thesis apart from detailing the main limitations of the research and making a set of recommendations for theory, research, policy and practice.

Chapter 2. ISFP in UK Construction – the VBMA

This chapter reviews the literature in performance theory to define, debate and evaluate the importance and relevance of ISFP in the UK construction industry. Section 2.1 analyses how ISFP is defined and debated among scholars. It suggests that the concept itself is under-theorised. Section 2.2 at one level establishes why ISFP is vital to the UK construction industry but at the second level descriptively analyses the key sectors in the industry and their salient features. Section 2.3 evaluates firm performance theory to show how current theories are inadequate to explain the sector-based differences in firm performance in an industry. Section 2.4 analyses why the VBM is a uniquely relevant theoretical framework to analyse and improve ISFP. The central concepts of the VBM are theorised in a set of nine observable and measurable likely determinants of ISFP in Section 2.5. Section 2.6 concludes the chapter, summarising it by reiterating the research question.

2.1 ISFP – definitions and debates

Definitions of firm performance are varied. Kumari and Kumar (2018) present detailed evidence of this wide dispersal in their meta-study of the performance literature straddling the disciplines of macroeconomics, strategy and finance. According to the authors, macroeconomic studies like Macdonald (1999), Hallward-Driemeier *et al.* (2006) and Sufian (2011) generally attribute firm performance to economy-wide changes with only a few ever referring to firm or industry-specific factors. Macroeconomic variables such as gross domestic product (GDP) growth, inflation rate, unemployment rate and exchange rate are used as determinants of firm performance. This strand of research also generally locates firm performance in variables such as stock returns, profit-to-sales ratios, total factor productivity, investment rate and sales growth rate.

A second strand of authors from the discipline of strategy such as Hawawini *et al.* (2003), Short *et al.* (2009), Goddard *et al.* (2005) and Galbreath and Galvin (2008) generally associate firm performance with industry performance although a few firm-specific factors are sometimes used. Studies here generally use determinants such as industry size, concentration ratio, industry growth and five-digit industry classifications. A small minority of studies such as Goddard *et al.* (2005) and Galbreath and Galvin (2008) use firm-specific factors such as market share, firm size, leverage and liquidity. However, all studies in this strand use a wider range of firm performance indicators than studies in the macroeconomic strand including operating income, total assets, total sales, sales growth and firm survival rates.

The final strand of performance studies from the discipline of finance generally uses the widest strand of firm-specific determinants apart from measuring firm performance most richly. Scholars such as Fama and French (1993), Glancey (1998), Vatavu (2014) and Al-Jafari and Samman (2015) are notable in this strand. That firm performance is measured using a range of different metrics as cited in Appendix 7 reflects how diverse this strand's assessment of firm performance is. Even in the examination of likely determinants of firm performance, the scholars here collate a very rich set of variables including total assets, intangible assets, sales, R&D expenses, advertising, liquidity, working capital, leverage, age and ownership.

This slice of the performance literature clarifies that firm performance is multidimensional and can be measured in different ways. It also highlights how decomposition of this performance can be challenging given the wide range of likely firm-specific, industry-related and macroeconomic determinants of such performance. Earlier studies do not concur on the best way to measure firm performance or the optimal set of determinants that can explicate it.

Notwithstanding this lack of consensus in the literature, firm performance studies have either grouped firms together irrespective of industry or focused on just a single one. Thus, leverage scholars like Khaliq *et al.* (2014), Yen and Hiep (2014), Khurshid (2013) and Yusuf *et al.* (2014) group firms from different industries together and analyse how debt affects firm performance. Working capital management and its effects on firm performance were studied in Kenya by Makori and Jagongo (2013) but the authors invariably study just the largest firms in the country without paying attention to different industries. a swathe of studies such as Khidmat and Rahman (2014) in chemicals and John and Adebayo (2013) and Niresh and Thirunavukkarasu (2014) in manufacturing often group firms from a single industry together and analyse the performance question in them.

But such industry-opaque or industry-specific performance analyses miss a very important likely source of firm performance differences. Firms even within an industry are hardly homogenous. Firms span different stages of the production process in any given industry and this makes them incomparable to other firms. Strategy scholars ranging from Porter (1996), Barney (1991), Kotler and Armstrong (2015) to Becerra (2009) and Liberman *et al.* (2017) invariably point to the rich diversities inherent in the value chains of industries. The authors show using their different theoretical narratives that it is in these value chain-based firm interrelationships that firm outperformance is forged. These interrelationships often enable the firm to compete more effectively in its industry and Becerra (2009) argues that it is one of the key sources of its value-based advantage. But by grouping all firms without regard to the differences in their business models a rich source of understanding their performances is lost.

This explains why in recent times discourses in strategy especially seem to underline how firms in the same industry differ in their performances primarily due to their different interrelationships with peers in other sectors of the same industry. Scholars like Becerra (2009), Besanko *et al.* (2017) and Grant (2019) seem to emphasise sector-based relationships and sector-to-sector comparisons of firms. This is what can be defined as ISFP. To put it simply, it is a critical sector-by-sector comparison-based analysis of firm performances in an industry.

ISFP has both a firm-specific and a sector-specific connotation. The concept flits between the firm's membership of its industry and its place in its separate sector. Every likely determinant of performance used in ISFP has to be compared and contrasted across the sectors of any given industry (Becerra, 2009; Besanko *et al.*, 2017). In addition, every performance determinant has to be linked with all other such determinants from the perspective of likely sector-based firm interrelationships. Therefore, ISFP is the more important aspect in industry-based firm performance theorisation that needs elaboration and analysis.

2.2 The unique problem of firm performance in UK construction

Construction sector firms differ widely in terms of their performance. Intra-firm and inter-year performance variation in UK construction is wider than in other industry sectors such as manufacturing or financial services (Glenigan, 2011; Enshassi *et al.*, 2009; Sweis *et al.*, 2013). Government surveys in the UK construction industry such as RICS (2012), UKCES (2012) and HM Treasury (2015) underline this by highlighting how construction firms exhibit larger extremes of performance at both ends of the scale.

The relatively poor performance of firms in construction in the UK has been traced to many factors. Barrett *et al.* (2007) underline the endemic confrontational culture widespread in the industry and suggest that it inhibits performance. These authors and others such as Wolstenholme (2009), Fearne and Fowler (2006), Pesamaa *et al.* (2009), Yadav and Ray (2015), Crompton (2016) and Aljohani (2019) also point to fragmentation in the industry supply chain, informal and unstructured learning processes, low investment in training and development, resistance to change, number and type of stakeholders, lack of openness, lack of customer focus and opportunistic behaviour as being rampant among industry firms. Many of these causative factors for underperformance seem to coalesce around a unique intra-sector dynamic in the industry. Unlike other industries, firm interrelationships across sectors linked by the industry supply chain are critical to UK construction firm performance.

Sub-contracting is generally more widespread in the construction industry but in the UK this has become a dominant feature of the industry. Ancell (2007), Akintan and Morledge (2013) and Malleson (2013) underline how UK construction firms generally implement traditional procurement routes rather than design and build, partnering or project management and therefore suffer from extensive levels of sub-contracting at every stage. Such a finding is robustly substantiated in industry studies of the Department for Business, Innovation and Skills. (2013). which find that even very large construction projects in the UK have more than 70% of their work sub-contracted out to smaller entities many of which produce a contract value of less than £10,000. Crompton (2016) argues that this level of sub-contracting stems from the widely held industry belief in the utility of separating design from production and stymies innovation or improvements in quality or efficiency. Sub-contracting naturally creates more and more divisions in an industry and fosters an 'us versus them' mentality. Thus, once again the ubiquitous tendency to subcontract in UK construction is one other key reason why firm performance cannot be studied in isolation. In this industry, it is in the crucial intra-sector dimension – the sub-contractor and sub-sub-contractor interrelationships – where the determination of firm performance happens.

It is in this context that the UK construction industry has recently seen a spate of policy and normative literature focused on the value of partnering. That a host of scholars such as Eriksson (2007), Packham *et al.* (2003), Thomas and Thomas (2005), Morledge and Smith (2013), Ross (2011) and Crompton (2016) have repeatedly stressed its importance suggests that the sub-contracting nature of the industry is suboptimal from a performance perspective. What is needed is more integrated solutions that can help firms create and appropriate value for money for both the client and themselves. Yet this still begs the question of whether partnering will improve performance especially in any construction industry given at least some evidence that it does not work well in building works (Chan *et al.*, 2006).

Evidence by Creedy (2004), Doloi (2013) and Koushiki *et al.* (2005) when read together strongly suggests that delinquency rates in UK construction are unusually high. Much speculative debate in the policy literature cited by Morledge and Smith (2013) traces this to fragile business models and adversarial relationships between firms, their contractors and sub-contractors. An inference is unmistakable that sector-based relationships across the value chain might explain the extremes of performance in the industry and the greater incidence of bankruptcy.

There are at least 200 listed firms in the industry, many of which are constituents of broader stock market indices such as the FTSE 100, FTSE 350 and FTSE 650. Some of these firms – notably CRH, Balfour Beatty, Kier Group and Morgan Sindall – are global in their scope and implement construction projects in different parts of the world. Such firms are diverse and present in many different sub-segments of the construction supply chain. Undoubtedly these are market leaders, executing very large complex projects and handling many human and financial resource bases. Yet diversity in firm size is an important characteristic of UK construction. Very large firms jostle for market space alongside many medium, small and even tiny single entrepreneur-led enterprises (Glenigan, 2011; CCF, 2000). This heterogeneity is at once both puzzling and topical to intra-firm performance in the sector.

Authors like Glenigan (2011), Morledge and Smith (2013) and Kabiri *et al.* (2012) decry the poor quality of deliverables, time/cost over-runs, supply chain and operational inefficiencies, irrational risk-sharing arrangements and poor technology adoption in the sector.

Operating and net margins in the sector have been declining for decades and much of the underperformance of firms has been attributed to this (de Valence, 2011; Runeson, 2000).

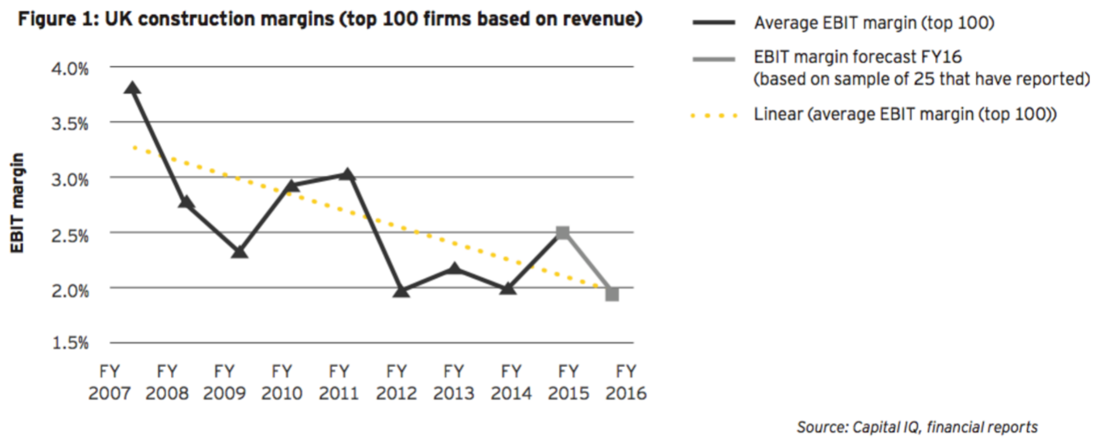

Figure 1: UK construction margins (top 100 firms based on revenue)

Source: Capital IQ, financial reports cited in Ernst and Young (2017)

The latest research suggests that the top 100 contractors in the industry had an average profit margin of just 1.5% in 2016. The downward trend in these contractor margins (see Figure 1) has even been documented by Ernst and Young (2017). This is even lower than retail and wholesale, which has one of the lowest net margins.

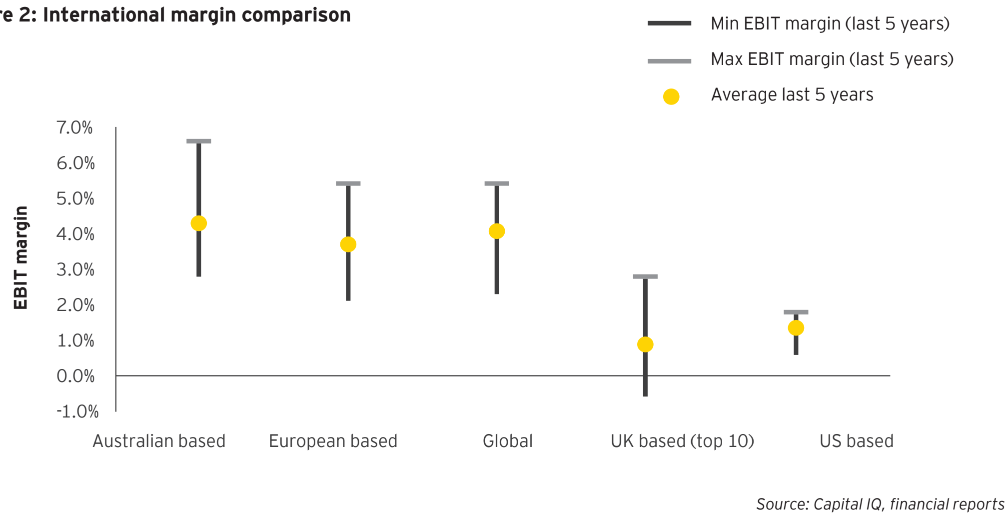

Figure 2: International margin comparison

Source: Capital IQ, financial reports cited in Ernst and Young (2017)

It is worth noting how in the UK low margins are particularly worrisome. Figure 2 shows that the country's firms are only able to extract the lowest such margins in the developed world.

These low margins are especially difficult in an industry that, unlike retail or wholesale, is engaged in a complete product transformation cycle from raw materials to finished products. The built environment delivered by construction is a combination of several types of firm and supply chain-based input resources (Hughes *et al.*, 2006; Morledge and Smith, 2013; Kabiri *et al.*, 2012). Retail and wholesale industries, by contrast, primarily break down, store and process bulk products. A low margin in this industry is inevitable given the nature of the average business model. A similar low margin in construction is inexplicable (Gruneberg and Francis, 2019; Kabiri *et al.*, 2012). It is quite plausible that the wide variation and volatility in ISFP in this industry can be directly traced to this distinct lack of elbowroom in setting and maintaining healthy profit margins.

Supply chain complexity and layering is another unique aspect of UK construction that exacerbates intra-firm performance differences in the sector. Department for Business, Innovation and Skills. (2013). documents at least three different layers of this supply chain including tier-1, tier-2 and tier-3 contractors sub-contractors and sub-sub-contractors. Different construction firms position themselves in distinct parts of this supply chain and use these positions to establish a unique value proposition to sustain their competitive advantage (Fernie, Leiringer and Thorpe, 2006; Fernie and Thorpe, 2007). This heterogeneity in firms in different parts of the supply chain would imply that intra-firm performance differences would stem in large part from strategic differences in the business models in use.

The UK construction industry is complex. In some sectors, it is highly fragmented whereas in others there is a strong element of concentration. There is a vast theoretical and policy literature that argues that interrelationships between firms in different sectors of the industry often face considerable challenges that are at the root of firm underperformance. Morledge and Smith (2013) discuss the many types of partnering and collaboration solutions to UK construction firm performance problems but repeatedly underline the many difficulties in operationalising them. Ancell (2007) cites many other authors such as Gruneberg and Ive (2000), Dietrich (1994) and Kumaraswamy and Dulaimi (2001) to record the unusually long interlinked supply chain of the industry, implying that firm interrelationships are key antecedents of performance in this industry. Elsewhere, Hughes *et al.* (2015) discuss the many layers and tiers of the industry which make any firm dependent in several ways on a multitude of small, medium and large firms in other sectors. As a consequence, according to them, firm performance in the industry is largely a function of the interrelationships between firms in the key sectors of the value chain. In other strands of policy-based literature, the UK government itself (Department for Business, Innovation and Skills, 2013; Cabinet Office, 2011; 2012; Rhodes, 2019) documents how a large number of firms in the industry are single-person outfits and suggests that this puts an enormous burden both on the firms themselves, their trade partners and the entire supply chain of the industry.

This discussion clarifies how ISFP is key to understanding the many performance problems in the UK construction industry. Without such a sector-by-sector evaluation, firm performance in the industry would remain inexplicable. The close relationships of firms with their contractors and sub-contractors plays a crucial and multifaceted role in determining performance. Trade-offs permeate all these relationships and firm managers have to make several strategic and operational decisions based on these trade-offs. Hence ISFP is an important missing part of the puzzle of construction firm performance in the UK.

2.2.1 ISFP in UK construction

ISFP in UK construction requires a clear understanding of the boundaries of the industry and the key sectors within it but this poses a singular challenge in itself. Hughes *et al.* (2015), Gruneberg and Francis (2019), Morledge and Smith (2013), Kabiri *et al.* (2012) and many others highlight the difficulties in deciding which firms should be included in the construction industry in the UK and which should not. Empirical databases like FAME use some simple rules to decide. If a firm derives x% of its revenues from construction-related activities, the database puts it in this category. But there are obvious problems with such approaches. FAME divides the industry into three main sectors based on Office for National Statistics (ONS) SIC taxonomy: 41 (construction of buildings), 42 (civil engineering) and 43 (specialised construction activities).

It is appropriate to use this taxonomy as the basis for ISFP in the UK construction industry for three main reasons. First, the wide range of types of construction projects including different types of buildings and civil engineering works included in sectors 41 and 42 encapsulate the widest possible range of contractors in the business. Sector

43 subsumes a whole range of specialised construction activities ranging from plastering, roof installation, painting and decorating to very complex services such as oil drilling, demolition and site preparation. This implies the complete range of construction firms in the country are included here and, in that sense, the entire supply chain of the industry is covered in this SIC classification. Since ISFP in UK construction needs a delineation of as many potential interrelationships of all the different types of construction firms in the industry, this taxonomy is essential. It also fulfils the interaction emphasis of the VBM model of assessment neatly.

Second, the theoretical definition of ISFP requires a comparative and simultaneous analysis of the firm's membership of its sector and its place within the industry. The 3 SIC codes of the UK construction industry do not segregate firms by function but instead group all of them by the produced output – a building, a project or a specialised service, as the case may be. This aids the comparative simultaneous industry and sector analysis needed for ISFP in a richer way than would otherwise have been possible. It also avoids any likely conflation between firm function and type of firm. Finally, those construction activities neatly categorised in SIC 43 makes possible an easy separation of the support activities that enable main and specialist contractors in SICs 41 and 42. This is appropriate to the ISFP emphasis on the supply chain interrelationships.

2.3 Strategic theories of ISFP

The existing theorisation of ISFP is limited. To extract an underpinning for this construct it is necessary to analyse existing firm performance theory. Four main theoretical paradigms are important, as stressed in seminal literature such as Porter (1985; 1996), Barney (1991), Spulber (2009) and Kotler and Armstrong (2015). These are the industry structure perspective (ISP), the resources based view (RBV), transaction cost economics (TCE) and marketing theory (MT). Each has a different strategic angle on the firm's performance question.

The ISP takes the view that firm performance is a complex function of the structure of the industry of which the firm is part. The latest version of this theory argues that at least six different forces are at work in an industry. These are barriers to entry and exit; the bargaining power of buyers and suppliers; the intensity of competition; the availability of substitutes; and complementors and governments (Besanko *et al.*, 2017: 255-258). It is the complex interaction between these forces that determine firm performance. Two main problems exist in such a formulation. First, firm performance is largely explained in terms of these five external industry-based forces and the theory accords very little importance to likely internal determinants. The resources and capabilities of the firm do not enter the performance equation except marginally. Second, the theory does not separate the industry into its constituent sectors although it does encapsulate a value chain analysis. A rich source of likely performance differences between firms – the intra-sector angle – is thus lost.

The RBV (Barney, 1991; Rumelt, 1984) takes a predominantly firm-specific view and argues that firm performance is a direct function of the ability of the firm to combine rare, valuable, inimitable and non-substitutable resources and capabilities to deliver higher value to customers. This premise also suffers from two main problems. First, the external industry angle is downplayed and it is suggested that the firm can somehow use its resources and capabilities to surmount industry problems. Second, in its internal focus, the theory once again neglects the important and likely intra-sector angle.

The TCEs paradigm (Spulber, 2009) argues that the only reason for the existence survival and performance of the firm is its unique internal bundling of resources. The main logic here is that firms as unique bundles of resources exist primarily only if they provide a cheaper and better alternative to existing customer-to-customer relationships. However, this theory also fails to either capture the myriad sources of value that a firm creates either by its significant non-resource-based internal capabilities or its unique industry positioning. The intra-sector angle is hardly explored or given any importance in the overall explanation of firm performance.

MT posits that a firm's performance is predominantly rooted in its ability to segment, target and position its products or services in such a way that it can achieve the right mix of product differentiation and cost leadership to create value for customers (Kotler and Armstrong, 2015). The theory is less concerned with either the industry-specific or intra-sector dimensions of performance.

The four existing strategic theories of firm performance are thus each deficient in one or more external or internal aspects and now has a direct imperative for ISFP. The core sector-based relationships that underpin a firm's strategic value creation and appropriation that ultimately results in its better performance are not covered effectively in any of these theories. A new theoretical umbrella to explicate ISFP is thus an important theoretical need.

2.4 The VBM and its relevance to ISFP

The VBM (Becerra, 2009) posits that a firm's performance is a direct consequence of its ability to create and appropriate economic value. In this, it is simple but more comprehensive and integrative than other strategic paradigms explaining firm performance such as TCE, RBV, ISP or MP. Three main distinguishing aspects of VBM make it a versatile tool to decipher intra-firm performance in any industry. First, according to Becerra (2009), Lieberman *et al.* (2017) and Gans and Ryall (2017), it combines a firm-based internal dimension with industry and sector-based external dimensions. Second, scholars such as Jacobides and Macduffie (2013) and Osterwalder and Pigneur (2010) show the many dimensions of firm performance and suggest there is a need for a holistic explanation that covers them all. Insofar as VBM coalesces a range of different theoretical explanations rooted in four different theories of firm performance, it cannot be faulted in terms of its coverage of all likely determinants of performance. Finally, Becerra (2009) and Lieberman *et al.* (2017) suggest that VBM strongly focuses on the sector-based dynamics in an industry. In this, the theory is unique and capable of bringing fresh insights to the determination of ISFP.

2.4.1 VBM central concepts

The central concepts constituting the fundamentals of the VBM are shown in Figure 1. Becerra (2009) and Lieberman *et al.* (2017) suggest that resource management (RM), competitive dynamics (CD) and MP of firms determine how they create and appropriate value. This value creation and appropriation are what determine firm performance.

The theory enunciates three concepts of the firm's performance question. First, RM implies that firms combine a set of internal and external resources so that they can create value for their targeted customers (Becerra, 2009; Grant 2019). The exact bundle of resources that should be combined in the firm entity is a key issue facing the firm. Simultaneously, how the chosen bundle of resources should be combined and linked interdependently to deliver value for customers is a related critical issue. VBM highlights how both these problems have firm-specific, industry-related and intra-sector dimensions.

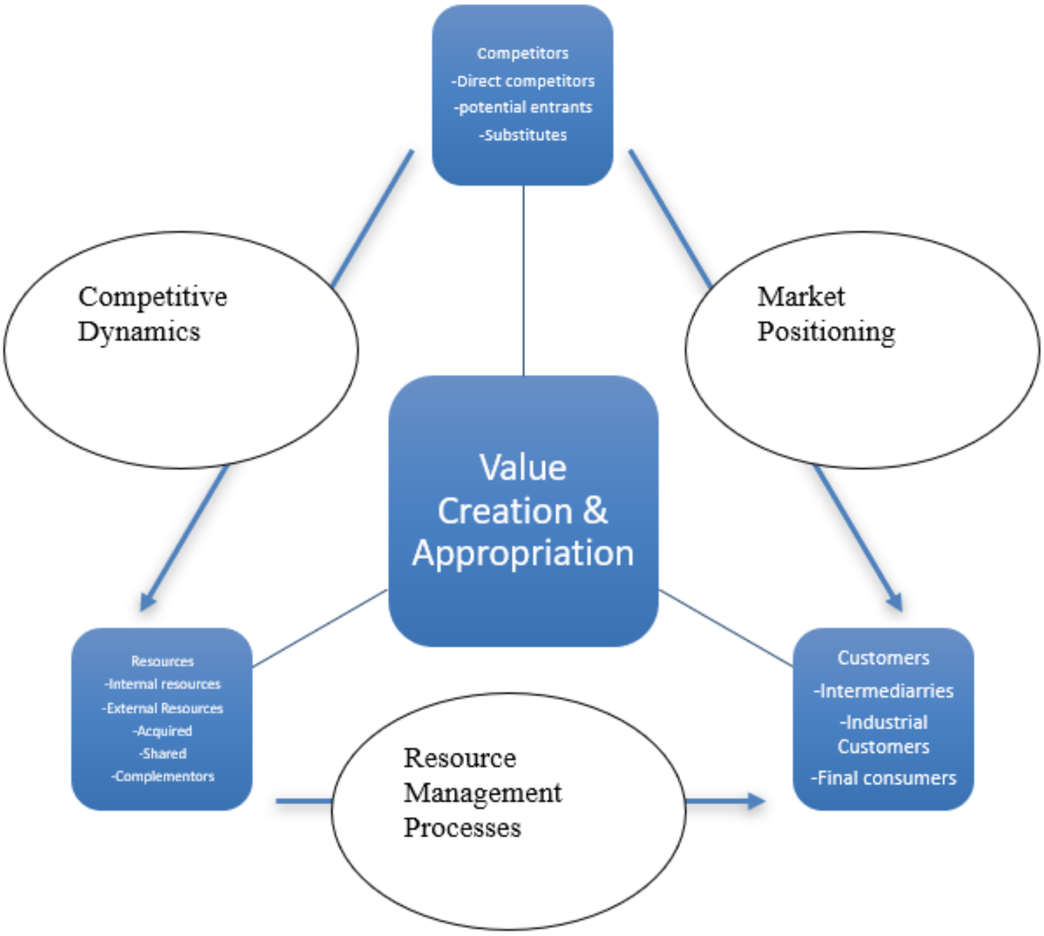

Figure 3: Central concepts

Source: Becerra (2009: 74)

What is unique in the theory is the inter-linkage with other concepts and the intra-sector focus (Becerra, 2009; Lieberman *et al.*, 2017). For example, RM in the firm has to take into account CD and MP. When choosing resources to bundle or link interdependently, a firm has to consider its competitor's strategic moves and any potential resource barriers erected. Similarly, the segmentation and differentiation strategies of existing competitors also need active consideration. VBM thus stresses that the firm takes account of the other two concepts while deciding the RM question. Even more importantly, and unlike RBV or TCE, VBM puts sector-to-sector firm interrelationships at the heart of value creation and appropriation by the firm (Becerra, 2009; Lieberman *et al.*, 2017). The theory predicts that how well a firm calibrates its relationships with supply chain partners; those firms in other sectors of the industry that will make or unmake its RM ability and which would consequently show up in better or worse performance.

Second, CD suggest that this value-creating process of RM takes place in the presence of direct and potential competitors for both resources and customers. Firms have to manage their dynamic interactions with competitor firms (Becerra, 2009). They also have to erect barriers to prevent these competitor firms from poaching their strategic resources. Here too VBM does not isolate the influence of competition. Instead, the theory actively incorporates the RM and MP angles. After all, the firm can only respond effectively to its competitors if it has an effective bundle of strategic resources worked out and has established an efficient set of working resource-based relationships. Similarly, the theory recognises that creating an effective barrier to strategic resources is only possible if the firm has already fully mapped its RM function. MP aspects enter the question of CD because the firm's response to competitors is directly linked to where in the market it has decided it can create the greatest value.

More importantly and uniquely, VBM implicates the intra-sector angle. Dynamic interactions with competitors include direct retaliation, avoidance, selective cooperation and a range of other behaviours and all of these suggest an intelligent calibration of interrelationships with other firms both in the industry and the sectors within it. Similarly, the erection of barriers for resources might involve a chain of relationships with value chain partners that are difficult to easily imitate (Barney 1991).

Finally, MP focuses on the fight for customers through effective segmentation, targeting and positioning of products and services. In this, customers and MP represent the third angle of the theory shown in Figure 3. Firms in all sectors must decide which customers to target with an optimal selection of products that enables them to create value and improve their performance (Liberman *et al.*, 2017; Becerra, 2009). As with the other concepts, VBM does not consider this concept in isolation or ignore the key intra-sector angle.

In each of these three concepts, the VBM is arguably superior to existing alternative theories of firm performance such as TCE, ISP and RBV (Becerra, 2009; Liberman *et al.*, 2017; Osterwalder and Pigneur, 2010; Grant, 2019). The model combines the internal with the external perspective – the intra-sector and intra-industry dimension – in one full explanation. This makes it more encompassing than either the internally orientated TCE and RBV paradigms or the externally orientated ISP and MT. The theory is unique in two features. First, it links the three concepts of RM, CD and MP in one holistic explanation of firm performance. Second, it brings an intra-sector firm focus to the core of the performance question.

2.4.2 Limitations of VBM

This is not to suggest that VBM does not have flaws and limitations which have been the subject of intense debate (Grant, 2019; Besanko *et al.*, 2017; Becerra, 2009). A principal criticism is that by encompassing so many theories and their diverse explanations, VBM runs the risk of not achieving any fundamental breakthrough in the understanding of firm performance. This criticism is easily countered; firm performance is not unidimensional. Grant (2019) shows how several drivers of performance both external to the firm and internal to it must be identified if any theory is to fully understand and explain firm performance. This argument is taken further by Besanko *et al.* (2017) and Favaro *et al.* (2012) who emphasise not only a full identification of the many drivers of performance but also an *inter-se* prioritisation among them so that such performance is fully deciphered. Unfortunately, most theories of firm performance evaluate it in a narrow unidimensional way and thus miss the complete picture. By unifying many competing explanations through a value-based axis, VBM allows the researcher to apply their skill and discretion in deciding which explanations are at work in any given industry and in what order of priority. This is why Becerra (2009) emphasises that fundamental breakthroughs in understanding firm performance through the VBM will emerge from the researcher's ability to intelligently interpret its application to any given industry.

The second criticism of VBM is that the model does not incorporate managerial processes and their relative efficacies in its explanations. According to Becerra (2009) and Martins *et al.* (2010), the strategic decisions taken by firms are operationalised through many different styles of managerial decision with very different effects on firm performance. But VBM is silent on these firm processes and therefore misses an important driver of performance.

Strategy scholars such as Grant (2019) and Besanko *et al.* (2017) admit that strategic explanations of performance should focus on the macro picture if an effective template for future performance is to be developed. Micro aspects of firm performance – the processes conducted by managers in the firm – constitute a distinct domain of investigation and may be used to complement and supplement the macro picture. This is why Hambrick and Fredrikson (2005) argue that any theory of performance from a strategic perspective should focus on the broader macro aspects, and VBM is no exception. This does not make it any less valuable as a tool to understand and explicate firm performance.

A final criticism of the theory is that VBM neglects soft factors such as human RM, motivation and culture (Martins *et al.*, 2010; Becerra, 2009; Lieberman *et al.*, 2017). Since the theory is too focused on the overarching strategic elements differentiating firm performance, it does not leave much room for these soft aspects that could undoubtedly have a defining impact. Although there is some merit in this argument, all theories of strategy and finance generally leave out discussions of these soft factors as they are the domain of other subjects in the performance question. VBM already has a large macro template under consideration which is a contribution in itself. It is more appropriate that soft factors are left to the expertise of human resource scholars who are better equipped to address these issues.

On the whole, VBM remains highly appropriate and relevant to building an overall understanding of firm performance in an industry's key sectors. Since it discusses aspects in the firm such as rarity and inimitability of resources, causal ambiguities in resource constellations, economies of scale and scope, transaction costs, operational synergies and cognitive and motivational factors and combines them with external aspects such as supply chain position and relationships, the bargaining power of buyers and suppliers, customer service and MP and risk management, it covers the entire strategic field and is therefore comprehensive (Becerra, 2009; Lieberman *et al.*, 2017; Gans and Ryall, 2017). The different mechanisms at work across key sectors of the industry and how they impinge on firm performance can be clearly delineated. In the process of explaining internal and external aspects, many issues connected with how the internal mechanisms interact with the external mechanisms also become clear. In this, the interrelationships between firms in the value chain and sub-sector dynamics are neatly clarified. This is why VBM is invaluable as a tool to understand and assess the tricky and complex trade-offs facing the managers in improving ISFP (Becerra, 2009; Lieberman *et al.*, 2017).

2.5 ISFP and VBM concepts

Having discussed the main advantages of the VBM as a tool to assess ISFP, this section examines the theory underpinning it. Each central concept in VBM – RM, CD and MP – is theorised and related to ISFP and a set of nine distinct measurable determinants are identified. This leads to the conceptualisation of the VBMA intended to be applied to the key sectors of the UK construction industry in this thesis as shown in Figure 4. Two observable and measurable determinants are identified in the concept of RM, four in CD and a further three in MP. The following section develops the theory underlying each of these determinants.

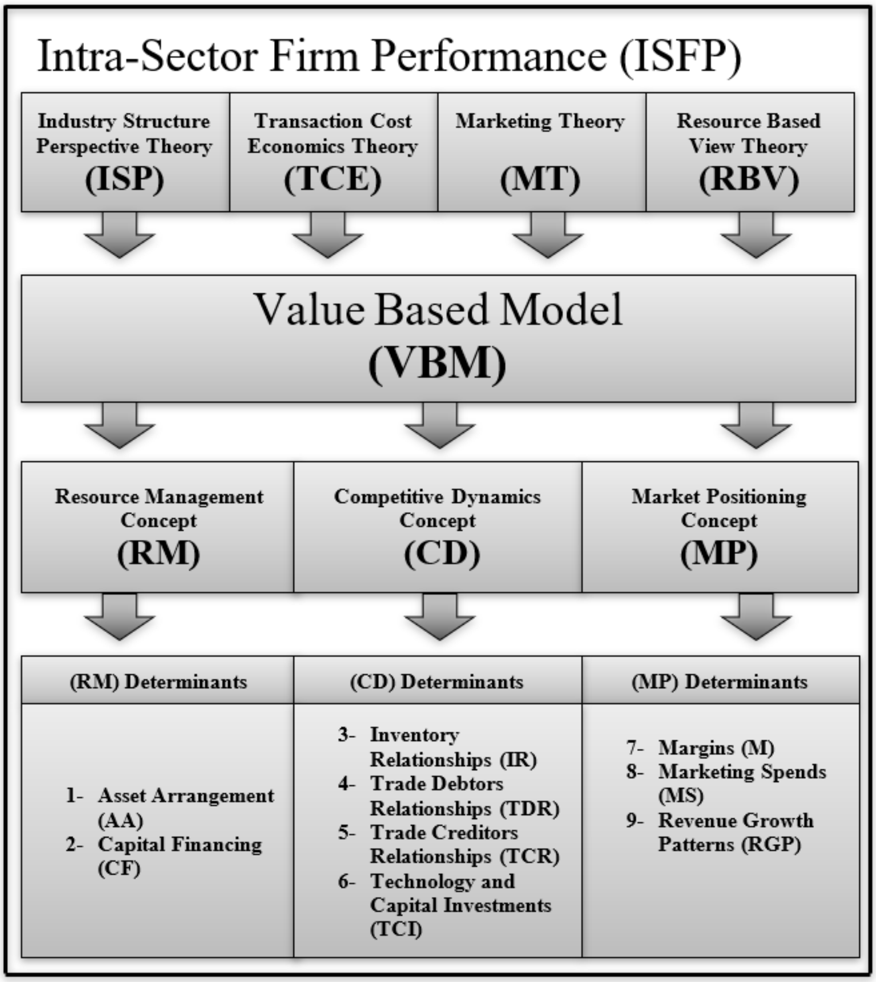

Figure 4: Intra-sector firm performance

Source: Author

2.5.1 ISFP and RM

According to VBM, RM in the firm is a key aspect that determines its superior or inferior value-based performance vis-à-vis other firms. But the theory is silent about how to measure RM. Many RM principles are not empirically observable or measurable

(Grant, 2019; Becerra, 2009; Lieberman *et al.*, 2017). Theorists in RBV and VBM admit that many of their core constructs may be very hard to observe or measure. Five core principles of RM as theorised are distinctly opaque and difficult to measure.

1. Identifying what is a resource and what is not is the subject matter of intense debate even among theorists of both RBV and VBM (Priem and Butler, 2001; Powell, 2001; Campbell-Hunt, 2000). For example, Becerra (2009) makes the point using RBV critics such as Priem and Butler (2001) and Powell (2001) that if everything *post facto* can be rationalised as distinctive RM, then it does not help managers to understand what to prioritise in a new situation.

2. Second, the rarity and value of resources are relative and subjective. What is rare in one firm or sector as suggested by RBV and VBM may not be so in another (Collis, 1994; Becerra, 2009; Lieberman *et al.*, 2017). This makes assigning a numerical value for value or rarity between firms or sectors impossible.

3. The causal ambiguities or unique ways in which firms marshal resources and capabilities in themselves is a key RBV concept borrowed by VBM. The theory suggests that it is this that determines firm performance (Barney, 1991; Becerra, 2009). But both theoretical and empirical scholars underline the difficulties in identifying and measuring differences in how firms organise such resources and capabilities (Peteraf, 1993; Amit and Schoemaker, 1993; Reed and DeFillipi, 1990).

4. Fourth, TCE and hence VBM theorises that firms exist and thrive because they understand and implement a resource bundling strategy. They know which resources should be combined in the firm and which should be retained at arms-length with suppliers, distributors and other supply chain partners. But identifying these resource bundles and their distinctive performance effects across firms and sectors in an industry is virtually impossible (Spulber, 2009; Becerra, 2009).

5. Finally, ISP and VBM posit that the value chain dynamics of different sectors in an industry must be deciphered to discover why firms differ so much in performance. But these dynamics are often difficult to identify, let alone objectively measure (Porter, 1996; Becerra, 2009: Gans and Ryall, 2017).

The opacity of RM is thus a major theoretical problem. Any empirical study that wishes to evaluate RM from the published financial data of the firm is faced with the challenge of determining how to operationalise the concept. But in the arguments between RBV and VBM scholars, RM can be discerned in at least two very important identifiable determinants that are easily extracted from the annual financial statements of the firm. These are asset arrangements (AA) and capital financing (CF). Both these measurable determinants are rather wide in scope and need a critical theoretical underpinning.

2.5.1.1 AA and its intra-sector performance impact

Many scholars in the economics and strategy literature highlight that AAs on the balance sheet of the firm are an important likely determinant of firm performance. Some, such as Besanko *et al.* (2017), Grant (2019) and Januszewski and Lederman (2009), argue that the 'make or buy' decision is central to the assets that a firm chooses on its balance sheet. They suggest that a calculated balancing of the costs and benefits of integration are what determine this decision. It is the bulky, one-off nature and non-reversibility of non-current asset or property, plant and equipment purchases that make them crucial to the RM decision (Becerra, 2009; Barney, 1991; Rumelt, 1984). A series of strategic questions have to be answered by the manager of the firm before deciding on this crucial make or buy question. These might need to factor in both forward and backward supply chain relationships and the ability of the firm to negotiate them more efficiently.

Liquidity-related performance theorists such as Deloof (2003) argue that the firm's choice to hold higher levels of current assets reduces the chance that it does not meet short-term liabilities and this buttresses its importance. Fogiolo and Luzzi (2006) and Goddard *et al.* (2005) extend these arguments, tracing a business cycle resilience angle to higher levels of working capital held by a firm. Elsewhere, cash levels are construed by TCE scholars like Spulber (2009) to be the glue cementing the abilities of a firm to pull through difficult times and outperform. ISP scholars like Stabell and Fjeldstadt (1998) point to the need for adequate cash at all stages in the secondary support activities of the value chain of the firm as essential for better performance. Ensuring transaction needs, grasping investment opportunities, maintaining risk provisions and avoiding agency conflicts are other performance-enhancing elements that firms gain out of holding cash stressed in the wider economic literature (Keynes, 1936; Jensen, 1986).

By contrast, strategic scholars of RBV, ISP and VBM (Barney, 1991; Porter, 1986; Kogut and Zander. 1996) take a different trajectory and point to the division of labour, coordination and communication benefits and bargaining benefits derived from acquiring land, property, plant and equipment and suggest that it is these non-current asset choices that enhance firm performance. Firms thus singularly gain a range of different benefits from holding higher levels of non-current assets.

Some strategy and performance theorists admit that sector-based resource relationships in an industry may change the way AAs in the firm affect its performance. In construction, Hughes *et al.* (2015) observe how some generalist contractors might choose higher levels of properties, land, facilities and equipment than their peers due to badly negotiated relationships in their supply chains. Due to the repeated breakdown of supply chain relationships involving the use of critical equipment, a large contractor may decide to purchase it and this would increase non-current asset proportions on its balance sheet. But whether or not this would cost-effectively solve its problem as compared to its peers is an empirical performance issue. After all, it could be that peers negotiate better deals with their supply chain partners and thus achieve greater cost economies through hiring or leasing the equipment.

Morledge and Smith (2013) argue why levels of working capital are often negative in many smaller specialist contractors in the UK unlike those in their larger peers. These firms might not have the luxury to invest in cash and inventory and therefore be forced to rely on trade and other available short-term credit in the industry to meet working capital needs. This might cause unforeseen problems leading to higher costs due to delays in cash flows with a negative effect on the firm's performance.

Porter (1996) and Besanko *et al.* (2017) argue that AAs in both industries and their sectors depend on the relationships shared by the firm with supplier and distributor firms in its value chain. Strong collaborative partnerships might preclude the need for high levels of certain types of equipment or plant. Morledge and Smith (2013) and Becerra (2009) suggest that some firms might co-invest in certain facilities or equipment with their supply chain partners and thus reduce levels of expensive non-current assets on their balance sheet.

On the whole, AA reflected in cash, working capital and non-current assets is an easily observable and measurable determinant of firm performance which has many direct and indirect ISFP connotations.

2.5.1.2 CF and its intra-sector performance impact

Theories of leverage trace a direct link between the capital structure decision and firm performance. The Miller and Modigliani (1958) irrelevance hypothesis suggests that in perfect markets without taxes or bankruptcy costs, leverage should not matter to the firm's performance. But real markets are not perfect and so there is a trade-off between a firm's leverage decisions and its value. Jensen and Meckling (1979) show that in such markets, firms take debt up to the level at which the present value of tax shield benefits from it just exceed the potential bankruptcy costs that it could entail. Yet these authors concede that agency costs could play a singular performance-distorting role in many industries.

Myers and Majluf (1984) argue that the asymmetric information between the managers and outsiders of a firm causes it to implement a pecking order of financing. Firm managers decide their financing decisions in a strict order. Only if internal cash flow sources of financing are unavailable do the firms choose external debt. Real option theory suggests that firms strategically take debt up to the level where the real value of the optionality embedded in it just exceeds the stand-alone value of the firm (Hull *et al.*, 2013; Brearley *et al.*, 2018). Overall, capital structure theory implies that leverage is a difficult decision that every firm regardless of its industry should carefully approach based on a full consideration of its business model.

But the business model of the firm has to do with its internal management of resources and capabilities and this is why RBV is connected to it. Barney (1991) and Rumelt (1984; 1986) aver that some causal ambiguities in the way a given firm arranges its assets allow it to tap into higher levels of external financing. This would consequently create special capabilities and competencies enabling it to outperform its peers. However, the authors also imply that, due to their access to higher debt levels, some firms may be able to build asset positions that create inimitable competencies. TCE experts like Spulber (2009) point to transaction cost reductions that may be achieved as a consequence of the firm investing in large scale assets that give it an intermediating advantage in the market. Through any of these modalities, the firm can create and extract value from leverage and this is why VBM scholars like Becerra (2009) infer that RM in the firm may be improved by leverage. Not only does borrowing enable the firm to invest in assets that help it outperform peers, it also frees up the equity of the firm to be invested in the day-to-day operations. This is what allows a firm to outperform its peers. But high levels of debt can be risky and Gruneberg and Francis (2019) and Hughes *et al.* (2015) argue that in industries such as construction it is a critical antecedent of insolvencies and significant underperformance.

Earlier performance studies in leverage and its effect on firm performance are highly diverse and contested. A large strand of studies finds evidence that leverage has a significant negative effect on firm performance. But there exists an important intra-sector angle in the leverage performance linkage. Becerra (2009), Hambrick and Fredrikson (2005) and Grant (2019) show how leverage differences might explain the resource mobilisation problems of some sectors. For example, depending on their business models, firms in an industry might need much higher levels of operational contracts to break even. This may require them to overbid for lucrative contracts. To manage internal resources to deliver such commitments they could be forced to borrow large sums at very high rates of interest. This could expose both them and their business partners and suppliers to risks of bankruptcy.

Elsewhere, the authors also suggest that firm interrelationships with other firms might have an important bearing on the CF decision itself. Closer collaborations and partnerships might obviate the need to take very high leverage to deliver on overpriced bids. This argument is further embellished by Brearley *et al.* (2018) who theorise that CF decisions might be intricately connected to supply chain-based interrelationships between firms in the typical sectors of an industry. For example, construction plant and equipment leasing companies might need to invest upfront in specific assets that involve large outlays. These outlays might either be financed through loans or finance leases. The generalist contractors, however, can obviate high CF or debt financing by simply establishing fail-safe arrangements to hire plant as and when needed from their captive leasing firms (Becerra, 2009; Brearley *et al.*, 2018). Thus, sector-by-sector differences in CF levels in the construction industry are inevitable and such differences would surely affect ISFP. In totality, CF is the other important and easily measurable determinant in RM of any firm that could shed light on why firm performance differs in the key sectors of any industry.

2.5.2 ISFP and competitive dynamics

The internal strategic RM of the firm is not conducted in a vacuum. It has to be done in a dynamic and highly competitive external market for these resources. VBM theorises two main issues in this concept. The first deals with how well a firm reacts and proacts to the strategic actions of its competitors and collaborators in all its resource markets. The second deals with how well a firm builds barriers to its strategic resources against its competitors (Becerra, 2009; Liberman *et al.*, 2017). Unfortunately, neither is either easily identifiable or measurable.

Three main obstacles in empirical research are easily collated. First, TCE and game theory empirical research (Spulber, 2009; Smith *et al.*, 2001) already document the myriad problems faced by empirical researchers in trying to assess the action-reaction dynamics of a firm with its competitors for resources. VBM is no different and this explains why much scholarly work here tends to be in form of computer simulation studies (KarimiAzari *et al.*, 2011; Nasirzadeh *et al.*, 2014; Xiang *et al.*, 2012). Second, ISP theorists and hence VBM ones have long faced difficulties in mapping first and second mover advantages (Smith *et al.*, 2001; Chen and Miller, 1994; Brandenburger and Nalebuff, 1996). Identifying and operationalising how a firm builds barriers to protect its resources has also proved to be remarkably elusive (Foss, 2005). Finally, Empirical RBV and VBM research has faced tremendous challenges in objectively measuring even the unique bundle of resources and capabilities that constitute the firm entity. This has led to even greater difficulties in capturing any barriers built by the firm around such resources and capabilities (Smith *et al.*, 2001; Porter, 1985). This explains why so much of the empirical work collated in the next chapter is either simulated and virtual or qualitative and opinion-based.

Nevertheless, at least four different aspects of CD can be observed and measured in the firm's annual reporting. Three of these have to do with how the firm builds and negotiates its relationships with suppliers, other intermediaries and customers in its overall value chain. The fourth has to do with how it builds barriers around its strategic resources and capabilities through its technology and capital investments (Becerra, 2009). Therefore, in this VBM concept, four separate measurable determinants can be identified: inventory relationships (IR), trade debtor relationships (TDR), trade creditor relationships (TCR) and technology and capital investments (TCI).

2.5.2.1 IR and its intra-sector performance effect

The economic theory of inventory-based relationships and their effects on firm performance admits to the many trade-offs and complexities that characterise these managerial decisions. At the core, there is the marginal costing perspective where a range of scholars (Banos-Caballero, *et al.*, 2010; Howorth and Westhead, 2003; Blinder and Maccini, 1991; Besanko *et al.*, 2017) attest to the important trade-off that exists at the intersection between the downward sloping marginal cost curve of inventory shortage and the horizontal marginal cost curve of inventory holdings. Inventory is space-consuming, using up the firm’s cash reserves and increasing chances of damage, spoilage and loss. There is the added complication that stocking high levels of inventory masks sloppy inefficient management based on poor forecasting, haphazard scheduling and inadequate attention to process and procedures (Milgrom and Roberts, 1988; Dudley and Lasserre, 1989; Herer *et al.*, 2002). However, low inventory levels heighten the risk of stock-out which can prove disastrous for the current and future business of the firm.

ISP theory underlines raw materials procurement as a key stage in the value chain-based analysis of any firm (Grant, 2019: 172-174). How effectively a firm bargains down raw material prices, chooses its ordering and reordering levels and manages these levels across time would all have a crucial role to play in its overall competitive position. This is what would enable it to lower its inventory costs, reduce its time to market and improve performance. But the entire argument in the theory is externally focused. Porter (1996) and Scherer and Ross (1990) seem to locate this ability to bargain down raw material prices and choose order and reorder levels in the CD of the raw materials market. Thus, the firm may or may not be able to implement these cost saving actions based entirely on the competitive intensity of the supplier market.

RBV, while averring that efficient inventory management is an important performance determinant, takes a predominantly firm-based view. Barney (1991) and Rumelt (1984) suggest that, irrespective of the dynamics of the external raw materials market, a firm would still be able to achieve a reduction in its input prices or a cost saving by calibrating its order and reorder levels simply based on its rare, valuable, inimitable and non-substitutable internal resources and capabilities. Thus, even when faced with a less competitive raw materials market, a firm might still be able to achieve its inventory cost savings by drawing on these unique resources and capabilities internally.

VBM goes beyond either an external or internal orientation by simply arguing that both factors might eventually be at play and might even feed off one another in this inventory decision. Becerra (2009) argues that firms need to both manage their dynamic interactions with competitors and build barriers around their resources to create and appropriate value and thus compete effectively in the market for the best raw materials price and order levels and to protect internal resources to generate inventory level capabilities. Both internal and external dimensions thus enter into the argument.

VBM also expands on the intra-sector dimension of IRs. Firms have to deal repeatedly with their key supplier firms to ensure more effective inventory management. Bargaining down prices may be profitable in the short-run but eventually ruin the firm's long-term stable relationship with its raw materials supplier. Similarly, reordering and expecting suitable delivery terms may be useful to the firm but prove difficult and onerous to the raw materials vendor (Becerra, 2009; Grant, 2019). Difficult trade-offs might exist and the firm may have to manage them to sustain the long-term relationship. VBM does not ignore these important intra-sector firm relationship issues and suggests that they might have implications for firm performance.

2.5.2.2 TDR and its intra-sector performance effect

The economics and management literature has specific conceptions about the utility of customer credit to enhance profits. Allen *et al.* (2005) and Ayyagari *et al.* (2010) contend that flexible consumer credit policies enable the firm to attract and retain future custom and that this enhances performance. Sartoris and Hill (1983), Kulp (2002) and Cachon and Fisher (2000) extend this reasoning by suggesting that granting credit to financially constrained customers helps the firm gain a solid reputation in the market. This in turn helps it sustain higher profits consistently in the long run. Cunat (2007) points to evidence that during recessions and economically stressed periods, both firms and customers face cash flow issues. Extending credit during such times could help both sides through a temporary cash flow mismatch and thus subsequently improve firm performance. Such arguments are taken further by Emery (1987), who suggests that giving credit may successfully convert inventories into receivables and thus reduce storage costs and avoid plant-altering expenditure. Other strands related to the asymmetric information hypothesis (Lee and Stowe, 1993; Long *et al.*, 1993) point out that consumer credit is a useful tool to reduce the information asymmetry that often exists between buyers and sellers in any given industry. By giving credit, the buyer's fears and anxieties about the future performance of the goods or service delivered can be successfully redressed leading to repeat custom. Additionally, there is an added attraction to the credit certified seller firm due to the enhanced bad debt protection generally afforded to credit sales by insurance providers. Yet not all performance imperatives identified in this part of the literature are necessarily salutary. Barrot (2016) and Murfin and Njoroge (2015) identify how granting consumer credit can also reduce the liquidity of the firm, forcing it to borrow at exorbitant interest rates and charges, thus reducing its profits.

ISP theory has a specific implication for trade debtor levels in a firm. In the value chain of a given industry, sales, marketing and customer service constitute key primary activities (Porter, 1996). A key component of this is the consumer credit advanced by the firm. How well a firm calibrates this decision determines its ability to capture and retain market share in its industry. Except in monopolies, consumers have substitutes available for any firm's product or service. Therefore, in most industries firms have to balance between their own requirements for early cash collections from customers and the general availability of consumer credit from other firms in the industry. However, RBV scholars like Barney (1991) argue that a firm's ability to advance more credit to consumers would depend on how it marshals internal resources and capabilities. Firms with a more flexible resource model would naturally be able to advance higher levels of consumer credit without facing cash flow problems. This would help them to attract and retain more customers and thus outperform rivals in the industry. At another level, the contextual uncertainty in managerial beliefs about customer demand is stressed by scholars such as Kirzner (1997), Barney (1986) and Shane and Venkataraman (2000). They suggest that depending on the forecasting accuracies of these beliefs, managers' decisions for or against granting more credit in their markets have either a positive or negative effect on profits.

VBM combines these arguments. The action response patterns of CD enunciated by Becerra (2009) has direct implications. How a given firm reacts to competitor firm policies on consumer credit is largely a function of its own specialist resources and competencies and its managerial foresight in reading industry dynamics. From the theory, an inference can be made of whether ensuring optimal levels of credit and remaining flexible on the issue of cash collections might or might not help a firm attract and retain more customers than its peers depending largely on the CD in the industry or sector of which it is part.

2.5.2.3 TCR and its intra-sector performance effect

IRs with suppliers in the value chain of a firm create the need for credit. The firm faces choices in the level of credit it advances to suppliers. ISP (Porter, 1985) argues that the flexibilities faced by the firm in these credit choices are determined by the competitiveness of the raw materials market. Strategic alliances and game theory scholars (Chen and Miller, 1994; Smith *et al.*, 1992; Ferrier *et al.*, 1999) underline how if there are many suppliers then the firm can play one against the other and achieve the best credit terms knowing that there are several alternatives available. However, in a monopoly or oligopoly situation in the raw materials market, the firm's ability to obtain more favourable credit terms will be limited. These supplier firms with greater bargaining power will be able to insist on faster payment (Fisman and Raturi, 2004; Dass *et al.*, 2015; Fabbri and Klapper, 2016). Nevertheless, ISP suggests that the structure of the external market for raw materials entirely explains a firm's trade credit terms.

By contrast, RBV theoretically demonstrates how even in the face of a difficult supplier market a firm can create resources, capabilities and competencies that enable it to manage with even lower levels of credit (Barney, 1991; Rumelt, 1984). Thus, a firm can insulate itself from the external raw materials market by building internal capacity thus continuing to outperform even in the face of difficult supplier credit conditions.

VBM combines these narratives and theorises that firms that outperform in the long run extract concessions where possible, build internal capabilities wherever not, and take the optimal route of combining either strategy. But Becerra (2009) also highlights a key intra-sector dimension. Extracting favourable credit terms from trade suppliers may have to be traded off against the benefits of having reliable and readily available good quality raw material sources. A firm might perform in its own sector but push its supplier to underperform in the raw materials market. Similarly, a tight credit policy might have to be traded off against the negative reputational effects of pushing suppliers into insolvency or playing favourites among various suppliers and using one supplier's credit to bankroll another – the free-rider hypothesis (Chod *et al.*, 2019).

Working capital management theory and literature generally encourage a tactical approach to supplier trade credit (Deloof, 2003; Wang, 2002; Lazaridis and Tryfonidis, 2006). Most scholars argue that minimising the cash conversion cycle by delaying payments to suppliers as long as possible may benefit firm performance, at least in the short to medium term. For the incumbent firm, this ability to demand longer credit terms from suppliers ensures that inventory supplies are as efficiently costed as possible and checked for quality and refunds/reorders regularly.

2.5.2.4 TCI and its intra-sector performance effect

The resource-based view argues that rare valuable inimitable and non-substitutable resources and capabilities help a firm to outperform its peers. Barney (1986; 1991) implies that developing such resources and capabilities will be a function of the level of technology and capital spends of the firm. Over time, it is these intelligently planned and executed investments that show up in the dynamic capabilities developed by the firm.

The knowledge-based view, an extension of the RBV, emphasises how investing in technology and capital assets helps expand a firm's stock of knowledge about its domain of operations which helps directly and indirectly to improve its profitability (Sullivan, 2000; Teece, 2006; Balogun and Jenkins, 2003). The exact channel of profit improvement is from the stock of knowledge gained over time allowing the firm to learn ever newer methods of working and expanding its repertoire of solutions to the challenges faced at the workplace. Organisational learning takes these narratives further. Argyris and Schon (1978) and Mavondo *et al.* (2005) suggest that calibrated and systematic technology and capital investment over the years creates an ambience in the firm that aids single loop, double loop and deuteron style learning amongst managers and staff.

However, the VBM also stresses the industry and contextual dynamic perspectives. Technology investments are generally industry-specific and a firm has to take the cue from its industry. Becerra (2009) argues that how well a given firm proacts to technology and capital spending patterns in its industry will enable it to both manage its dynamic interactions with competitors and erect barriers around its strategic resources and capabilities. It is this that will enable it to create and appropriate value and thus outperform its peers.

VBM also posits an ISFP dimension here that is unique. Capital and technology spending decisions are rarely made exclusively in one industry. Suppliers, distributors and other partners in the value chain of the industry are often an inextricable part of this decision. Becerra (2009: 163) cites a wide and growing literature comprising Smith *et al.* (2001), Chen and Miller (1994) and Brandenburger and Nalebuff (1996) on first-mover advantages, cooperation, co-investment and alliances or partnerships. The author argues that VBM implies that TCIs might have strategic elements involving suppliers and other firms in the value chain. The foresight to determine when to invest singly and when to share investments with partners may significantly alter the firm's performance.

2.5.3 ISFP and MP

The concept includes two important questions (Kotler and Keller, 2016). First, how effectively does the firm segment the market of customers and choose its target segments? Second, how effectively does it differentiate its products from other firms selling in the same segment? Once again both these questions are not easily observable or measurable in an empirical sense.

There are at least three clear obstacles to identifying and measuring the MP of firms in the different sectors of an industry. First, the marketing strands in VBM suggest strong inter-linkages between segmentation and differentiation (Becerra, 2009; Porter, 1996; Lancaster, 1990). The two aspects are so interlinked that many theoreticians admit to difficulties in separating the two. Second, segmentation of customers in specific markets and how firms do this is completely inside the firm and rarely if ever observable from the outside (Kotler and Armstrong, 2015). Third, differentiation of products, although perceivable in the depth and width of the product range on display, is not generally reported by the firm (Kotler and Keller, 2016).

But this does not mean that some important aspects of MP cannot be identified or measured. The margin choices (M), marketing spends (MS) and revenue growth patterns (RGP) of firms can be easily ascertained from their financial data. These constitute the key determinants of its MP.

2.5.3.1 Margin choice and its intra-sector performance effect

MT underlines the importance of a firm's segmentation of its markets and correct targeting and positioning of its products and services (Kotler and Armstrong, 2015). Yet it takes a predominantly market-based angle. The gross and operating margins of firms, according to Day *et al.* (1979) and Dickson and Ginter (1987), are essentially a function of how skilfully firm managers analyse the many customer segments in an industry and choose the best ones to serve with appropriately marketed products and services. The overall narrative of the theory is that if firms do not discern market segments, choose target customers or position products well they will be constrained to exhibit margin choices that force underperformance. ISP scholars extend these arguments by suggesting that once having targeted the right market segments of customers the firm still needs to choose rightly between the three generic strategies of cost leadership, product differentiation and focused differentiation to outperform peers (Lancaster, 1990). Higher gross margins, according to these theorists, would reflect a product differentiation emphasis while higher operating margins would suggest a cost leadership bias. Yet the theory is less forthcoming on the trade-offs and complexities that might exist between these choices on two types of margins. Economic explanations that emphasise product differentiation as an important source of performance enhancement include Dixit and Stiglitz (1977), Spence (1976) and Hart (1985) who invariably associate this with the degree of substitutability in the relevant markets.

The RBV approach identifies product differentiation generally seen in higher gross margins with the product innovation of the firm. According to Peteraf (1993) and Barney (1991), firms that can generate higher gross margins generally do so on the back of a crafted product innovation programme systematically implemented in the firm. It is this that enables the firm to retain customers despite charging significantly higher prices. Such an argument is further extended by a rich innovation-based literature (Rogers, 1995; Davis, 1989) that emphasises creativity in product design to improve functionality relevance and attractiveness in the product enabling higher gross margins.

Operating margins are associated with the firm's ability to extract economies of scale, scope and learning. Being able to spread costs widely across the production function, achieving a much wider range of products on the chosen asset base and reducing time, effort and resources through experiential learning – all three elements of economies –

are underlined by a range of economists including Besanko *et al.* (2017), Penrose (1995) and Roberts (2004). According to these scholars, it is these economies that enable the firm to reduce costs even while delivering a wider product range with a compelling value proposition to the market. The transaction costs hypothesis (Spulber, 2009) avers that firms achieve effective disintermediation in a given market only by effectively bundling resources that lower transaction costs and deliver a compelling product to the market. The theory posits that the ability to lower costs while delivering a high-quality product or service is evidenced by a high operating margin and this should have a positive effect on profits.

VBM applies the value creation and appropriation paradigm to unify understandings of both types of margins, their interrelationships and their joint complex influence on firm performance. Using a large set of strategy studies across industries (Mintzberg, 1988; Dess and Davis, 1984; Calori and Ardisson, 1988), Becerra (2009: 157) argues that, from a value perspective, a firm could do product differentiation (higher gross margins) or cost leadership (higher operating margins) or even combine both effectively to improve its performance when compared to its peer group. Therefore, the theory posits a much more complex narrative where all three forms of generic strategies could co-exist in complex ways. A firm could trade-off increases in the two margins in a range of different ways. It could choose different degrees of cost efficiency or product superiority and still produce a compelling market position. This unique margin pattern would help it create and extract value better than its competitors. This is what would enable it to outperform.

However, in this too VBM highlights an important intra-sector angle. Becerra (2009) argues that the fine degrees of margins that a firm exhibits might involve complex trade-offs between product differentiation and cost leadership. These trade-offs would involve a marshalling of internal resources that might need intelligent relationships with its supply chain partners at every stage in its production process. Achieving cost leadership or product differentiation or a combination of the two would surely need a finely tuned calibration of cooperation and competition with the entire range of supply chain partners. VBM draws attention to this and suggests that this is what would determine firm performance.

2.5.3.2 Marketing spend and its intra-sector performance effect

A key observable determinant of the MP of a firm is reflected in the level of its spending on selling, general and administrative (SG&A) expenses. Kotler and Armstrong (2015) in their presentation of MT make a strong case for intelligent calibration of MS. According to them, firms that optimally calibrate their SG&A spending improve their product differentiation and this enables higher profitability. Such arguments are corroborated by other scholars, notably Lancaster (1990) and Rosen (1974), who suggest that effective marketing spending achieves a product market recognition and recall that ensures that customers repeatedly buy the firm's products and this has a positive effect on its profits. In the copious marketing literature, Kotler and Keller (2016) argue that firms spending effectively on marketing, segmentation and targeting of their products and services should uncover unmet consumer needs and this would help them enhance their profits. Various marketing devices including sales trials, advertising, promotions and branding should yield greater customer reach and this should translate to higher performance. Yet not all marketing scholars laud SG&E expenditures. Morgan (2012) and Kumar (2008) suggest that in some markets and sectors such spending beyond a point may be futile and wasteful.

In the ISP RBV and TCE literature, several strands maintain that marketing and promotional activities insofar as they do not change the intrinsic characteristics of the service or product that the firm sells, do not really achieve any strategic performance advantage for the firm. For example, Barney (1991) suggests that product-based innovation, by altering its features and attributes, is critical to strategic performance advantage. Similarly, Porter (1996) stresses the importance of product differentiation as opposed to mere marketing spin as the key channel to achieving higher profits. Bundling together resources in an optimal way to achieve a fundamental shift of the production frontier is what differentiates the outperforming firm rather than mere marketing (Spulber, 2009).

Taking such negative imperatives further, VBM refers to other strategic narratives to suggest why higher SG&A spending may not necessarily have a salutary outcome on profits. In particular, Becerra (2009) refers to the findings of Miller (1992) and Kotha and Vadlamani (1995) to show why increasing advertising and promotion expenditures in itself might not be appropriate in every situation. Instead, managers might need to consider how much to spend after careful consideration of whether the promotion fits with the overall product novelty and its likely internal resource implications.

At another level, the theory also details a sectoral perspective. SG&A spending might need to be calibrated to suit how supply chain partners position themselves or how they add or detract from the firm's overall MP. In some cases, a firm might be able to lower its spending due to enhanced spending by a distributor whereas in others the firm might have to spend higher amounts to support the combined MP with the distributor.

2.5.3.3 RGP and its intra-sector performance effect

The growth versus value debate in strategy and finance studies traces the link between the revenue growth of a firm and its performance. As a firm ages, it achieves much higher revenues and growing faster on that base tends to be tougher and so revenue growth slows down but the profits generated remain high as it gains from economies in operations due to its size. This is the standard life cycle theory of the firm.

At a different level, firms with higher annual revenue growths are generally product differentiators who are capturing higher market shares due to their unique products with features and attributes that do not have substitutes in the market. Those with lower growth are value firms with established products that have many substitutes available. This argument thus fits in the availability of substitutes concept in ISP (Porter, 1985). Scherer and Ross (1990), Anderson and Zeithaml (1984), Porter (1996) and Grant (2019) argue how such established firms necessarily need to spend less on marketing and promotion and therefore generate higher profits. Such sentiments are echoed by Lancaster (1990) from the marketing strands of research.

In the RBV (Barney, 1991), the generally inverse link between revenue growth and profitability is explained as arising from the successful imitation achieved by the competitors of a given firm. As its revenue grows, many competitors get wind of this and copy the firm's success and so resources become scarcer and costlier, reducing profitability. TCE takes a different perspective of this inverse relationship, tracing it to levels of asset specificity, opportunism and sub-contracting prevalent in any industry or sector (Williamson, 1991; Coase, 1937; Spulber, 2009). Revenue growth, according to this theory, becomes costlier as the firm grows because this increases the need to subcontract or opportunistically time input, resource and asset markets. The business model of the firm thus becomes costlier resulting in a natural dip in profits.

The VBM extends this idea further. Becerra (2009) suggests that a firm's revenue growth reflects its ability to either lower costs or differentiate its products or combine both in a way that makes the greatest economic sense to a well-selected segment of customers in its market. Naturally, this ability could only stem from a complex combination of internal RM, technology investment and effective external market segmentation and positioning. The theory appreciates the interactions between all three aspects and thus captures the widest scope in its discussion of this determinant.

This section has not only theorised the nine measurable determinants of ISFP as identified in the VBM and associated theoretical literature, but also shed light on the intra-sector dynamics through which these determinants might affect the firm's performance. It is to be anticipated that how these determinants affect firm performance in the industry in its key sectors and across time would be informed by the critical theoretical narratives collated above.

2.6 Discussion summary and research question

Chapter 2 has shown how ISFP is under-theorised. There is a need for an overarching theoretical tool of analysis to decipher firm performance in the UK construction industry. In line with this need, the chapter first established how existing scholars have defined and theorised firm performance in ways that often fail to capture industry sector-based interrelationships. It then showed how these sector interrelationships have strategic dimensions that play important roles in determining any given firm's performance.

The chapter next showed how strategic theories of performance (ISP, MT, RBV and TCE) present external and internal dimensions of performance but fail to integrate them to provide a full explanation. They also only criticise performance from their own non-holistic perspectives. VBM provides a holistic assessment tool that redresses these limitations. Despite its limitations, the theory provides a unique and appropriate value-based framework to critically evaluate ISFP and thus is a useful and comprehensive underpinning for ISFP.

In the next section, the chapter theoretically elucidated the three concepts of VBM (RM, CD and MP) and formulated a set of nine measurable determinants constituted within them. Each determinant was carefully analysed to reveal its theoretical basis and the intra-sector perspective of its likely influence on performance. As a consequence, the chapter evolved the VBMA theoretical tool in its totality.

The chapter finally demonstrated why ISFP is highly relevant in the UK construction industry. Salient features of the industry such as its procyclicality, its many tiers, the nature and extent of interrelationships in key sectors and the types of concentration and collaboration patterns in it make it imperative that construction sector performance studies do not neglect the sectoral aspects. The chapter clarified that in this industry it is in the interrelationships of firms that RM, CD and MP of firms interact and form the basis of over- or underperformance.

The Chapter developed a unique theorisation of ISFP. It identified a theoretical framework based on the VBM that is fit to unpack such performance in the UK construction industry. A set of nine observable and measurable determinants of firm performance were identified and collated in this framework that can be used as a tool of analysis to decipher ISFP in the UK construction industry. This VBMA tool is further analysed in terms of what the existing regulatory policy and firm practice research have found in relation to it in the next chapter.

Chapter 3. ISFP in UK Construction – Policy and Practice

As demonstrated in figure 4 the previous chapter collated a theoretical tool of firm performance analysis, the VBMA. There it was shown that this tool is highly relevant to deciphering the puzzle of ISFP in the UK construction industry. This chapter assesses what existing policy and practice scholars have found with respect to each of the nine potential determinants of firm performance collated by the VBMA. Sections 3.1 to 3.9 discuss earlier policy narratives and scholarly analysis of each in turn. Every determinant is analysed in two main sub-sections: policy and practice. In Section 3.10, the discussion in all the previous sections is summarised and the components of the principal research gap are formulated. In what follows the policy and practice literature in each of these determinants are analysed.

3.1 Asset arrangements (AA)

3.1.1 Policy narratives in AA in UK construction

Despite the importance of AA to ISFP in the construction industry, existing regulation and government policy rarely mention it explicitly. Implicit references to AA can, however, be discerned in many policy papers and government-sponsored white papers on UK construction. Common minimum standards for the procurement of built environment in the public sector of the UK were last issued in March 2017 (Infrastructure and Projects Authority, 2017, Section 4.7) when the government stipulated that construction clients should achieve strong commercial behaviours and strive to get value for money. It can be inferred that an intelligently calibrated AA is directly in this guideline. After all, but for such a carefully chosen suite of capital and working capital assets, the construction firm will not be able to derive value for money either for itself or its clients.

In earlier policy discussions, Department for Business, Innovation and Skills, (2013) highlights that there has been extensive consolidation in the supply chain of the industry due to limited reinvestment in plant and equipment. Simultaneously, the discussion also points out how there has been a reduction in the levels of cooperation across the supply chain and this has led to a decline in integrated solutions. Clearly, the government views this adversely. The implication seems to be that correct AA decisions can only be taken when there is effective collaboration between the firm and its supply chain partners.

Otherwise, the firm might either be saddled with larger or smaller levels of non-current assets than are optimal.

3.1.2 Existing research in AA

In terms of AA on the balance sheet of the firm, two broad strands of studies can be distinguished in the general industry performance literature. The first is focused on the working capital question exclusively, while the second evaluates all kinds of AAs in the context of general determination of firm performance in their samples.

Studies in the first strand generally find a positive effect of working capital on the firm's profits. Aktas *et al.* (2015), Deloof (2003) and Enqvist *et al.* (2014) are noteworthy in this regard. Einarsson and Marquis (2001) find in their empirical study that companies that rely on bank finance to cover working capital find themselves more in trouble in difficult economic periods. Clearly, this is proof that higher net current assets have a positive effect on profits, performance and stability. Yet not all studies find a positive association. Kieschnick *et al.* (2013) find that the incremental dollar invested in working capital is less valuable than the incremental dollar invested in cash suggesting a negative link to profitability.

In the second strand of studies, Nucci *et al.* (2005) find that greater levels of intangible assets reflect a higher innovative content in the strategy of the firm and thus improve performance. Chowdhury and Chowdhury (2010) find in their Bangladesh sample that fixed asset-to-turnover ratios have a negative association with share price, the market-based assessment of firm performance. Nunes *et al.* (2009) document a significant negative association between the levels of tangible assets and firm performance in their Portuguese sample, a fact corroborated in a Japanese sample by Pushner (1995) and in a Belgian sample by Deloof (2003). A similar result is documented by Ramli *et al.* (2018) in their Malaysian and Indonesian samples. Proportions of fixed assets are shown to be positively associated with firm performance in a Romanian sample by Pantea *et al.* (2013). Hossain (2016) uses a slightly different formulation of fixed assets as a capacity utilisation by dividing revenues by fixed assets and finds a positive association with firm performance.

On the whole, a range of AAs, including net current assets, non-current assets, and tangible and intangible assets as proportions of either total assets or total revenues, have been investigated for their association with a range of firm performance indicators.

Most studies use AAs as expressed in one of these variables singly. There is a dearth of studies that use a combination of two or three variables to proxy such arrangements. Yet AAs are not straightforward and encapsulate more than one type of asset on the balance sheet of the firm. They need to be proxied by the use of more than one indicator.

However, something else that is missing is the intra-sector dimension. There are no investigations into how AAs differ in the sectors of an industry or how these differences might affect firm performance. As pointed out in Chapter 2, almost all research into firm performance is focused either on the economy as a whole or on one or two industries. The many sectors in the industry, firm interrelationships and their effects on firm performance are not critically examined anywhere and this is also the case with AA.

Although AA is easily observable and measurable in the annual financial statements of construction firms, the actual quantitative investigative work done with AA is surprisingly narrow in scope and sparse. Most scholarly work is argumentative and normative. The three strands from such qualitative work show what authors have already found in research on AA in the construction industry.

Strand 1 – Chan *et al.* (2011), Suprun (2014), Gunduz and Yahya (2018), Gligor and Holcomb (2012) and Hanna *et al.* (2013) suggest that the different types of non-current and current assets have important effects on supply chain and risk management in construction firms. Based on surveyed managerial opinions these authors apart from other findings uncover how working capital coverage and the low levels of fixed assets in different parts of the industry are responsible for supply chain breakdowns and excessive risk levels. But there is no detailed discussion of how AA is associated with overall firm performance or how this association differs in the key sectors of the construction industry.

Strand 2 – Pal *et al.* (2017), Venselar *et al.* (2015) and Loosemore and McCarthy, 2008) argue that productivity of the workforce is often a function of which non-current assets or facilities are owned or hired. There may be severe gaps in work continuity resulting in loss of momentum, morale and productivity due to nonavailability of hired or leased equipment or facilities at the right time and this is especially true in the construction industry. Supply chain management, collaboration and partnership between firms in construction is advanced as an important solution to this AA problem but managerial opinions gathered in a survey fail to establish the exact implications for ISFP in UK construction.

Strand 3 – Ferreira *et al.* (2015), Dubois and Gadde (2002), Yeo and Ning (2002), Brahm and Tarzijan (2016), Ibn-Homaid (2002), Ala-risku and Karkkainen (2006), Thomas and Sanvido (2000) and Ercan and Koksal (2016) analyse, among other determinants, the property plant and equipment (PPE) levels in different parts of the construction industry in the UK and elsewhere. They show how managers in the industry often feel that PPE levels that are lower than competitors may force suboptimal risk management strategies or inconvenient supply chain relationships. But the entire analysis is managerial and opinion based and so there is limited scope to verify these concerns. In addition, overall firm performance is only obliquely studied in these papers.

In totality, all three strands of qualitative empirical studies based on questionnaire surveys, semi-structured interviews and focus groups of managers and other expert practitioners in the construction industry underline important effects of AA in the construction industry tangentially. None of these studies rigorously detail the effects or examine them in the key sectors of the industry. The empirical question of how AA affects ISFP remains largely unresolved.

In the limited quantitative empirical performance research on construction (Horta *et al.*, 2016; Horta *et al.*, 2012; Pilateris and Mccabe, 2003, Deng and Smythe, 2014; Ive and Murray, 2013), there is much about AA that is left uninvestigated. For example, Horta *et al.* (2016) map productivity frontiers in the Portuguese and Spanish construction industries using the date envelopment analysis (DEA) tool. They find some significant evidence of how firms differ in their performance due to their different levels of vertical integration across the supply chain. The only aspect of AAs studied is current assets which are used as one of the firm outputs in the DEA model. However, even this variable is used not in relation to the total assets of the firm but simply on its own as one of the performance dimensions of construction firms. This is flawed as it is one of the AAs that drive performance and must not be conflated with it. In addition, the authors also pay no attention to sector-by-sector variation in the industry in either country except to distinguish between different types of vertical integration.

Pilateris and Mccabe (2003) and Horta *et al.* (2012) investigate performance frontiers using the same DEA tool in their separate Canadian and cross-country samples. Both studies suffer from the problems of a micro-sample with the former studying just a cross-section of construction firms and the latter analysing 118 firms across just 9 years in several countries. Each study uses very simple measures such as revenue, cost of goods sold and total current liabilities to distinguish the inputs and outputs of the construction industry in their samples; despite its crucial importance, AA is ignored. The authors do not distinguish the assets or their arrangements in the different sectors of construction and thus a rich and important opportunity to understand performance determinants in construction is lost.

Konno (2014) examines key determinants of bankruptcy in the Japanese construction industry and uses a modest cross-sectional sample of firms to do so, examining a few AA-based ratios including the current ratio and acid-test ratio using the non-parametric tool of DEA, but the contribution is limited by the focus on predicting bankruptcy rather than explicating performance. The study also groups all Japanese construction firms, not distinguishing them into sectors. This makes any analysis of ISFP trends impossible.

Deng and Smyth (2014) conduct a detailed investigation of firm performance in 265 large firms of the UK construction industry between 2002 and 2011. They use a combination of the DEA and discriminant analysis (DA) and develop an extensive filtered list of appropriate ratio-metrics of firms using factor analysis. However, along with their use of a non-parametric method, their lack of focus on firm-to-firm or industry sector comparisons constrains their analysis. ISFP in the industry is simply left unexamined. Additionally, AA is only peripherally if ever examined in the paper.

AA is examined in slightly greater detail by Ive and Murray (2013), especially in the three tiers of UK construction contractors between 2005 and 2011. The authors' show through their uni- and bivariate analysis how tier 1 contractors in the UK construction industry are relatively under-capitalised. This strongly suggests that such contractors work with significantly lower levels of non-current assets. However, the authors hardly examine the multivariate effect of such levels on ISFP in the industry. In other parts of their analysis, the authors conduct fairly detailed investigations on working capital and cash levels in different tiers of the industry but they do not evaluate the effects of these on performance over time in a longitudinal model. Instead, most of their analyses are cross-sectional.

Many papers (Lee and Wu, 2016; Al-Joburi *et al.*, 2012; Sueyoshi and Goto, 2009; Audia and Greve, 2006; Yang *et al.*, 2012; Sun and Price, 2016; Raudszus *et al.*, 2014) investigate a range of peripheral issues related to construction industry ISFP. Although these papers are invariably quantitative in their approach using various financial measures, most of the discussion is limited to bankruptcy determinants, risk management influences, research and development effects, marketing capabilities and mergers and acquisitions. Any reference to AA or understanding of how it influences firm performance in these papers is oblique. None explores or even mentions ISFP.

Overall, it is clear that the practice studied by existing construction industry literature whether qualitative or quantitative has not investigated AA in any kind of granular detail or with an intra-sector focus. Instead, most of these studies strongly hint that it is important to supply chain relationships between firms across the value chain but ignore intra-sector differences in the industry.

3.2 Capital financing (CF)

3.2.1 Policy narratives in CF in UK construction

Leverage policies of construction and contractor firms are not directly mentioned in the policy guidance from the UK government. However, there are many indications in policy discussions that the government is indeed seized of the problem of excessive unproductive leverage in the industry. For example, in Department for Business, Innovation and Skills, (2013) there is mention that construction supply chain firms often suffer from cash flow problems due to low profitability and limited availability of bank funding. The discussions here and in Infrastructure and Projects Authority (2017) discussion papers seem to suggest the systemic gaps in external financing options available to UK construction firms. The inference has to be that policy formulators concede the significant gap in cost-effective leverage solutions for the industry. Thus, despite the lack of specific guidance concerning leverage levels in the industry, the government's general understanding of leverage in the industry is that it is rudimentary and in need of intervention and upgrading.

3.2.2 Research in CF

Leverage is largely seen to harm firm performance across several industries. Pham and Pham (2020), Serrasqueiro and Nunes (2008), Yazdanfar and Ohman (2015), Nuber *et al.* (2019), Jang *et al.* (2019) and Salim and Yadav (2012) among others document how rising levels of leverage in a range of industries including manufacturing, chemicals, pharmaceuticals and electronics only reduce firm performance and profitability. Most of these authors interpret their results in terms of the increasing levels of agency conflict that leverage engenders and attribute the lower firm performance to this. Therefore, they generally concur that long-term CF based on equity is the most useful and generates the best performance outcomes irrespective of industry.

However, there are some such as Bagh *et al.* (2016), Nwaolisa and Chijindu (2016) and Ganiyu *et al.* (2019) that document the insignificant effect of leverage in at least some industry samples. Others like Hossain (2016), Angahar and Ivarave (2016) and Chowdhury and Chowdhury (2010) even document a positive effect on firm performance. While these studies rely largely on Miller and Modigliani's (1959) leverage irrelevance arguments, these studies are more the exception than the rule. Most leverage studies in the industry firm performance literature document a negative association between leverage and firm performance.

Construction industry-based performance studies, especially those based on qualitative surveys of firm practitioners, often evaluate leverage as a risky solution to the problem of firm performance. Authors as diverse as Jin *et al.* (2017), Kommunuri *et al.* (2016), Zeng *et al.* (2007), Hanna *et al.* (2013) and Chan *et al.* (2011) trace aspects of ineffective risk management in the firm to excessive leverage by the construction firm. Gligor and Holcomb (2012) and Gunduz and Yahya (2018) suggest that even effective supply chain coordination and communication between firms in the industry may be impeded by risky financing strategies leading to a decline in firm performance.

Quantitatively orientated studies in the construction industry rarely use leverage explicitly as a likely determinant of firm performance. The two notable exceptions are Ive and Murray (2013) and Horta *et al.* (2012). Both sets of authors examine leverage in some detail but the first only compare leverage levels in the industry sectors without mapping their firm performance effect whereas the second use leverage as one of the firm inputs in their data envelopment analysis-based decipherment of firm performance in their sample.

Existing scholarly work on CF in the literature on industry performance largely misses the intra-sectoral angle of the effect of such financing on firm performance.

3.3 Inventory relationships (IR)

3.3.1 Policy narratives in IR in UK construction

IRs in the construction industry supply chain are rarely directly mentioned in the policy pronouncements of the UK government. Yet in the guidance for the public sector, there are several indications of what the government sees as best practice in terms of supply chain collaborations and relationships and these impinge on IR. The Infrastructure and Projects Authority (2017, ss4.8 and 4.9) stipulates that procurement processes for major works infrastructure and capital investments above a value of £10 million should be done using code of practice BS:1192-2007 which stipulates collaborative balanced scorecard mechanisms. The extensive set of guidelines here seems to strongly indicate how important policymakers consider collaborative practices in the supply chain, particularly between raw materials suppliers and the construction firm (Akintan and Morledge, 2013; Farooqui and Azhar, 2014; Cheung *et al.*, 2006). Many of these narratives underline how a partnership-orientated relationship is vital to combat risk-shifting behaviours in the construction supply chain. Rhodes (2019) in a government briefing paper (no 01432, 16 Dec 2019) refers to the sector deal for the industry enunciated by policymakers that stresses offsite construction mechanisms in government infrastructure projects. It seems that inventory largely associated with project site operations is considered a liability and waste and in need of change by the policy apparatus in the industry.

3.3.2 Existing research in IR

IRs are the focus of attention in many firm performance studies in industries as diverse as chemicals, manufacturing and retail. The difficult economic trade-offs involved in correctly maintaining an effective balance in inventories so as to neither clutter the production workspace nor inadvertently be exposed to an inventory stock-out is often articulated. Earlier evidence on the associations between inventory levels and firm performance is largely negative and significant (Goncalves *et al.*, 2018; Shah, 2016;

Enqvist *et al.*, 2013 and Bui, 2020) although at least two scholars document a positive association (Kumaraswamy, 2016; Bagh *et al.*, 2016) and two find insignificant relationships in their samples (Pakdel and Ashrafi, 2019; Dissanayake and Mendis, 2019).

Construction industry research rarely explicitly evaluates inventory levels and their influence on firm performance. Yet many qualitative strands of research do examine material procurement efficiencies of the construction firm at some length. Brahm and Tarzijan (2016) cite and collate the findings of a large set of scholarly findings such as Ibn-Homaid (2002) (50-60% of project costs are from building materials); Ala-risku and Karkkainen (2006) (nearly half of the variance in construction project schedules is explained by materials delivery timing); and Thomas and Sanvido (2000) (between 20 and 50% of decreased labour productivity is caused by late or erroneous materials delivery). These findings seem to echo the exaggerated importance of inventory levels and timing on construction firms' performance. This is perhaps why in the regulatory and policy level narratives in the industry, effective partnering relationships in the supply chain especially between the firm and its raw materials suppliers is stressed by commentators such as Akintan and Morledge (2013), Farooqui and Azhar (2014) and Cheung *et al.* (2006). In large strands of exploratory action research, Ferreira *et al.* (2011), Dubois and Gadde (2002) and Yeo and Ning (2002) document the importance of structured raw material procurement strategies to improve firm performance in the construction industry. The implication seems to be that inventory levels need effective and optimal calibration here if the performance of the firm is to be improved.

Despite this, however, there is hardly any discussion anywhere in the literature about the important and likely intra-sector angle and its differentiated contours in the inventory level-firm performance association in construction.

3.4 TDR

3.4.1 Policy narratives in TDR in UK construction

Policy-based discussions about trade debtor-based relationships in the UK construction industry are inevitably indirect. There is much indirect reference to customer relationships and their criticality to the performance of UK construction firms, particularly in the repeated references to closer supply chain partnerships and easier and better payment terms, particularly for smaller and more vulnerable clients

Department for Business, Innovation and Skills, (2013). Construction customers other than the government are usually small, fragmented and place one-off orders. There are many normative suggestions that such small clients must be supported through delayed invoice collection, implying that the larger contractors hold higher levels of trade debt despite its likely negative effect on internal cash flows. Ive and Murray (2013) find the unfair and unequal credit situation in UK construction where larger firms give as much credit as they take while their smaller peers are forced to give more credit than they can obtain. In Department for Business, Innovation and Skills, (2013) the government admits that larger customers may bring certainty and reliability to the entire supply chain and allow a better value for money for all participants, yet there is no indicated solution for how this is to be achieved. All that these policy discussions suggest is that the UK government's current approach in being strategic in its construction procurement will set the lead for the industry. There is no effective guidance on how private construction firms, particularly the larger ones, should approach the all-important consumer credit problem.

3.4.2 Existing research in TDR

Industry firm performance studies on trade debtor levels and their effect on firm performance are mixed. The complexity of the consumer credit question and its dependence on the patterns of CD in any given industry is at the centre of the analyses. Kumaraswamy (2016), Pakdel and Ashrafi (2019), Shah (2016) and Goncalves *et al.* (2018) document a negative and significant association between consumer credit levels and firm performance but Dissanayake and Mendis (2019) and Enqvist *et al.* (2013) find an insignificant one, while Pham and Pham (2020), Bagh *et al.* (2016) and Box *et al.* (2018) establish a positive association in their different industry-based samples. More complex linear-nonlinear patterns of association are reported by Hoang *et al.* (2019).

In the construction industry, trade debtor levels and their effect on firm performance are not directly assessed by the existing studies. However, in many strands of normative qualitative literature such as by Renault and Agumba (2016), Dey and Ogunlana (2004), Olamiwale (2014) Al-Salman (2004) and Warszawski and Sachs (2004) there are references to supply chain collaboration, partnership-based arrangements between clients, designers and construction firms, the increasing and profitable use of design-build contractual forms in the industry and effective payment negotiations between construction firms and their customers that presuppose a flexible payment system with customers. In the quantitative studies about the industry, Ive and Murray (2013) highlight how in their sample it is the small and medium enterprises generally in tier 3 of the construction industry supply chain that suffer adverse terms of trade and are often forced to give much greater credit than they obtain. Yet apart from this univariate pattern none, of the earlier studies critically examine intra-sectoral differences in the effect of trade debtor levels on firm performance in this industry.

3.5 TCR

3.5.1 Policy narratives in TCR in UK construction

In Department for Business, Innovation and Skills, (2013) a strong and resilient supply chain is underlined as an important prerequisite for the UK construction industry. The discussions indicate the challenge of building an integrated supply chain in an industry that is highly fragmented in terms of sub-contracting. Even in large building projects in the £20-25 million range, 70% of sub-contracts are below £10,000 in value. The authors agree that equitable financial arrangements and certainty of payment to suppliers is crucial in such a supply chain. The implication of these regulatory voices seems to be that trade creditor levels of construction firms must be kept to the minimum so that the small and medium enterprises at the very end of the supply chain receive payment promptly. Yet there are hardly any innovative suggestions about how such prompt payment is to be achieved in an industry where cash preservation in the operating cycle is so important and there are so few external bridge financing options available to even the large well-established contractor.

3.5.2 Existing research in TCR

Industry firm performance studies largely document a negative relationship between trade creditor levels and performance attributing it to the working capital efficiency and reduction in potential financing costs that lower levels of credit given to suppliers accommodates (Shah, 2016; Yusuf, 2019; Xu and Dao, 2020; Mweta and Kipronoh, 2018; Kumaraswamy, 2016; Bagh *et al.*, 2016; Pham and Pham, 2020). Yet there are at least three studies (Enqvist et al., 2013; Pakdel and Ashrafi, 2019; Dissanayake and Mendis, 2019) that document an insignificant effect of TCRs on firm performance in their respective industry samples while only one (Asimakopoulos et al., 2017) finds a positive one. The complexity of trade creditor levels and their effect on firm performance is demonstrated by Hoang *et al.* (2019) and Goncalves *et al.* (2018) the former revealing linear-nonlinear effects while the latter documenting time-based differences in the association.

In this determinant, direct references to TC firm performance relationships in the construction industry are few and far between. However, from the same strands of qualitative and normative literature as in TD relationships – Renault and Agumba (2016), Dey and Ogunlana (2004), Olamiwale (2014) Al-Salman (2004) and Warszawski and Sachs (2004) – it can be inferred that supply chain partnerships and collaborations are emphasised that militate against any reduction in trade creditor levels among contractor firms. After all, such reductions would have the greatest adverse effect on small and medium suppliers down the chain of the industry sorely in need of credit support from their larger customers. These indirect references notwithstanding, the rich intra-sector differences in how creditor levels might affect firm performance remain largely unexplored in the UK construction industry.

3.6 TCI

3.6.1 Policy narratives in TCI in UK construction

The infrastructure cost review (HM Treasury, 2014) underlined how the UK government itself seems to be extremely concerned about building information modelling and its implementation across the public sector value chain. A similar theme has been stressed in other policy literature including that by the Infrastructure and Infrastructure and Projects Authority (2017), notably in Sections 5.1 to 5.9, where BIM level 2 competence among all stakeholders is stressed. This is evidence of the importance that the government attaches to technology investments to improve productivity in the industry. It can be inferred that this is one indication of best practice recommended for construction firms although this is not explicitly stated. the Infrastructure and Projects Authority (2017) repeatedly emphasises smarter infrastructure and technology-based innovations and investments in government and private construction contracts across the built environment industry. In their oft-repeated guidance, these policy formulators underline the use of volumetric and manufactured approaches to construction, both of which require larger amounts of technology investment, and argue that there is a need for the UK industry to embrace and apply these offsite construction methods. They argue that these methods would help the firm not only reduce costs across all aspects of the construction cycle but also improve capacity development and unlock the scale and pace of potential productivity benefits while reducing errors and defects. Such themes are reiterated in the Cabinet Office's exhortations to departmental contractors Cabinet Office, (2015).

3.6.2 Existing research in TCI

The effect of TCIs on firm performance is largely documented as a positive one in the general industry-based performance research. Grazzi *et al.* (2016), Bayraktaroglu *et al.* (2019), Rahman and Ferdaous (2020), Kim *et al.* (2017), Gui-long *et al.* (2017), Peng and Quan (2019) and Lee and Wu (2016) confirm in their varied industry samples that firms investing steadily in a portfolio of TCIs are more profitable than their industry peers. But there are rich variations in the literature. For example, Argilés-Bosch *et al.* (2018), Daghouri *et al.* (2019) and Alarcon and Pavlou (2017) document both insignificant and inverted U-shaped relationships in their samples. An optimality criterion in technology and capital investment wherein either too low or too high levels of such investment negatively affect firm performance cannot be ruled out, or so it seems from these authors' samples. Kim *et al.* (2017) and Usman *et al.* (2017) demonstrate how technology and capital investment may often have a delayed and lagged effect on firm performance in some industries. At least three studies – Shin *et al.* (2017), Zwaferink (2019) and Chappell and Jaffe (2018) – find a negative and significant effect of technology investments on firm performance in their samples. These complex and multiple findings seem to underline the difficult trade-offs that firm managers across different industries face in correctly deciding levels of technology and capital investment to improve firm performance.

Qualitative surveys of firm managers in the construction industry, notably those by Ercan and Koksal (2016), show that managerial opinion favours systematic investment in technology R&D and competence building in the firm. Most of the managers in their sample concur that such systematic investment generally improves the firm's performance and helps it to gain market share and competitive advantage. Sun and Price (2016), in a rare quantitative study of the construction industry, find evidence for a U-shaped relationship between R&D investment and the risk of default. In totality, then, industry firm performance research in the construction industry underlines how important and complicated technology and capital investment levels in this industry are. Most of this research shows the challenge that managers face in deciding the levels of such investment. A swathe of other scholars such as Xiang *et al.* (2012), KarimiAzari *et al.* (2011), Yeung *et al.* (2012), Połoński (2015), Li *et al.* (2014) and Tang *et al.* (2006) demonstrate the importance of technology and capital investment to firm performance in this industry using computer-based simulation studies. Billal *et al.* (2016), in their meta-study of technology and innovation research in the construction industry, cite a range of technological advances that have been seen to have a significant positive effect on firm performance including big data, building information modelling, resource and waste optimisation, generative design, clash detection and resolution, performance prediction, visual analytics, social networking services, personalised services, facility management, energy management and analytics. However, as in most of the determinants discussed earlier, the sectoral differences in how technology and capital investment affect firm performance in UK construction remain largely unexplored.

3.7 Margins (M)

3.7.1 Policy narratives in M in UK construction

In the normative literature on UK construction, there are several indications that gross and operating margins are seen as highly important for the profits of firms. Scholars such as Kabiri *et al.* (2012), Hughes *et al.* (2015) and Ive and Murray (2013) repeatedly draw attention to the slim nature of margins of many firms in the industry and suggest that this creates an unhealthy and non-performance orientated ambience. Elsewhere, in the policy literature, several discussions indirectly implicate margins by stressing the need to rationalise and reduce the cost structures of contractors and clients in the supply chain to improve firm performance. For example, HM Treasury (2014) charts the cost savings in the highways, rail, water, energy and flood defence sectors of the UK public sector and emphasises the importance of lifecycle-based cost relationships in the overall supply chain of service providers. The narratives in the paper seem to recommend that firms develop such relationships with a range of their supply chain partners to reduce operating costs. The implication of such a recommendation seems to frame the importance of healthy and growing operating margins to firm performance in the industry. Similarly, Department for Business, Innovation and Skills, (2013) and Rhodes (2019) makes mention of strategic ambitions of the government to reduce initial costs of construction and whole life cost of assets in all government procurement projects by 33%. The implication of these statements seems to be that the government, at least in its facilitative role as infrastructure developer for the economy, is well aware of the critical need for operating margin-based efficiencies in construction projects. It also seems to suggest that at least in the department there is a growing understanding that suppliers and contractors in the industry do have significant room operationally to cut costs through scale, scope and learning efficiencies. Such refrains are echoed in the Infrastructure and Project Authority's (2017) discussion papers where at least two core departmental initiatives, namely the *Project 13* programme of the institution of civil engineers and infrastructure clients' group and the crown commercial service's *Procuring for growth balanced scorecard* make many references to the need for construction firms to use scale and scope economies to achieve various cost reduction targets. The construction cost reductions, cost benchmarks and cost reduction trajectories discussed in the Cabinet Office (2015) white paper make many references to trajectories involving standardisation of materials, products and components making bulk purchase savings possible, savings on labour costs and so on. The inference is on the scope for improvement in operating margins. Still, explicit guidance by the policy formulators in various government departments for the private firms in the industry on the exact modalities to achieve these economies and consequently improve margins remains thin.

3.7.2 Existing research on M

Earlier industry-based firm performance studies largely seem to discover a positive effect of gross or operating margins on profitability. Scholars such as Batchimeg (2017), Seetharaman *et al.* (2016), Vithessonthi (2016) and Shin *et al.* (2017) find a positive association in gross margins whereas others such as Chu (2019), Chen *et al.* (2017), Pham (2020), Bai and Yan (2020) and Shin *et al.* (2017) find a similar positive one in operating margins. Negative and insignificant associations are few, but Adachi-Sato and Vithessonthi (2019) must be noted. Most of these studies that find positive margin associations explain them on the basis that higher margins allow firms greater flexibility to outperform their peers on the whole. After all, to achieve higher gross margins the firm needs to have mastered its position in its market and made customers or potential customers fixated on its products and services even if prices are higher than substitutes available in the market. Similarly, to achieve higher operating margins the firm should have been able to keep operating costs in check even while expanding its operations. All of these studies underline how their respective sample findings corroborate these intuitive understandings.

Cost efficiencies and the need to enhance operating margins are convincingly demonstrated in other ways in the qualitative survey-based studies in the construction industry. Gunduz and Yahya (2018), Gligor and Holcomb (2012) and Brahm and Tarzijan (2016) find that firm managers stress, among other things, cost savings and efficiencies derived from a tighter knit supply chain and closer relationships between the firm and its suppliers. The implication of these studies is surely on the important positive effect that operating margins have on construction firm performance. In the quantitative firm performance literature, Rankin *et al.* (2008), Nasir *et al.* (2012), Beatham *et al.* (2004), Bassioni *et al.* (2005), Luu *et al.* (2008) and Jin *et al.* (2013) collate and analyse the utility of a range of performance determinants including various types of firm-level margins but face considerable challenges in operationalising them in their investigations. These studies corroborate the importance of margins in the industry as drivers of firm performance even though they do not fully substantiate the direction of significance of their economic effects. In totality, although most of the existing research corroborates the important performance effect of firm margins in the industry there is almost no engagement with the intra-sector or time-based differentiations of this effect.

3.8 Marketing spend

3.8.1 Policy narratives in MS in UK construction

The policy and regulatory literature in UK construction is remarkably sparse in terms of guidance or discussions on marketing spending in the industry. This is hardly surprising given the traditional nature of most firms in the industry that are either business-to-business (B2B) sellers or contractors with very little need for promotional expense. Yet some narratives do obliquely seem to imply that the best types of marketing spend in this industry are the push variety across the supply chain, especially among distributors and traders. This fits in the overall theme of supply chain collaboration, integrated design-build solutions and supplier-led innovation initiatives stressed by Department for Business, Innovation and Skills, 2013) and Infrastructure and Projects Authority (2017). It is through these marketing co-investments integrating suppliers and clients that most improvements in firm performance are likely and policy commentators across the industry emphasise this.

3.8.2 Existing research in MS

Four industry firm performance studies independently find evidence that MS are a positive and significant determinant of firm performance in their respective industries. Lee (2009), Seetharaman *et al.* (2016), Sun and Price (2016) and Silva *et al.* (2017) invariably cite the positive effects of sales promotion, advertising and branding in improving profits as the key argument while explaining their findings. These authors invariably attest to the veracity of MT and its principles in their results, strongly advocating a range of marketing initiatives as a sound foundation for capturing and retaining market share and consequently improving firm performance. This is not to suggest that all existing scholarly studies find such positive effects of marketing spend on firm performance. At least one study each (Markovitch *et al.* (2020) and Haislip and Richardson (2015)) find a negative and insignificant relationship with firm performance in their different samples, respectively.

Construction industry studies find other interesting insights into the relationship between marketing spend and firm performance. Sun and Price (2016) find in their construction sample that marketing expenditures help moderate the effect of R&D on firm performance. By spending on marketing initiatives, the firm can modulate and remove the U-shaped effect that research and development generally have on profits. They consequently aver that marketing capabilities acquired through effective and systematic spending help a construction firm to stave off default. Ercan and Koksal's 2016 paper among other recommendations also opines that in the construction firms in their sample, marketing initiatives accelerate firm performance. According to the authors, these are the functional level strategies with the greatest efficacy in supporting R&D and technical competence improvements. Normative and theoretical industry studies such as Morgan (2012) also suggest that a strategic approach to marketing mix decisions in this industry should surely improve firm performance. Yet this is not to disregard the many other normative studies that argue that MS do not matter to firm performance in the industry. Morledge and Smith (2013), Ive and Murray (2013), Gruneberg and Francis (2019) and others imply that the contractor firm's business model is largely based on trade relationships with other firms which are either contractors, traders, architects, designers or clients. Such a business model gains very little from marketing pull initiatives such as advertising or branding and so these authors aver that a construction firm is better off minimising its spend on such items.

Notwithstanding such a plethora of multidimensional findings in the construction industry, the sectoral or time-based differences in how marketing affects the firm's performance are hardly explored in the literature. There is undoubtedly much scope for elaboration and detail in the construction industry with regard to the intra-sector and time-based changes in this determinant performance relationship.

3.9 RGP

3.9.1 Policy narratives in RGP in UK construction

Normative voices in the policy literature underline how UK construction is characterised by excessive reliance on an outmoded lowest price tendering approach to projects. Scholars like Gruneberg and Francis (2019), Ancell (2007) and Hughes *et al.* (2015) infer that this would make revenue growth in the industry costly and difficult to come by. Elsewhere, the ability of a construction firm to grow its revenues sustainably is often the subject matter of regulators and policymakers in their various discussions and published commentaries. Department for Business, Innovation and Skills, (2013) evokes a vision of the industry that is at the forefront of SMART construction and digital design that can as a consequence grow revenues particularly export revenues rapidly. Similarly, the Infrastructure and Projects Authority (2013), while pointing out various initiatives in the digital Britain umbrella of the government, maintains that private firms that supply infrastructure projects should capitalise on these developments and sustainably grow their revenues and margins across the next decade. In a briefing paper of the House of Commons no 6594 Rhodes, (2018) the priorities of the government's infrastructure spending are made explicit. One of the guiding principles mentioned here is that 'projects must have the potential to drive economic growth or attract significant private sector investment'. Policymakers seem to be fully cognisant of the need to encourage private sector investment by ensuring that government projects are seen as revenue drivers in the industry. However, despite these normative indications, there are still many gaps in the narratives here, especially with regard to differentiation in the RGPs in the sector and implications for firm performances. Policy framers in the industry do not seem to engage with the many conundrums of the growth performance trade-offs that characterise it.

3.9.2 Existing research in RGP

Industry-based firm performance studies generally document the positive effect of higher revenue growth on firm performance. Yusuf (2019), Hoang *et al.* (2019), Dary and James (2018), Yazdanfar (2013), Asimakopoulos *et al.* (2017), Doan (2020) and Argilés-Bosch *et al.* (2018) represent the largest strand of studies here and most seem to explain the positive relationship between growth and performance as a logical one. Revenue growth enables a range of scale, scope and learning economies which also help the growing firm to grow profits. Yet one must not lose sight of the general expectation that revenue growth is difficult for firms that have already achieved profitability and scale and it is in this vein that some studies such as Pantea *et al.* (2013), Pakdel and Ashrafi (2019) and Mazlan and Leng (2018) do find insignificant effects whereas others such as Bokhari and Khan (2013), Ali *et al.* (2020) and Enqvist *et al.* (2013) find negative effects.

Many studies in the construction industry (Laryea and Hughes (2011), Akintoye and MacLeod (1997), Ahmed *et al.* (2002), Smith and Bohn (1999), Tah and Carr (2000) and Zeng *et al.* (2007)) underline the ubiquitous and rampant under-pricing of contract bidding in the industry. In their pursuit of higher revenues from larger contracts, firms in the industry lack caution and price their bids lower and then invariably find costs overshooting revenues. In such an industry scenario there is reason to expect that revenue growth will not be easy or cheap to come by. A negative relationship between revenue growth and profitability is thus a natural inference from such industry-based studies. The problems of revenue growth in an industry where net margins are so low are highlighted by scholars such as Hughes *et al.* (2015), Morledge and Smith (2013) and Gruneberg and Francis (2019). The implication is that revenue growth in this industry would burden the firm with unusually high operating costs that would naturally lead to declining profits. On the whole, while some partial investigation of this determinant is seen in construction, the intra-sector dynamics or time-based changes here remain largely unexplored.

3.10 Discussion summary and research gap

Policy and practice literature on firm performance in general and the construction industry in particular presents at least five salient features that are worth noting. These illustrate the contours of a research gap in the body of knowledge. First, scholars seem to study firm performance based on generic sets of determinants that lack theoretical cohesion. Regardless of industry, most studies lack an underpinning such as the VBM that derives from a wide yet cohesive theoretical canvas of firm-level strategy. Scholars group together arbitrary determinants capturing the leverage, liquidity and operations of a firm without an overarching or meaningful framework that explains its performance. This makes the task of fully explaining performance in its multidimensional aspects fractured.

Second, most studies tend to examine performance from one of three perspectives: the firm internal angle, the industry external angle or some specialised industry-based angle. Hardly any combine these different perspectives although it is absolutely clear that explaining firm performance in a strategic sense requires the rounded and holistic combination of all three. In that sense, there seems to be a clear need for a synthesised explanation of firm performance using an overarching theoretical framework such as the VBM.

Third, most firm performance studies, especially in the construction industry, overlook two important aspects: the interrelationships between the determinants of firm performance and the policy and regulatory narratives establishing the relative importance of each of these determinants. Both aspects are critical. After all, firm performance is rarely determined in isolation and all potential determinants of such performance act in concert rather than unilaterally. Missing out on the patterns of interrelationships between these determinants and their joint influence on the firm's performance would surely reduce the utility of any explanation. At another level, without a critical discussion of existing policy-based understandings in each determinant and how they pair with sample findings, insights for calibrating future policies in the industry are impossible. Thus, there is an important need to include both policy and practice-based understandings in firm performance studies in the construction industry.

Fourth, even a cursory inspection of the industrial firm performance literature reveals a glaring neglect of the intra-sector dynamics. This is particularly true of studies in the construction industry and is ironic given the complexity and interrelated nature of the supply chain. Sector dynamics are particularly differentiated in the industry and buyer-seller relationships abound between the sectors. Many of the sectors in the industry share a business-to-business transactional relationship with their peer sectors and this complicates the firm's performance picture. There is also much evidence of significant heterogeneity in the size and nature of business models in the industry that ought to differentiate firm performance drivers across it. These differences, when combined with the complex interrelationships between sectoral firms, imply that performance difficulties in one firm spread almost contagion-like across many firms in the sectors of the industry. A sector-by-sector decomposition and analysis of firm performance using a rounded theoretical tool like the VBM is therefore essential in this industry.

From another angle, the intra-sector dynamics in the UK construction industry are seen to be an important debate across the normative qualitative and anecdotal literature reviewed in this chapter. The adversarial nature of the industry and its exaggerated competition, especially at the contract bidding stage, is repeated by many scholars. Sectoral firms overbid just to ensure contract wins but such wins invariably come at a cost. The winning firm is unable to deliver, especially due to contractual difficulties stemming from intra-sector firm-to-firm dynamics. This is further accentuated by the unique cost dynamics of construction project sites and their need for multi-disciplinary teamwork where sectoral relationships play a crucial role. Often that is what is missing, leading to mishaps in firm performance. Understanding and evaluating such ever-increasing performance mishaps in the industry needs a quantitative yet intra-sectoral perspective. Despite this, there is a clear gap with studies in the industry failing to incorporate and investigate such a perspective.

Finally, in UK construction stressful economic times and business cycles play an important role by affecting determinant performance relationships. The industry seems to be among the last to be affected by economic downturns. The scheduling of construction projects provides buffers that insulate service providers from immediately experiencing the loss in demand due to economic fluctuations. Yet the industry is also the last to exit periods of economic decline as demand for projects recovers only after firms and clients are already seeing visibility in their respective income streams. Thus, longitudinal and time-based research is essential but the literature review shows how rare such research is in the industry. These five contours of a research gap exist in the body of knowledge in strategic performance studies in the UK construction industry. The main aim of this thesis is to fill this research gap by answering the research question posed in Chapter 1.

3.11 Chapter summary

This chapter reviewed the policy and practice literature in the UK construction industry in each of the determinants of the VBMA tool of performance assessment forged in the previous chapter. As a consequence, five important contours of a research gap emerged: lack of an overarching theoretical canvas, the need for a holistic rounded perspective, missing interrelationships between determinants and their policy narratives, the important yet missing intra-sectoral angle of analysis and a vital time-based quantitative decomposition of firm performance. These five underlie the aim and objectives of this thesis.

Chapter 4. Methodology

The purpose of this chapter is to elucidate and rationalise the approaches used by this thesis to answer the research question and objectives posed in Chapter 1 and reiterated in the previous chapter. It uses the research onion concept of Saunders *et al.* (2019) to unravel the detailed and interlinked aspects of the methodology. It begins with presenting the research philosophical positioning in Section 4.1 and then moves on to explain and justify the overall research approach in Section 4.2. Section 4.3 evaluates why an explanatory narrative and a quantitative deductive orientation are essential in the thesis. The unique facets of the research are detailed in the research strategy and design in Section 4.4. This then naturally leads to a complete description of the empirical regression model developed in this thesis in Section 4.5. Section 4.6 explains the three separate stages of the analyses –industry, intra-sector and time-based – while at the same time presenting stylised sample data-based considerations and econometric robustness devices implemented. Section 4.7 concludes with a chapter summary.

4.1 Research philosophical positioning

This research is primarily positivist and pragmatist in its philosophical orientation (Bryman, 2008; Easterby-Smith *et al.*, 2002). It uses a carefully collated conceptual framework based on strategic theories of performance. This is done a priori and before any empirical evidence is used. It then applies this framework to the existing financial information of UK construction industry firms to determine how and why these entities perform the way they do and is a posteriori too in that sense. Based on these inferences, the research tries to build a robust explanation of ISFP that can help improve the entity's performance at one level but also the theoretical conception of such performance at another. The latter aim has to necessarily involve some elements of interpretivism and constructivism (Crotty, 1998; Saunders *et al.*, 2019: 148-151).

At another level from its findings and analysis, the thesis also intends to support firm-level actions to improve performance and external regulatory initiatives to improve the industry as a whole. Practical solutions to the problem of ISFP fall squarely in its remit. It is in this sense that it is pragmatic (Kelemen and Rumens, 2008; Elkjaer and Simpson, 2011). Thus, it would be fair to classify the research in the continuum between pragmatic-positivism and constructivism with a clear slant towards the former.

4.2 Research approach

The approach adopted by any research is a function of at least three interrelated balances: deduction vs induction, explanatory vs exploratory and qualitative vs quantitative. (Saunders *et al.*, 2019)

4.2.1 Deductive approach

In this research, the approach is deductive. The thesis designs a conceptual tool (the VBMA) to analyse ISFP based on the theory of the value-based model (Becerra, 2009). This tool of performance assessment is then applied to historical financial data of firms in the UK construction industry. At the industry, intra-sector and longitudinal levels, the VBMA is applied to validate or contradict theoretical predictions. The thesis, therefore, moves from the theory of firm performance to empirical data on firm performance to test, assess, analyse and interpret (Suddaby, 2006; Van Maanen *et al.*, 2007).

4.3 Quantitative research

The thesis is a quantitative ISFP study in the UK construction industry. The choice of a quantitative approach is deliberate. At least three important reasons are advanced for this choice and must be carefully considered.

4.3.1 Theoretical logic of ISFP

The first of these reasons is rooted in the theoretical logic of the construct of ISFP that is the very basis of the research question of this thesis. It can be argued that ISFP is necessarily a comparative construct dependent on intra-sector comparisons of firm performances. Such intra-sector comparisons whether based on measures of central tendency or dispersion cannot be made on a firm-by-firm basis. They have to be surveyed across the industry, its sectors and several years of available data. A qualitative approach based even on multiple case studies of firms will not be robust enough to answer the research question and especially to generalise any findings.

4.3.2 Nature of the VBMA and its determinants

A second reason for the quantitative approach is the nature of the theoretical framework and its operationalisation in this research. Chapters 2 and 3 used the VBM and its encapsulated strategic theories to design a conceptual framework grouping together nine measurable determinants. This was done with the express purpose of analysing the joint utility of these determinants in explaining ISFP. These determinants are distinctly proxied by 12 identified variables that are computable from a firm's financial data. All these variables are quantitative and numerical. Only a quantitative approach will enable a deeper analysis of such data. A qualitative or mixed-methods approach would be completely futile in such a context.

4.3.3 The research gap already identified earlier

The third reason is that most of the empirical studies done to date in the construction industry have been based on questionnaire surveys, interviews and focus groups and involved primary data collated by researchers. These are largely subjective managerial and expert opinion-based studies. There is a singular lack of quantitative studies that answer the objectively measurable question of firm performance. In Chapters 2 and 3 this research gap was identified. To fill this gap the thesis has to objectively quantify firm performance and how it can be improved using a VBM based tool of assessment. Therefore, quantitatively well defined firm performance and determinant metrics are essential. This is also why the project has avoided the use of a mixed-methods or qualitative approach.

4.4 Research strategy and design

Figure 5 encapsulates the overall research strategy and design of this thesis. It combines a visual depiction of the theoretical basis and the conceptual design. The left-hand side shows how the thesis combines and coalesces an overarching umbrella of VBM theory carefully interpreted with an intra-sectoral perspective that subsumes and adds richly to the explanations of four pre-existing strategic theories of firm performance: ISP, the RBV, TCE and MT. This is the underpinning of the thesis and represents a theoretical tool of assessment that forms the very basis of the research strategy. The right-hand side presents the main design of the empirical regression model used in this thesis. The nine specific, observable and measurable determinants of firm performance extracted from the three core concepts of VBM theory are further disaggregated into the 12 variables shown. These are the variables that are used as the independent regressors of firm performance in the empirical model described in the next section.

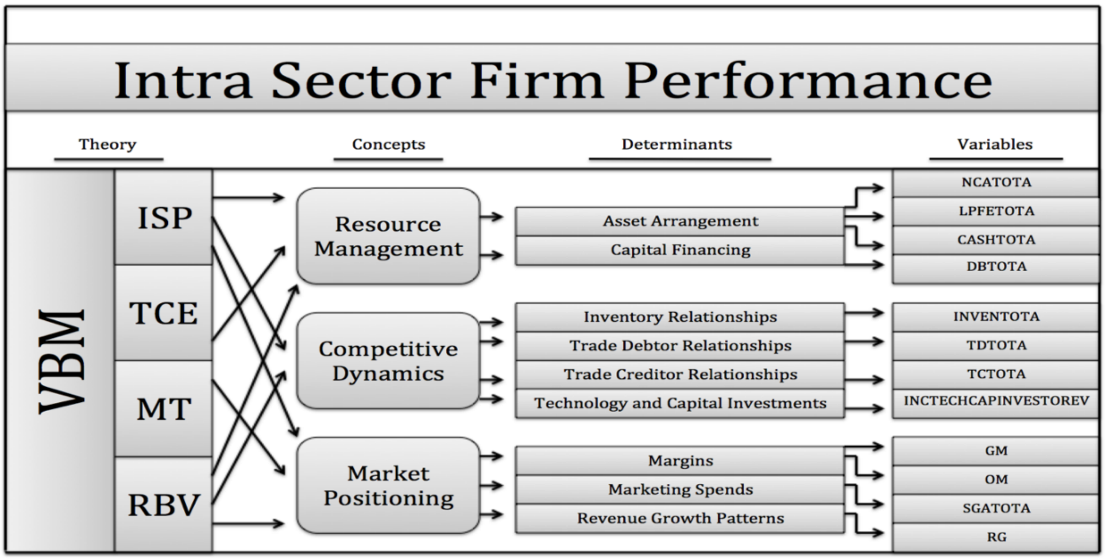

Figure 5: Intra-sector firm performance

Thus, the figure neatly encompasses the research strategy and design and will reveal not only the current determinants of UK construction industry firm performance but also aid a fuller analysis of ISFP and time-based changes in such performances.

4.5 Empirical model

Based on the conceptual framework designed in Figure 5 above, three versions of the main regression model proposed in this thesis are shown below.

Equation 1 represents the model in terms of the abstract concepts of the VBM. Thus here firm performance is a function of the three interrelated concepts of RM, CD and MP.

Firm performance = F (RM, CD, MP) .... **(1)**

Equation 2 transforms this to the nine observable and measurable determinants constituting these three VBM concepts. Here firm performance is a linear function of AAs, CF, IRs, TDR, TCRs, TCIs, margins, MS and RGPs.

$$FP_{i,t} = \beta 0 + \beta 1(AA_{i,t}) + \beta 2(CF_{i,t}) + \beta 3(IR_{i,t}) + \beta 4(TDR_{i,t}) + \beta 5(TCR_{i,t}) + \beta 6(TCI_{i,t}) + \beta 7(M_{i,t}) + \beta 8(MS_{i,t}) + \beta 9(RGP_{i,t}) \quad \textbf{(2)}$$

Where

FP = Firm Performance

AA = Asset Arrangement

CF = Capital Financing

IR = Inventory Relationships

TDR = Trade Debtor Relationships

TCR = Trade Creditor Relationship

TCI = Technology and Capital Investments

M = Margins

MS = Marketing Spends

RGP = Revenue Growth Patterns

i = Firm

t = Year

The actual regression equation in the empirical model is specified in Equation 3 below. The set of 12 independent variables and one dependent variable are proxies intended to capture the nine determinants and firm performance respectively.

$$Ln(PAT)_{i,t} = \beta_0 + \beta_1(NCATOTA_{i,t}) + \beta_2(LPFETOTA_{i,t}) + \beta_3(CASHTOTA_{i,t}) + \beta_4(DBTOTA_{i,t}) + \beta_5(INVENTOTA_{i,t}) + \beta_6(TDTOTA_{i,t}) + \beta_7(TCTOTA_{i,t}) + \beta_8(INCTECHCAPINVESTOREV_{i,t}) + \beta_9(GM_{i,t}) + \beta_{10}(OM_{,t}) + \beta_{11}(SGATOTA_{i,t}) + \beta_{12}(RG_{i,t}) + \beta_{13}(Ln(TOTR)_{i,t}) + u_{i,t} \quad \textbf{(3)}$$

Where:

Ln(PAT) = Ln (Profit after tax)

NCATOTA = Net Current Assets/Total Assets

LPFETOTA = Land, Plant, Fixtures and Equipment / Total Assets

CASHTOTA = Cash / Total Assets

DBTOTA = Total Long-Term Debt/Total Assets

INVENTOTA = Inventory / Total Assets

TDTOTA = Trade Debtors / Total Assets

TCTOTA = Trade Creditors / Total Assets

INCTECHCAPINVESTOREV = Incremental Technology and capital Investment / Total Revenues

GM = Gross Margin = Gross Profit/ Total Revenues

OM = Operating Margin = Operating Profit/ Total Revenues

SGATOTA = Selling, General and Administrating Expenses / Total Assets

RG = Revenue Growth

(Ln(TOTR)) = Ln (Total Revenues)

i = Firm and t = Year

As seen in Equation 3, the model is a panel-based one. The i subscript in every variable refers to firm 'i' while the t subscript refers to the specific 't' year of the observation. This panel is unbalanced and consists of 3,096 firms in the UK construction industry and their financial data between 2000 and 2019. Thus, the total number of potential observations in the sample is 61,920.

The proposed model, although adapted from the industry firm performance literature extensively used in strategy, finance and economics (Kumari and Kumar, 2018; Short *et al.*, 2009; Hallward-Driemeier *et al.*, 2006; Chandrapala and Knápková, 2013), is nevertheless, a unique conceptualisation based on an eclectic theoretical underpinning. Firm performance is measured by the financial measure of the natural logarithm of profit after tax, Ln(PAT). This measure of firm performance has been extensively used across the literature.

Ln(PAT) is regressed against 12 independent variables capturing the key concepts of the VBM that is the basis of the conceptual framework designed in Chapters 2 and 3: resources management, CD and MP. The intuition behind the model is straightforward and theoretic. The VBM (Becerra, 2009) posits that a firm's strategic choices in each of these three concepts both jointly and severally will determine its overall performance. Therefore, the model combines these 12 variables in a classical panel-based OLS regression to explain such firm performance.

The main argument in this model is that a firm's performance is a complex linear function of its AA, CF, IR, TDR, TCR, TCI, margins (M), MS and RGP. These nine determinants are firm-specific in nature and this research claims that together they capture most of the easily observable and measurable aspects of the three key strategic concepts of the VBM. Simultaneously, the model also controls for the firm size effect by using the log of firm revenues as a control variable.

Although theoretically constructed, the model's use of the dependent variable Ln(PAT) is not unique. Economy and industry-based performance studies use this variable either on its own or in the form of earnings per share metric. In what follows, the preceding literature in firm performance studies is briefly analysed to show how this model adds to the body of knowledge in the UK construction industry.

Several earlier studies in finance, accounting, strategy and economics use financial ratio-based regression analyses to evaluate different aspects of the firm's performance question. A useful way to organise this body of literature is to classify it by discipline as done in Kumar and Kumari (2018).

Macroeconomic studies of firm performance such as Hallward-Driemeier *et al.* (2006), Rehman *et al.* (2011), Sufian (2011), Kumar and Padhi (2012) and Patel (2012) use a wide range of economy-wide variables ranging from foreign and domestic ownership, regulatory burden, technological infrastructure to GDP, wholesale price index (WPI), Interest rate and exchange rates to explicate firm performance generally using cross-sectional time-series regressions. Most of these studies focus either on one economy or a set of economies to richly distinguish macroeconomic determinants of firm performance. Multivariate classical regression models are common, but what is generally missing is an industry or intra-sector focus.

Strategic studies of firm performance such as Hawanini *et al.* (2003), Caloghirou *et al.* (2004), Goddard *et al.* (2005), Galbreath and Galvin (2008) and Short *et al.* (2009) use more firm-focused variables to explicate such performance. These range from marketing assets, industry effects and capabilities to concentration ratios, industry structures, gearing and liquidity. However, even these studies generally focus less on the intra-sector variations in firm performance despite the strategic refrain generally arguing for a firm and sector inter-relationship perspective.

The largest strand of literature is from the discipline of finance where ongoing work uses a wide range of firm performance regression models and firm- and industry-specific determinants. Recent work here includes Al-Jafari and Samman (2015), Pratheepan (2014), Vatavu (2014), Chandrapala and Knápková (2013) and Patibandla (2006). Scholars use regression models ranging from simple pooled and cross-sectional regressions to highly advanced multistage regression models. In more recent work, Leow and Mao (2017) predict bankruptcy in the sectors of the UK construction industry using a multiple discriminant analysis (MDA) combined with an ANOVA. While a range of ratios is used, they are only linked together to enable the identification of non-bankrupt firms from their bankrupt counterparts.

This literature clarifies how my model remains unique and relevant in at least three ways. First, the exact use of these 12 independents in this combination is theoretically a conceptual tool of assessment, the VBMA derived from VBM theory and justified in Chapter 2. In that sense, it is a unique strategy-based formulation. While the use of such panel-based regressions is ubiquitous in both the strategy and financial strands of the literature, its direct and complete theoretical coagulation as in this tool is unique. Second, the model is used not just in the overall construction industry but also separately in each of the three different sectors of the UK construction industry to explicate the intra-sector aspects of firm performance. This is a regression comparison approach that walks through the different results to understand the complexities of interrelationships between firms in the sectors and supply chain of the industry. Finally, a time-series based analysis is also conducted in this thesis using the same model across the 20 years of the sample. This is another novel contribution.

4.5.1 Model analysis

Three separate regression analyses are intended with this model to answer each of the three research objectives identified in Chapter 1.

Industry-wide regressions. This is the overall industry regression model, the results of which are presented in Chapter 6. This explicates how the nine different determinants captured in 12 independent variables affect firm performance in the UK construction industry. The main emphasis in analysing this model is on the *inter-se* priorities of influences of the determinant independent variables on the dependent performance variable. However, the result also examines how the performance effect of any single determinant is modified or altered due to changes in other independents. Thus, the interrelationships between independent variables are also considered. In this regression the entire UK construction industry is the focus irrespective of the sectors of the industry; all 3,096 firms across the 20 years in the sample are analysed in this regression. This is how the first research objective of the thesis is addressed.

Intra-sector regressions. The regression is estimated in each of the three SIC-based sectors of the UK construction industry – 41, 42 and 43 – and the results are analysed in Chapter 7. It is expected that building, civil engineering and specialist trade firms will significantly differ in their performance determination. Sector-based regression results also examine differences in the interrelationships between determinants across each sector. These regressions thus address research objective 2 of the thesis.

Time-based regressions. The industry and intra-sector regressions are divided by implementing a structural break in 2010, at the credit crisis. These time-divided regression results are analysed in Chapter 8. It is expected that both in the industry and its three key sectors the protracted period of economic decline during the credit crisis changed the nature of firm performance determination. This addresses research objective 3 of the thesis.

4.5.2 Robustness checks

In all the regressions, the sample data is descriptively analysed to support the regressions in terms of standard central tendency and dispersion measures (Saunders *et al.*, 2019: 598). On the whole, all three regression stages are robustly supported by their own univariate and bivariate descriptive analyses.

The bivariate correlations comprise the Pearson (linear) correlation coefficient. The idea is to ensure that the analysis flags all significant linear correlations in the sample. This will help confirm the variables entering each of the three regressions. All regressions are robustly tested and adjusted for the usual likely problems of heteroskedasticity, autocorrelation, multicollinearity, abnormality in variable distributions, cointegration and endogeneity (see Appendices 1, 2, 5, 6 and 11). To ensure this, five separate sensitivity checking regressions are performed everywhere (pooled OLS, entity fixed effects, two-way fixed effects, GLS random effects and MLE random effects). Every care is taken to retain and interpret these sensitivities, checking regressions for purposes of triangulation of the insights.

4.6 Chapter summary

This chapter presented and justified the key elements of the research methodology used in this thesis. Beginning with the research philosophical positioning and approach, it then described and analysed the unique research strategy and design in the project. This was followed by a full explanation of the empirical regression model. Finally, the chapter described the three stages of regressions and important data-related considerations in the regressions.

Chapter 5. Data Descriptive Statistics and Variables

This chapter is the first of the analytical chapters in this thesis. Section 5.1 enumerates salient aspects of the sample of firm performance metrics. It reflects on the nature of data collated, the sources from which these are collected and the important particularities that attend the entire effort. This is followed by a full description of the dependent and independent variables in Section 5.2. Sections 5.3 and 5.4 present and analyse the descriptive statistics of the variables. In the first of these, the univariate statistics are presented and analysed at the level of the industry, the intra-sector and the time-divided intra-sector. In Section 5.4, the bivariate correlation tables are presented and analysed at these same three different levels. The chapter then concludes with a summary.

5.1 Methods of data collection and sampling

Given the quantitative nature of this research, a wide and detailed sample of firm-year metrics of UK construction firms is essential. To achieve this in a short time, the FAME database of the OSIRIS project is used as the main source. This database is an aggregator of the financial data of UK firms. It does not assess or manipulate any of the observations recorded by firms in their balance sheets, profit and loss accounts or cash flow statements. Instead, it merely collates them under specific categories and therefore the researcher can access all the financial data in one place.

An encompassing approach to data collection is implemented. Unlike some earlier UK construction studies (notably Ive and Murray (2013)), this thesis does not take a technical approach to the problem of construction firm diversity. The very nature of the research question implies that all types of construction firms must constitute the empirical landscape of the thesis. FAME itself divides the construction industry into three main sectors: 41 buildings, 42-sector civil engineering and 43 specialist trades. Yet the database itself admits that a wide range of firms ranging from contractors, architects, designers to land and project developers, sub-contractors, suppliers of specialist equipment and trades enter these sectors. For this investigation of ISFP, such a wide variety of different construction firms is both essential and welcome. After all, sector-to-sector relationships and performance effects cannot be studied if filters are applied to restrict the sample to only one or the other category of construction firms. In addition, the VBM theory which is the basis of the conceptual analysis in this thesis emphasises the supply chain of an industry as the main channel of determinant influences on ISFP. The utility of FAME's three sector taxonomy lies in that such broader categorisation ensures that no part of the supply chain of the UK construction industry is left unrepresented in the sample. Therefore, the use of such an unrestricted sample has definite advantages for this sector- and supply-chain-based analysis of firm performance.

Data in this research is based on a panel of firm-year observations i.e. each observation pertains to the 'i' firm and the 't' year. The use of panel data in this study is driven by three considerations. First, firm performance comparisons are at the core of the research question. Heterogeneity in both UK construction industry firm performance and their likely determinants is what needs to be measured and assessed. Without a firm entity-based differentiation such a comparison is impossible. Second, the time element of firm performance is needed to analyse the dynamics of variations in such performance and to answer the third research objective of how ISFP in UK construction changed across the two decades of the sample. Finally, one of the core aspects of the research gap identified in the previous chapter is the dearth of studies examining the longitudinal aspects of firm performance in the UK construction industry. This gap can only be met through a wide enough panel of firm performance metrics.

5.2 Variables descriptions

5.2.1 Dependent variable

Firm performance in this research is measured by the accounting metric of the natural logarithm of profit after tax, as explained below.

5.2.1.1 Ln Profit after tax (Ln (PAT))

This is defined as the natural logarithm of the profit after tax reported by a firm. Since after tax profits are essentially the firm's earnings after all of its selling, operating and financial charges have been removed, the variable can be construed to be a good indicator of the economic value added by the firm to its equity owners (Lieberman, *et al.*, 2017). In that sense, its choice as the prime indicator of ISFP is appropriate as the VBM theory that is at the base of the conceptual framework is itself a value-based explanation of firm performance. Ln (PAT) has been used in earlier performance studies but in slightly different ways. For example, Bokhari and Khan (2013) and Hasan *et al.* (2014) use earnings per share (EPS) as one of their firm performance measures. EPS is calculated by dividing profit after tax by the number of outstanding shares and, although scaled differently, is similar to Ln (PAT).

5.2.2 Independent variables

A set of 12 different variables are used as independent variables in the regression model of this thesis and they are defined below.

5.2.2.1 NCATOTA

This is defined as the ratio comparing net current assets (i.e. current assets minus current liabilities) with total assets. The choice of this variable as a determinant in the RM concept of the VBM has already been conceptualised as a working capital asset arrangement in Chapters 2 and 3. This variable and some closely related modifications have been widely used in the working capital literature in industry-based firm performance studies (Al-Jafari and Samman, 2015; Safdar *et al.*, 2016; Mazlan and Leng, 2018; Ho and Mohd-Raff, 2019; Asimakopoulos *et al.*, 2009; Ding *et al.*, 2012; Huang *et al.*, 2019; Hoang *et al.*, 2019). Most prior studies document a positive association between this variable and firm performance.

5.2.2.2 Land property/plant furniture equipment to total assets (LPFETOTA)

This is obtained by aggregating the non-current asset sub-categories of land, property, plant, furniture and equipment and dividing them by the total assets. This is a tangibility type of asset arrangement conceptualised as a determinant in the RM in Chapters 2 and 3. The variable has been less used in earlier performance studies although Ramli *et al.* (2018) used it as one of their likely determinants of industry performance and found a positive association between it and the firm's performance.

5.2.2.3 Cash to total assets (CASHTOTA)

This is obtained by dividing cash by total assets. This is a liquidity-based asset arrangement conceptualised as a determinant in the RM of the firm as discussed in Chapters 2 and 3. Cash level proportions in relation to the total assets of the firm have been used as determinants of firm performance by Hoang *et al.* (2019), Huang *et al.* (2019), Xu and Dao (2020), Chen *et al.* (2017) and Haislip and Richardson (2015).

Most of these studies document a negative association between this variable and the firm's performance.

5.2.2.4 Debt to total assets (DBTOTA)

This is obtained by dividing the non-current debt by total assets and represents the leverage level of the firm. This is a leverage-based asset arrangement conceptualised as a determinant in the RM of the firm as discussed in Chapters 2 and 3. There is a large and rich capital structure strand of performance studies that use this type of indicator to study different aspects of the debt question. Prominent studies here include Hossain (2016), Hasan *et al.* (2014), Bokhari and Khan (2013), Jayiddin *et al.* (2017), Bui (2020) and Ramli *et al.* (2018). Although most of these studies examine different types of leverage including short- and long-term debt, they are mostly focused on an industry or a geographic region or country. The literature is largely mixed in terms of the direction of association with significant strands documenting positive, negative and no material associations between the variable and firm performance.

5.2.2.5 Inventory to total assets (INVENTOTA)

This is obtained by dividing the inventory levels on the balance sheet by the total assets. In essence, the ratio captures firm-to-firm interrelationships and CD embedded in the inventory level decisions of construction firms. In short, the variable is part of the IRs determinant of the CD as conceptualised in Chapters 2 and 3. Earlier use of INVENTOTA in the literature generally follows two distinct trajectories. One uses inventory levels directly or as a ratio to total assets (Argilés-Bosch et al., 2018; Chandrapala and Knápková, 2013; Mathuva, 2013). The second either converts it into a day count dividing inventories by sales and multiplying by 365 or divides by sales (Lee, 2009; Safdar et al., 2016; Enqvist et al., 2013; Goncalves et al., 2018; Dong et al., 2010; Shah, 2016). Most use the variable as an independent determinant of firm performance in a single industry but Mathuva (2013) uses it as a dependent variable in line with his research context. Most studies find a negative association between the variable and firm performance.

5.2.2.6 Trade debtors to total assets (TDTOTA)

The variable is computed by dividing trade debtors by total assets. In essence, the ratio captures the firm's credit-based relationships with its customers and is conceptualised in the CD of the VBM in Chapters 2 and 3. Working capital and trading studies in firm performance generally use this variable as one of the determinants of firm performance. However, even here two standard versions of the variables are used. In one, either trade debt itself or its ratio to total assets is used (Dary and James, 2018; Asimakopoulos et al., 2017). In the other, the debtor days computation is used, i.e. trade debt is divided by sales and multiplied by 365 (Bui, 2020; Yusuf, 2019; Mathuva, 2013; Innocent et al., 2013; Shah, 2016; Goncalves et al., 2018; Safdar et al., 2016; Mazlan and Leng, 2018). The ratio is generally used as an independent determinant of firm performance in an industry context but Dary and James (2018) also use it as a dependent variable in line with their research emphasis. Most studies document a negative association between this variable and firm performance.

5.2.2.7 Trade creditors to total assets (TCTOTA)

The variable is defined as the ratio of the trade creditors to the total assets of the firm. In essence, the ratio captures the firm's credit-based relationships with its suppliers and is conceptualised in the CD of the VBM in Chapters 2 and 3. Just as in the previous variable, this is widely used in the working capital literature as a determinant of firm performance. Once again, two standard versions of this variable are used. In the first, either the variable itself or its ratio to total assets is used (Enqvist et al., 2013). In the second, the variable is either divided by the cost of goods sold or converted into creditor days measured by dividing it by the cost of goods sold and multiplying by 365 (Bui, 2020; Yusuf, 2019; Pakdel and Ashrafi, 2019; Hoang et al., 2019; Koumanakos, 2008; Mathuva, 2013; Innocent et al., 2013; Shah, 2016; Goncalves et al., 2018; Safdar et al., 2016; Mazlan and Leng, 2018). Most studies document a negative association between this variable and firm performance.

5.2.2.8 Incremental technology and capital investment to total revenues (INCTECHCAPINVTOREV)

This variable is computed by adding the net capital expenditures[1] of the firm in respect of tangible and intangible assets and dividing the sum by the total revenues of the firm.

[1] Net tangible capital expenditures are defined generally in the finance literature as the difference between tangible assets in year t and year t-1 with the depreciation added back. Net intangible capital expenditures are defined as the difference between intangible assets in year t and year t-1 with the amortisation added back. Here the sum of the two is used and termed net capital expenditure.

The variable is designed to capture the TCIs of the firm and is a determinant conceptualised in the CD concept of the VBM model of assessment presented in Chapters 2 and 3. It is one of only two first difference variables defined and used in this thesis. While studies using this exact specification of investment variable are rare, at least four use versions of firm investment proxies in their firm performance investigations (Asimakopoulos et al., 2009; Khemiri and Noubbigh, 2020; Mathuva, 2013; Asimakopoulos et al., 2017). These studies document a positive association between this variable and firm performance in their samples.

5.2.2.9 Gross margin (GM)

This variable is defined as the gross profits divided by total revenues. Most marketing and strategy studies use this variable as a determinant both of profitability and performance. In essence, the variable is conceptualised as a determinant under the concept of MP in the VBM model of assessment presented in Chapters 2 and 3. GMs are used as strategic determinants of industry firm performance (Hill et al., 2018; Seetharaman et al., 2016; Leow and Mao, 2017). Most studies document a positive association between this variable and firm performance.

5.2.2.10 Operating margin (OM)

This variable is defined as the operating profits divided by total revenue. Marketing and strategy-related studies use this variable as a firm performance determinant. In essence, the variable is conceptualised just like GMs under the concept of MP in the VBM model of assessment presented in Chapters 2 and 3. San and Heng (2011), Haislip and Richardson (2015), Ali *et al.* (2020) and Chu (2019) are among the prominent recent studies that use this variable as a determinant of firm performance. Most studies find a positive association between this variable and firm performance.

5.2.2.11 Selling general and administrative expenses to total assets (SGATOTA)

The variable is defined as the ratio of SG&E expenses to the total assets of the firm. The variable is common in marketing studies that generally use it both as a firm performance determinant and a dependent variable on its own. Here, this variable is conceptualised as a market positioning determinant as discussed in Chapters 2 and 3. Among the earlier studies that have used this variable are Markovitch *et al.* (2020), Seetharaman *et al.* (2016), Ptok *et al.* (2018), Fan and Liu (2017), Martynov (2016) and Hill *et al.* (2018). While most of these studies use the variable as an independent determinant of firm performance largely in an industry context, at least one – Seetharaman *et al.* (2016) – uses it as a dependent variable in line with their research objectives.

5.2.2.12 Revenue growth (RG)

This is defined as the natural logarithm of the ratio between a firm's given year's revenues divided by its revenues in the previous year. It reflects how the firm is positioned strategically in its market and is therefore conceptualised under the MP concept in the VBM in Chapters 2 and 3. The ratio has been widely used as a performance determinant in earlier industry-based studies (Chowdhury and Chowdhury, 2010; Nunes et al., 2009; Asimakopoulos et al., 2009; Afolabi et al., 2019; Jayiddin et al., 2017; Bokhari and Khan, 2013; Chandrapala and Knapkove, 2013; Hossain, 2016; Hoang et al., 2019; Bennett et al., 2017; Seetharaman et al., 2016; Doan, 2020; Fan and Liu, 2017; Haislip and Richardson, 2015; Ali et al., 2020; Markovitch et al., 2020; Leow and Mao, 2017; Mazlan and Leng, 2018). Most studies document a negative association between this variable and firm performance.

5.2.3 Control variable

5.2.3.1 Ln total revenues Ln(TOTR)

The total revenue of the firm is used as a control variable to assess firm size effects in this UK construction sample. The general assumption is that in a large sample such as this, the effect of firm size on its performance will be significant and therefore the model needs to distinguish between performance effects derived from the 12 independent determinants and those deriving purely from the firm's size. The variable is scaled using the natural logarithm to ensure compatibility with the other ratio-based variables in the regression.

5.3 Univariate descriptive statistics

5.3.1 Overall industry

The sample univariate statistics for the entire UK construction industry are presented below.

Table 1: Summary statistics, overall industry – full period – 2000-2019

Variable	Mean	Median	SD	CV	Min	Max	N
Ln (PAT)	6.745	6.655	1.798	0.267	1.946	11.937	33581
NCATOTA	0.220	0.198	0.287	1.304	-1.014	0.990	45094
LPFETOTA	0.077	0.011	0.151	1.975	0.000	0.898	45094
CASHTOTA	0.158	0.096	0.178	1.128	0.000	0.869	45094
DEBTOTA	0.075	0.000	0.179	2.370	0.000	1.000	45094
INVENTOTA	0.161	0.034	0.255	1.590	0.000	0.986	45094
TDTOTA	0.238	0.181	0.240	1.006	0.000	0.853	45094
TCTOTA	0.199	0.148	0.197	0.987	0.000	0.772	45094
INCTECHCAPINVESTOREV	0.878	0.050	3.765	4.288	0.000	32.577	34805
GM	0.183	0.148	0.180	0.979	-0.233	1.000	35857
OM	0.060	0.035	0.271	4.503	-2.281	1.436	35857
SGATOTA	0.292	0.175	0.438	1.502	0.000	2.817	45094
RG	1.751	1.655	1.235	0.705	-4.104	9.557	23967
Ln (TOTR)	10.233	10.112	1.366	0.133	4.796	14.572	35854

At least three interesting patterns need to be noted. First, while the median is invariably smaller than the mean in all variables, the difference between the two measures is greatest in the four variables of LPFETOTA, DEBTOTA, INVENTOTA and INCTECHCAPINVESTOREV. This suggests that in this UK sample levels of non-current assets, debt, inventory and technological and capital investments are skewed significantly towards lower levels. Most of the firms choose far lower values of these variables than their peers. Second, the four variables of OM, INCTECHCAPINVESTOREV, DEBTOTA and LPFETOTA display the greatest spread around mean values. The coefficients of variation (CV) in these four variables are the highest in this sample suggesting the significant heterogeneity in firm choices. Levels of OMs, technological and capital investments, debt and non-current assets vary much more widely than the other variables in this sample. Nevertheless, this is substantive evidence of the heterogeneity that exists in this sample and validates the variables chosen. Finally, of the 13 variables on display in the table at least nine exhibit a full count of 45,094 firm-year observations. Yet no variable shows an N value of less than 23,964. Thus missing values are not very material in this sample and consequently, the granularity of this dataset is not questionable.

5.3.2 Full industry pre- and post-credit crisis

When the full industry sample is divided into two time periods of 2000 to 2010 and 2011 to 2020, the univariate patterns observed in the full sample above remain largely unaltered. This is seen in Tables 2 and 3.

Table 2: Summary statistics, overall industry – pre-crisis period – 2000-2010

Variable	Mean	Median	SD	CV	Min	Max	N
Ln (PAT)	6.440	6.290	1.791	0.278	1.946	11.937	15835
NCATOTA	0.197	0.175	0.280	1.423	-1.014	0.990	22438
LPFETOTA	0.064	0.005	0.148	2.299	0.000	0.898	22438
CASHTOTA	0.148	0.080	0.179	1.210	0.000	0.869	22438
DEBTOTA	0.072	0.000	0.174	2.424	0.000	1.000	22438
INVENTOTA	0.171	0.049	0.255	1.495	0.000	0.986	22438
TDTOTA	0.194	0.114	0.220	1.132	0.000	0.853	22438
TCTOTA	0.189	0.130	0.198	1.049	0.000	0.772	22438
INCTECHCAPINVESTOREV	0.894	0.056	3.747	4.192	0.000	32.577	14405
GM	0.186	0.151	0.184	0.989	-0.233	1.000	15450
OM	0.043	0.032	0.288	6.754	2.281	1.436	15450
SGATOTA	0.314	0.186	0.471	1.502	0.000	2.817	22438
RG	1.663	1.606	1.245	0.748	-0.951	8.351	9765
Ln (TOTR)	10.034	9.948	1.519	0.151	4.796	14.572	15449

Table 3: Summary statistics, overall industry – post-crisis period – 2011-2019

Variable	Mean	Median	SD	CV	Min	Max	N
Ln (PAT)	7.018	6.937	1.759	0.251	1.946	11.937	17746
NCATOTA	0.243	0.223	0.292	1.201	-1.014	0.990	22656
LPFETOTA	0.089	0.019	0.154	1.732	0.000	0.898	22656
CASHTOTA	0.168	0.111	0.177	1.053	0.000	0.869	22656
DEBTOTA	0.079	0.000	0.183	2.319	0.000	1.000	22656
INVENTOTA	0.150	0.023	0.255	1.695	0.000	0.986	22656
TDTOTA	0.282	0.253	0.250	0.888	0.000	0.853	22656
TCTOTA	0.210	0.164	0.195	0.930	0.000	0.772	22656
INCTECHCAPINVESTOREV	0.867	0.045	3.777	4.358	0.000	32.577	20400
GM	0.182	0.147	0.176	0.971	-0.233	1.000	20407
OM	0.073	0.037	0.257	3.492	2.281	1.436	20407
SGATOTA	0.270	0.167	0.402	1.488	0.000	2.817	22656
RG	1.811	1.691	1.224	0.676	-4.104	9.557	14202
Ln (TOTR)	10.385	10.207	1.216	0.117	4.796	14.572	20405

While the lowest count of firm-year observations both before and after the credit crisis is in the growth variable in both periods, at least eight variables show a full sample count of 22,438 and 22,656 pre- and post-crisis, respectively. The coefficient of variation shows a similar variation in both sub-samples as it does in the full industry sample while mean and median comparisons also remain broadly similar. The inferences drawn in the full sample thus apply equally well to these sub-samples.

However, there are some stylised changes in the independent variables that are worth noting. After the credit crisis, there are significant increases in OMs, trade debtor levels, non-current assets and working capital and similar significant decreases in inventory and investment levels and GMs. While some of these increases, notably those in trade debtors and working capital, are explanatory based on the economic stresses caused by the credit crisis, others such as OMs and non-current assets seem less straightforward. On the whole, the economic storm of 2009-11 is seen to have affected many different aspects of the strategy of UK construction firms. Thus a key plank of this thesis is validated.

5.3.3 Intra-sector

SIC sector-based sub-samples show other differences as seen in Tables 4, 5 and 6.

Table 4: Summary statistics, sector: 41 – full period – 2000-2019

Variable	Mean	Median	SD	CV	Min	Max	N
Ln (PAT)	7.027	6.908	1.991	0.283	1.946	11.937	15537
NCATOTA	0.240	0.205	0.320	1.332	-1.014	0.990	20556
LPFETOTA	0.065	0.005	0.152	2.334	0.000	0.898	20556
CASHTOTA	0.150	0.081	0.181	1.205	0.000	0.869	20556
DEBTOTA	0.092	0.000	0.206	2.241	0.000	1.000	20556
INVENTOTA	0.247	0.057	0.324	1.313	0.000	0.986	20556
TDTOTA	0.171	0.057	0.215	1.257	0.000	0.853	20556
TCTOTA	0.184	0.105	0.206	1.119	0.000	0.772	20556
INCTECHCAPINVESTOREV	1.424	0.040	4.996	3.509	0.000	32.577	16639
GM	0.181	0.124	0.214	1.185	-0.233	1.000	17149
OM	0.078	0.035	0.350	4.468	-2.281	1.436	17149
SGATOTA	0.218	0.106	0.412	1.890	0.000	2.817	20556
RG	1.676	1.573	1.243	0.741	-4.104	9.425	11288
Ln (TOTR)	10.339	10.243	1.504	0.145	4.796	14.572	17146

Table 5: Summary statistics, sector: 42 – full period – 2000-2019

Variable	Mean	Median	SD	CV	Min	Max	N
Ln (PAT)	6.615	6.632	1.513	0.229	1.946	11.937	3943
NCATOTA	0.194	0.175	0.250	1.291	-1.014	0.990	5253
LPFETOTA	0.099	0.024	0.162	1.632	0.000	0.898	5253
CASHTOTA	0.173	0.123	0.176	1.017	0.000	0.869	5253
DEBTOTA	0.075	0.002	0.180	2.385	0.000	1.000	5253
INVENTOTA	0.065	0.010	0.120	1.830	0.000	0.986	5253
TDTOTA	0.286	0.269	0.242	0.849	0.000	0.853	5253
TCTOTA	0.220	0.188	0.194	0.881	0.000	0.772	5253
INCTECHCAPINVESTOREV	0.601	0.071	2.662	4.426	0.000	32.577	4096
GM	0.148	0.129	0.139	0.940	-0.233	1.000	4216
OM	0.045	0.032	0.208	4.607	-2.281	0.855	4216
SGATOTA	0.308	0.199	0.462	1.498	0.000	2.817	5253
RG	1.820	1.696	1.230	0.676	0.000	7.766	2869
Ln (TOTR)	10.252	10.138	1.274	0.124	4.796	14.572	4216

Table 6: Summary statistics, sector: 43 – full period – 2000-2019

Variable	Mean	Median	SD	CV	Min	Max	N
Ln (PAT)	6.333	6.330	1.487	0.235	1.946	11.937	11830
NCATOTA	0.208	0.204	0.250	1.202	-1.014	0.990	16194
LPFETOTA	0.075	0.018	0.133	1.758	0.000	0.898	16194
CASHTOTA	0.167	0.112	0.176	1.056	0.000	0.869	16194
DEBTOTA	0.047	0.000	0.120	2.551	0.000	1.000	16194
INVENTOTA	0.089	0.029	0.139	1.562	0.000	0.986	16194
TDTOTA	0.311	0.299	0.250	0.803	0.000	0.853	16194
TCTOTA	0.221	0.196	0.189	0.854	0.000	0.772	16194
INCTECHCAPINVESTOREV	0.193	0.048	1.286	6.661	0.000	32.577	11647
GM	0.194	0.181	0.126	0.647	-0.233	1.000	11996
OM	0.038	0.035	0.138	3.577	-2.281	1.436	11996
SGATOTA	0.365	0.283	0.436	1.194	0.000	2.817	16194
RG	1.789	1.706	1.204	0.673	0.000	9.557	8169
Ln (TOTR)	10.015	9.942	1.122	0.112	4.796	14.572	11996

First, the smallest sector-based sub-sample is the 42-sector civil engineering firms with only 5,253 firm-year observations, and the largest is its 41 buildings peer with 20,556 firm-year observations. It is obvious from the above mean and median patterns that these twelve independent variables are highly differentiated across the three key sectors of the UK construction industry. Firm managers choose very different levels of these variables in each of these sectors and these are derived from profitability differences due to these choices. These different profitability levels are documented in the mean and median differences in the dependent variable of LNPAT in these univariate results. This intra-sector heterogeneity in these independent variables further justifies why they are the appropriate choice for this thesis.

5.3.4 Intra-sector pre- and post-credit crisis

The credit crisis period shows its many influences across the key sectors of the UK construction industry in the univariate descriptive statistics. Patterns of the twelve independent variables before and after the credit crisis show many robust sets of changes that differ from the overall industry univariates, as seen in Tables 7 to 12.

Table 7: Summary statistics, sector: 41 – pre-crisis period – 2000-2010

Variable	Mean	Median	SD	CV	Min	Max	N
Ln (PAT)	6.768	6.633	1.963	0.290	1.946	11.937	7258
NCATOTA	0.216	0.179	0.309	1.433	-1.014	0.990	9882
LPFETOTA	0.072	0.004	0.174	2.411	0.000	0.898	9882
CASHTOTA	0.142	0.066	0.182	1.281	0.000	0.869	9882
DEBTOTA	0.083	0.000	0.193	2.319	0.000	1.000	9882
INVENTOTA	0.258	0.081	0.324	1.253	0.000	0.986	9882
TDTOTA	0.138	0.031	0.187	1.358	0.000	0.853	9882
TCTOTA	0.185	0.099	0.210	1.135	0.000	0.772	9882
INCTECHCAPINVESTOREV	1.372	0.046	4.834	3.525	0.000	32.577	6996
GM	0.181	0.127	0.213	1.173	-0.233	1.000	7500
OM	0.047	0.032	0.365	7.799	-2.281	1.436	7500
SGATOTA	0.251	0.119	0.456	1.816	0.000	2.817	9882
RG	1.626	1.557	1.245	0.766	-0.951	8.351	4634
Ln (TOTR)	10.191	10.110	1.643	0.161	4.796	14.572	7499

Table 8: Summary statistics, sector: 41 – post-crisis period – 2011-2019

Variable	Mean	Median	SD	CV	Min	Max	N
Ln (PAT)	7.255	7.122	1.987	0.274	1.946	11.937	8279
NCATOTA	0.262	0.232	0.327	1.247	-1.014	0.990	10674
LPFETOTA	0.059	0.006	0.128	2.182	0.000	0.898	10674
CASHTOTA	0.158	0.093	0.180	1.139	0.000	0.869	10674
DEBTOTA	0.100	0.000	0.217	2.172	0.000	1.000	10674
INVENTOTA	0.237	0.036	0.325	1.372	0.000	0.986	10674
TDTOTA	0.202	0.090	0.234	1.158	0.000	0.853	10674
TCTOTA	0.184	0.111	0.203	1.103	0.000	0.772	10674
INCTECHCAPINVESTOREV	1.462	0.037	5.110	3.496	0.000	32.577	9643
GM	0.181	0.122	0.216	1.194	-0.233	1.000	9649
OM	0.103	0.038	0.335	3.264	-2.281	1.436	9649
SGATOTA	0.187	0.095	0.363	1.944	0.000	2.817	10674
RG	1.711	1.581	1.240	0.725	-4.104	9.425	6654
Ln (TOTR)	10.454	10.316	1.376	0.132	4.796	14.572	9647

Table 9: Summary statistics, sector: 42 – pre-crisis period – 2000-2010

Variable	Mean	Median	SD	CV	Min	Max	N
Ln (PAT)	6.218	6.190	1.499	0.241	1.946	11.270	1815
NCATOTA	0.172	0.161	0.242	1.407	-1.014	0.990	2623
LPFETOTA	0.064	0.007	0.143	2.249	0.000	0.898	2623
CASHTOTA	0.152	0.095	0.171	1.126	0.000	0.869	2623
DEBTOTA	0.076	0.000	0.191	2.523	0.000	1.000	2623
INVENTOTA	0.081	0.016	0.134	1.655	0.000	0.986	2623
TDTOTA	0.225	0.179	0.228	1.016	0.000	0.853	2623
TCTOTA	0.202	0.156	0.194	0.961	0.000	0.772	2623
INCTECHCAPINVESTOREV	0.739	0.080	3.023	4.090	0.000	32.577	1653
GM	0.145	0.127	0.143	0.986	-0.233	1.000	1773
OM	0.043	0.026	0.225	5.229	-2.281	0.855	1773
SGATOTA	0.324	0.208	0.491	1.515	0.000	2.817	2623
RG	1.706	1.595	1.278	0.749	0.000	7.399	1145
Ln (TOTR)	9.959	9.927	1.421	0.143	4.796	13.809	1773

Table 10: Summary statistics, sector: 42 – post-crisis period – 2011-2019

Variable	Mean	Median	SD	CV	Min	Max	N
Ln (PAT)	6.953	7.016	1.442	0.207	1.946	11.937	2128
NCATOTA	0.216	0.195	0.257	1.189	-1.014	0.990	2630
LPFETOTA	0.135	0.070	0.171	1.273	0.000	0.898	2630
CASHTOTA	0.195	0.153	0.179	0.918	0.000	0.869	2630
DEBTOTA	0.075	0.005	0.168	2.236	0.000	1.000	2630
INVENTOTA	0.050	0.007	0.101	2.028	0.000	0.962	2630
TDTOTA	0.346	0.354	0.241	0.696	0.000	0.853	2630
TCTOTA	0.238	0.208	0.192	0.806	0.000	0.772	2630
INCTECHCAPINVESTOREV	0.508	0.066	2.382	4.689	0.000	32.577	2443
GM	0.151	0.132	0.137	0.907	-0.233	1.000	2443
OM	0.047	0.037	0.195	4.171	-2.281	0.819	2443
SGATOTA	0.293	0.193	0.431	1.471	0.000	2.817	2630
RG	1.896	1.770	1.191	0.628	0.000	7.766	1724
Ln (TOTR)	10.465	10.276	1.109	0.106	4.796	14.572	2443

Table 11: Summary statistics, sector: 43 – pre-crisis period – 2000-2010

Variable	Mean	Median	SD	CV	Min	Max	N
Ln (PAT)	5.995	5.951	1.489	0.248	1.946	11.375	5631
NCATOTA	0.185	0.181	0.251	1.360	-1.014	0.990	8350
LPFETOTA	0.048	0.006	0.096	1.993	0.000	0.898	8350
CASHTOTA	0.159	0.097	0.180	1.132	0.000	0.869	8350
DEBTOTA	0.048	0.000	0.125	2.594	0.000	1.000	8350
INVENTOTA	0.103	0.041	0.150	1.460	0.000	0.986	8350
TDTOTA	0.251	0.210	0.241	0.961	0.000	0.853	8350
TCTOTA	0.198	0.163	0.190	0.960	0.000	0.772	8350
INCTECHCAPINVESTOREV	0.221	0.054	1.480	6.701	0.000	32.577	4699
GM	0.201	0.187	0.138	0.687	-0.233	1.000	5047
OM	0.033	0.034	0.164	5.015	-2.281	1.000	5047
SGATOTA	0.371	0.285	0.467	1.260	0.000	2.817	8350
RG	1.669	1.628	1.215	0.728	0.000	8.240	3270
Ln (TOTR)	9.749	9.667	1.289	0.132	4.796	14.572	5047

Table 12: Summary statistics, sector: 43 – post-crisis period – 2011-2019

Variable	Mean	Median	SD	CV	Min	Max	N
Ln (PAT)	6.641	6.671	1.416	0.213	1.946	11.937	6199
NCATOTA	0.232	0.231	0.246	1.059	-1.014	0.990	7844
LPFETOTA	0.104	0.038	0.157	1.511	0.000	0.898	7844
CASHTOTA	0.176	0.128	0.172	0.979	0.000	0.869	7844
DEBTOTA	0.046	0.000	0.115	2.499	0.000	1.000	7844
INVENTOTA	0.074	0.018	0.125	1.676	0.000	0.986	7844
TDTOTA	0.375	0.379	0.243	0.647	0.000	0.853	7844
TCTOTA	0.246	0.226	0.185	0.749	0.000	0.772	7844
INCTECHCAPINVESTOREV	0.174	0.043	1.135	6.518	0.000	32.577	6948
GM	0.190	0.178	0.116	0.612	-0.233	1.000	6949
OM	0.043	0.036	0.114	2.681	-2.281	1.436	6949
SGATOTA	0.360	0.282	0.401	1.114	0.000	2.817	7844
RG	1.869	1.767	1.190	0.637	0.000	9.557	4899
Ln (TOTR)	10.207	10.053	0.937	0.092	4.796	14.572	6949

This variegated intra-sector pattern substantiates the core proposition of this thesis that construction industry studies in the UK must not ignore the important time dimension. That the determinants vary so much even in their intra-sector pattern across time suggests that managers in different parts of the industry have been changing their strategic choices as economic circumstances in their respective sectors change and this should have a profitability linkage. It is worth noting how the CVs of most variables in all the sectors are either near or above one, highlighting the significant spread of the dataset. In addition, the CVs in the pre- and post-sector-based sub-samples show a highly differentiated pattern. The dispersions of all variables around their mean values change significantly after the crisis suggesting that the economic storm has left none of them unaffected. This is further substantiation that time-based changes in firm performance determinant relationships across the sectors of the UK construction industry are important and need detailed investigation in this sample.

5.4 Bivariate descriptive statistics

The correlation Table 13 reveals an interesting pattern strongly highlighting important statistical properties of this sample of UK construction firms. None of the 12 independent variables or one control variable exhibit very high levels (i.e. >0.7) of bivariate correlations among themselves. This is proof that multicollinearity is less likely to be a serious statistical issue in this data set.

Table 13: Pearson correlation table, overall industry – full period – 2000-2019

	-1	-2	-3	-4	-5	-6	-7	-8	-9	-10	-11	-12	-13	-14
(1) Ln (PAT)	1													
(2) NCATOTA	0.144**	1												
(3) LPFETOTA	0.033**	-0.206**	1											
(4) CASHTOTA		0.178**	-0.139**	1										
(5) DBTOTA	0.144**	0.099**	0.203**	-0.192**	1									
(6) INVENTOTA	0.122**	0.235**	-0.146**	-0.232**	0.062**	1								
(7) TDTOTA	-0.284**	-0.035**		-0.026**	-0.187**	-0.329**	1							
(8) TCTOTA	-0.307**	-0.149**	-0.051**	0.111**	-0.218**	-0.192**	0.536**	1						
(9) INCTECHCAPINVESTTOREV	0.24**	-0.199**	0.12**	-0.154**	0.26**	-0.092**	-0.236**	-0.241**	1					
(10) GM	0.224**	0.013*	0.153**	-0.097**	0.191**	0.025**	-0.169**	-0.264**	0.344**	1				
(11) OM	0.378**	0.045**	0.061**	-0.032**	0.112**	-0.01*	-0.117**	-0.135**	0.172**	0.335**	1			
(12) SGATOTA	-0.186**	-0.072**	0.018**	0.057**	-0.101**	-0.143**	0.24**	0.232**	-0.135**	-0.093**	-0.115**	1		
(13) RG	0.13**	0.042**	0.094**	-0.022**		-0.076**		-0.019**	0.081**	0.061**	0.088**	0.027**	1	
(14) Ln (TOTR)	0.652**	0.016**	-0.03**		-0.017**		-0.025**	0.022**	-0.105**	-0.137**	0.155**	-0.058**	0.213**	1

**p<.01, *p<.05

5.5 Chapter summary

This chapter presented and analysed the sample salient features, variables, univariate and bivariate descriptive statistics of the UK construction industry sample collected in the thesis. Chapter 6 begins the first stage of multivariate analysis at the overall UK construction industry level.

Chapter 6. UK Construction Industry Regression Analyses

Having analysed the descriptive statistics of the UK construction industry sample, this chapter and the two that follow perform the three different levels of multivariate regression analyses intended in the thesis. This first part is an interpretation of the results in the overall construction industry of the UK and seeks to address research objective one. All available 21,101 firm-year observations in the sample are included and represent a robust estimation of the determinant performance relationships in the whole industry.

6.1 Overall UK construction industry regressions

The dependent firm performance variable in the regression is Ln (PAT). In the first section that follows, each coefficient and its association is discussed both in theory and in previous scholarly work. This is then followed by a brief discussion of the overall model and its statistics. The last section of the analysis discusses the *inter-se* magnitude of coefficient effects on the dependent variable followed by the model sensitivities in the four additional regressions presented in Table 14.

6.1.1 NCATOTA

The association is positive and significant at 1%. Every unit increase in this variable increases profit after tax of the average construction firm in the sample by 107.9% (see adjusted beta and its calculation in Table 1 column 3). Net current assets (current assets minus current liabilities) as a proportion of total assets of the firm is a strong positive influence on firm performance in the UK construction industry. Thus, the extent to which a construction firm arranges its current assets to exceed its current liabilities in each year generates a positive effect on its profitability and performance. This is a confirmation that AAs rooted in the way a firm manages its internal resources are a significant determinant of its performance as predicted by VBM (Becerra, 2009) and the RBV (Barney, 1991; Rumelt, 1984). However, such a strong positive effect also seems to suggest how working capital efficiencies are a critical factor driving firm performance in the UK construction industry. Such efficiencies stem from operational synergies in its business model. Scholars like Grant (2019) and Besanko *et al.* (2017) argue that the firm obtains the flexibility to maintain large net current asset ratios

Table 14: Dependent variable: Ln (PAT). Overall construction industry

Independent Variables (Model)	Pooled OLS			Entity FE			Two-way FE			GLS RE			MLE RE		
	b	se	exp(b)-1	b	se	exp(b)-1	b	se	exp(b)-1	b	se	exp(b)-1	b	se	exp(b)-1
NCATOTA	1.068***	(0.073)	1.91	0.730***	(0.077)	1.075	0.732***	(0.077)	1.079	0.891***	(0.066)	1.438	0.898***	(0.039)	1.455
LPFETOTA	0.534***	(0.094)	0.706	0.087	(0.092)	0.091	0.179	(0.094)	0.196	0.250**	(0.080)	0.284	0.259***	(0.055)	0.296
CASHTOTA	0.419***	(0.087)	0.52	0.871***	(0.077)	1.389	0.866***	(0.075)	1.377	0.674***	(0.066)	0.962	0.665***	(0.052)	0.944
DBTOTA	-0.748***	(0.109)	-0.527	-0.790***	(0.119)	-0.546	-0.711***	(0.117)	-0.509	-0.765***	(0.094)	-0.535	-0.764***	(0.058)	-0.534
INVENTOTA	0.123	(0.070)	0.131	-0.368***	(0.100)	-0.308	-0.373***	(0.095)	-0.311	-0.018	(0.066)	-0.018	-0.008	(0.047)	-0.008
TDTOTA	-0.460***	(0.079)	-0.369	-0.375***	(0.059)	-0.313	-0.299***	(0.061)	-0.258	-0.400***	(0.056)	-0.33	-0.401***	(0.041)	-0.33
TCTOTA	-1.052***	(0.093)	-0.651	-0.690***	(0.088)	-0.498	-0.647***	(0.086)	-0.476	-0.884***	(0.078)	-0.587	-0.891***	(0.055)	-0.59
INCTECHCAPINVESTOREV	0.042*	(0.020)	0.043	0.059***	(0.017)	0.061	0.054***	(0.016)	0.055	0.055***	(0.016)	0.057	0.055***	(0.003)	0.057
GM	1.692***	(0.146)	4.43	1.374***	(0.175)	2.951	1.285***	(0.170)	2.615	1.559***	(0.150)	3.754	1.566***	(0.057)	3.787
OM	2.255***	(0.405)	8.535	2.017***	(0.333)	6.516	1.951***	(0.321)	6.036	2.150***	(0.332)	7.585	2.155***	(0.050)	7.628
SGATOTA	-0.172***	(0.039)	-0.158	-0.204***	(0.043)	-0.185	-0.197***	(0.042)	-0.179	-0.211***	(0.035)	-0.19	-0.211***	(0.021)	-0.19
RG	-0.049***	(0.007)	-0.048	-0.027***	(0.006)	-0.027	-0.033***	(0.006)	-0.032	-0.033***	(0.006)	-0.032	-0.033***	(0.005)	-0.032
Ln (TOTR)	0.945***	(0.013)	1.573	0.923***	(0.020)	1.517	0.857***	(0.026)	1.356	0.928***	(0.015)	1.529	0.928***	(0.007)	1.529
Constant	-3.214***	(0.179)	-0.96	-2.926***	(0.233)	-0.946	-2.266***	(0.273)	-0.896	-3.042***	(0.185)	-0.952	-3.047***	(0.083)	-0.952
Time FE	NO			NO			YES			NO			NO		
Observations	21101			21101			21101			21101			21101		
N Groups				3025			3025			3025			3025		
In R-squared				0.442			0.462			0.439					
Between R-squared				0.694			0.697			0.72					
Overall R-squared	0.688			0.668			0.673			0.684					
Chi-sq.										8909.348			14515.219		
Log likelihood	-29772.826			-23116.11			-22742.041						-27364.243		
Null log likelihood	-42076.932			-29278.879			-29278.879						-34621.852		
F	992.632			350.806			206.192								

Notes: All the regressions in the table are with robust standard errors (VCE Cluster). The regressions are defined as follows: pooled Ordinary Least Square (pooled OLS); entity fixed effects (Entity FE); two-way fixed effects (Two-way FE); generalised least square random effects (GLS RE); and maximum likelihood estimation random effects (MLE RE). The interpretation of the model is based on the two-way fixed effects regression presented in column 3. The b column presents the coefficients of the variables and the star signs next to the variables (*, **, ***) indicate the significance at 5, 1, and 0.1 per cent levels, respectively. The exp(b)-1 column presents the exponential coefficient values to explain the effect on profit after tax rather than the effect on the Ln (profit after tax).

only due to well-planned AAs that allow this. It is this more effective RM that can be construed to be the source of the higher firm performance seen in this sample.

At another level, it does seem that UK construction sample firms benefit from greater liquidity as shown in the higher levels of net current assets. Deloof (2003) maintains that firms with very high levels of current assets have a lower risk of not fulfilling short-term obligations and this enhances their performance. Perhaps this is what is seen here among UK construction firms. Goddard *et al.* (2005) and Fagiolo and Luzzi (2006) suggest that such liquidity buttresses the firm's ability to respond to rapid market changes and thus protects its performance across different business conditions. This UK sample across 20 economic cycles seems to prove such a contention.

Earlier work on firm performance is largely unsupportive of these sample findings. Many studies found a negative (Huang *et al.*, 2019; Leow and Mao, 2017; Ramli *et al.*, 2018; Singh, 2013; Serrasqueiro and Nunes, 2008; Batchimeg, 2017; Chu, 2019) or insignificant (Hoang *et al.*, 2019) association in current ratios (current assets divided by current liabilities or current assets divided by total assets). Mweta and Kipronoh (2018) find a statistically insignificant relationship between gross working capital and current ratio with the ROE of Kenyan firms. The only studies corroborating the positive finding in this sample are Safdar *et al.* (2016), Ho and Mohd-Raff (2019) and Dissanayake and Mendis (2019). Nevertheless, strands of normative and policy-based discourse in UK construction highlight how important liquidity is in the industry. For example, Ive and Murray (2013) find that smaller contractors often face difficult trading conditions especially where their short-term liabilities exceed their short-term sources of funds (lower values of net current assets) and that it is this that affects their performance. Similarly, policy discussions such as Department for Business, Innovation and Skills, (2013) highlight the crucial importance of effective supply chain collaborations that are sadly lacking in the UK construction industry. That working capital levels are seen to have such a strong positive effect on performance may reflect this fragility in effective collaboration in the supply chain of the industry. This is why net current assets seem to be such an important positive determinant. The average construction firm is critically dependent on a positive working capital balance.

6.1.2 LPFETOTA

The coefficient is insignificant but positive in sign. In this UK construction sample, a firm's investment in land, property, furniture and equipment (LPFE) – the non-current assets – do not seem to affect profitability. This is counterintuitive and seems to contradict both RBV and VBM expectations. One would have expected that among the bundle of resources that a construction firm ought to aggregate in its boundaries (Kogut and Zander, 1996; Williamson, 1991), non-current assets, particularly plant and equipment, should have featured prominently but this does not seem to be the case. Instead, it does appear that unlike the strong positive association in working capital seen in NCATOTA, there is no association between fixed capital and the construction firms' performance.

The result here can be interpreted in two main ways. First, as stressed by Becerra (2009), the internal effects of adding non-current assets to a UK construction firm's resource portfolio does not seem to generate new options for division of labour or operational synergies due to economies of scale, scope and learning. Neither do these non-current assets combine with the existing resources of the firm and facilitate better communication coordination and learning leading to more innovative performance as predicted by Kogut and Zander (1996). Second, and surprisingly in an industry involved in the construction of non-current assets, acquiring more of these assets does not seem to improve the bargaining power of the firm in relation to its industry peers as posited by Porter (1996). The result instead seems to suggest no salutary effect on a firm's performance due to any such non-current asset acquisition.

The sample result runs contrary to most of the earlier performance studies. The largest strand of studies here including Ganiyu *et al.* (2019), Doan (2020) and Hoang *et al.* (2019)[2] document a negative and significant association between tangibility (i.e. LPFETOTA) and firm performance. Others such as Khemiri and Noubbigh (2020) and Pantea *et al.* (2013) document a positive and significant association. None of the earlier authors discovers an insignificant relationship in this variable and this seems to highlight a key difference in how the AAs of UK construction firms affect their performance. Ive and Murray (2013) document how most contractors in the UK are

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[2] Others here include Serrasqueiro and Nunes (2008), Argilés-Bosch et al. (2018), Mishra et al. (2019) and Nunes et al. (2009).

under-capitalised. Perhaps this sample result is showing why this might be the case. After all, when a firm derives little performance benefit from investing in non-current assets (i.e. LFPE) then it is rational to remain under-capitalised and choose lower levels of such assets.

6.1.3 CASHTOTA

The association is positive and significant at 1%. Every unit increase in this variable increases the profit after tax of the average construction firm in the sample by 137.7%. Cash levels of firms in UK construction are a robust positive determinant of performance. In a sense, this result is part of the already positive association documented and interpreted theoretically in NCATOTA. Cash is part of net current assets. However, the construction firm's profits are 1.86 times more sensitive to unit changes in cash proportions than to unit changes in net current asset proportions. This higher sensitivity to cash levels seems to suggest how crucial maintaining higher levels of cash in the internal RM of the firm is in this industry.

In the TCE perspective, Spulber (2009) emphasises that cash levels of firms are construed to be an essential glue maintaining liquidity levels and thus helping the firm to deliver a cost-effective product or service to the customer that they would not have otherwise been able to deliver. Similarly, industry structure scholars Stabell and Fjeldstad (1998) maintain that among the secondary support activities in the value chain of the firm calibrating cash levels to the requirements of each stage of the production is a vital performance prerequisite. Both these theoretical predictions are confirmed in these sample results.

Economists like Keynes (1936) stress that cash holdings help firms ensure transaction needs, grasp investment opportunities and maintain risk provisions. The positive association here may be reflecting this. There is less evidence, at least in this sample, that higher cash levels create opportunity costs of omitted investments or agency conflicts between firm managers and owners (Jensen, 1986) and thus reduce profitability.

Earlier studies both in firm performance in general and in the construction industry are neatly mixed concerning this variable. At least three studies – Hoang *et al.* (2019), Dary and James (2018) and Doan (2020) – find a similar positive and robust association between CASHTOTA and firm performance. They use both fixed effects and random effects specifications and also an instrument for endogeneity but find no change in this association. Three other recent studies find a robust and significant negative association between the variable and firm performance – Asimakopoulos *et al.* (2017), Xu and Dao (2020) and Chen *et al.* (2017) – even after controlling for various econometric issues in their respective samples still observe this negative association.

Overall, it seems that cash levels have a distinct positive effect on the UK construction firm's performance. Unlike other industries, in UK construction there is proof that holding cash is beneficial to firm performance. Explaining why this might be traced to comments of industry policy think tanks like Department for Business, Innovation and Skills, (2013) that have often stressed how the industry supply chain is highly fragmented and lacks effective and robust interrelationships. This fragmentation may have meant that most firms lack access to trade-based credit either from their own customers, suppliers or from external financiers. It is this scarcity in access to ready finance that manifests itself in this tendency of high performing firms to maintain large cash holdings.

6.1.4 Total long-term debt to total assets (DBTOTA)

The association is negative and significant at 1%. Every unit increase in DBTOTA decreases the UK construction firm's profit after tax in this sample by 50.9%. Leverage is thus a negative influence on the profitability of the firms. From a theoretical perspective, how a construction firm finances its resource bundle is a critical determinant of its performance as predicted by the VBM. Equity capital sources are preferable to external debt in this industry because the latter is likely to drag down profits after tax. Acquiring a larger asset portfolio through external debt does not bring any operational synergies or lower transaction costs for the construction firm. TCEs arguments on this line by Spulber (2009) are thus negated. Similarly, the result calls to question industry structure views (Porter, 1996; Becerra, 2009) that gaining scale by acquiring assets through debt can generate bargaining power for the firm vis-à-vis suppliers or customers and thus help it in reducing costs and increasing profits. There is also no evidence here that such scale acquisition by the construction firm through leverage makes for better productivity or vertical integration benefits as predicted by Stabell and Fjeldstad (1998). Rather, the sample result seems to corroborate agency theory-based arguments. The result may only be suggesting that higher debt levels in

UK construction firms create conflicts between debt holders, firm owners and managers (Jensen and Meckling, 1976). After all, each of these stakeholders has their own vested interests that could pull in different directions. It is these conflicts that may be causing the negative debt profitability relationship seen here in this sample.

At another level, in this UK construction industry sample, large levels of non-current assets do not seem to matter at all (see LPFE results) or that higher levels of cash holdings generate positive firm performance (see CASHTOTA results). This can be construed as another reason for debt-profit negative relation. The firm does not have any incentive to acquire expensive non-current assets as they simply do not matter to its profits. If the firm still chooses to borrow large sums (i.e. high DBTOTA) it is probably to meet other exigent expenditures that ought to have been met by regular operating cash flows. It thus pays the price in terms of a reduction in its profitability.

Papers studying the relationship between DBTOTA and firm performance document a mix of findings. The largest strand such as Pham and Pham (2020), Serrasqueiro and Nunes (2008), Yazdanfar and Ohman (2015), Nuber *et al.* (2019), Jang *et al.* (2019) and Salim and Yadav (2012) find evidence of a negative and significant association, as in this sample. However, others reveal either an insignificant (Bagh *et al.*, 2016; Nwaolisa and Chijindu, 2016; Ganiyu *et al.*, 2019) or even a positive association (Hossain, 2016; Angahar and Ivarave, 2016; Chowdhury and Chowdhury, 2010) between the variables. However, that most of the rigorous estimations here generally document a negative and significant association.

The negative effect of leverage on firm performance in UK construction seems to fit both the general narratives in the policy and regulatory discourse and the picture of construction firm financial data emerging from scholars such as Brearley *et al.* (2018) and Ive and Murray (2013). The former's argument that closer levels of collaboration and partnership can obviate the need to invest in expensive assets using debt seems reflected in performing firms' debt avoidance in the sample. However, the latter in particular find that most construction contractor firms in the UK use very low levels of bank loans generally not exceeding 10% of their total assets.[3] An inference that the average construction firm in the UK simply lacks effective access to long term sources

[3] Even in this sample the DBTOTA variable has a mean of 7.5% and a median of 0% and almost 75% of the firm year observations show zero debt (see univariate statistics).

of external debt would not be far wrong. In such an industry scenario, it is unsurprising to find that taking debt is a signal of desperation and that all internal sources have dried up and the firm is forced to borrow even on exorbitant terms. Naturally, there is a negative performance effect and this is what is seen in this sample. In a sense, these results seem to corroborate a pecking order of financing in the industry (Myers and Majluf, 1984). The best performers use equity first and avoid external debt. Perhaps this is why the Egan report (1998) and subsequent Wolstenholme review (2009) have repeatedly stressed the need for innovative and sophisticated external financing structures and mechanisms tailored to help the industry become more productive. This would help the average firm effectively gain scale, scope and learning advantages through debt while avoiding any of its negative effects.

6.1.5 INVENTOTA

The association is negative and significant at 1%. Every unit increase in INVENTOTA decreases the profit after tax of a UK construction firm by 31.1%. Holding large inventory levels is seen to have a clear negative effect on profitability in this industry. In theory, such a negative and significant association can be traced to at least two interlinked explanations. First, the UK construction firm's ability to lower its inventory levels despite growing its project order book appears to be critical to its performance. This ability can only arise from its better bargaining power with both suppliers of raw material inputs and distributors of its products and services as predicted by ISP scholars Porter (1996) and Geroski *et al.* (1990). It seems that, in this sample, the higher the bargaining power of the firm, the lower its average inventory levels leading to higher profits after tax. Second, closely linked to this explanation is the RBV-based argument (Barney, 1991; Grant, 2005) that in industry environments where property rights are not well defined and there is social embeddedness, relative bargaining will determine competitive advantage. The strong negative effect of higher inventory levels highlights the need for the UK construction firm to hone its bargaining abilities. The sample result seems to support the theory-based argument that the firm's dynamic capabilities across time to drive a hard bargain with supply chain partners makes a significant difference to its profits.

Another theoretical angle to interpret this negative association derives from economic theory. Besanko *et al.* (2017), among others, aver that the firm has to trade off the downward sloping marginal cost curve of inventory shortage against the horizontal marginal cost curve of inventory holdings when deciding its inventory levels (Banos-Caballero, *et al.*, 2010; Howorth and Westhead, 2003; Blinder and Maccini, 1991). Too much inventory consumes physical space, creates a financial burden and increases the possibility of damage, spoilage and loss. It also compensates for sloppy and inefficient management, poor forecasting, haphazard scheduling and inadequate attention to process and procedures. Therefore, minimising inventory is stressed across the operation management literature (Milgrom and Roberts, 1988; Dudley and Lasserre, 1989; Herer *et al.*, 2002). Yet there is also the strong possibility that inventory levels that are too low may create a stock-out situation and this could have a disastrous effect on demand. Therefore, economic theory suggests a tricky trade-off. Yet, this UK sample result seems to emphasise lower rather than higher inventory levels. Construction firms in the country perform better if they hold lower inventories.

Earlier industry-based performance studies flag this difficult economic trade-off that firms often face in deciding optimal inventory levels. While a large set of studies including Goncalves *et al.* (2018), Shah (2016), Enqvist *et al.* (2013) and Bui (2020) document a negative and significant association between the variable and the firm's performance just as in this sample, others reveal insignificant (Pakdel and Ashrafi, 2019; Dissanayake and Mendis, 2019) or even positive (Kumaraswamy, 2016; Bagh *et al.*, 2016) associations. Nevertheless, the sample result is not entirely unexpected. The normative and qualitative research especially in partnering approaches in the UK construction industry (Akintan and Morledge, 2013; Farooqui and Azhar, 2014; Cheung *et al.*, 2006) has often emphasised the influence of inventory-based relationships and the need for construction firms to actively reduce the adversarial and risk-shifting behaviour in the supply chain of the industry. Perhaps it is this that is being flagged in the significant negative association of INVENTOTA and profits in this sample. The average firm in the industry would benefit from lowering its inventory levels and if that has to be achieved while improving project completions, the only way to do so is by ensuring that raw material suppliers support the firm through a just-in-time (JIT) approach. This would ensure that there is no material spoilage or cluttering of space on site and more efficient and effective project operation.

6.1.6 TDTOTA

The association is negative and significant at 1%. Every unit increase in TDTOTA decreases profits after tax for the UK construction firm by 25.8%. Credit given to customers seems to have a direct negative effect on the profits of the firm in this industry. From a theoretical perspective, there are at least two ways to explain this result. First, that lower levels of credit sales (i.e. lower TDTOTA) improve profits seems to corroborate that buyers of construction firm outputs have relatively weak bargaining power (Porter, 1985; Besanko *et al.*, 2017). Therefore, a firm seeking better performance in this industry can and should force its customers to accept tighter credit terms and demand earlier payments from them. This subsequently shows itself as higher profits in such a firm. Second, the sample result shows how CD in the construction industry affects a firm's credit policies. It does seem that the contextual uncertainty in different managers' beliefs about customer demand, as stressed by the RBV (Kirzner, 1997; Barney, 1986; Shane and Venkataraman, 2000), does lead to trial and error decisions at least by the wiser firms. They are insisting on tighter payment terms secure in the belief that this will not lead to a loss in custom. This is what seems to be flagged in the positive outperformance of such UK construction firms.

Yet other theoretical predictions in the economics and management literature seem to be contradicted in this result. For example, Allen *et al.*'s (2005) and Ayyagari *et al.*'s (2010) contentions that trade credit is an important form of financing that boosts firm performance is not held in this sample of construction firms. Instead, the extent of credit given by the firm to its customers is a clear drag, reducing the profits of the firm. Similarly, there is no evidence that extension of trade credit to financially constrained customers of this industry strengthens firms' operations relative to industry competitors as predicted by Sartoris and Hill (1983), Kulp (2002) and Cachon and Fisher (2000). In this industry, there is no evidence that credit advanced to customers help the firm to weather economic crises as suggested by Cunat (2007).

From another angle, construction is an industry where informational asymmetries exist in product quality. Building integrity and utility can only be assessed long after the buyer occupies the premises and so the buyer knows much less about the goods or service than the seller. Still, trade credit in this industry which ought to provide a means to reduce such asymmetry (Lee and Stowe, 1993; Long *et al.*, 1993) does not seem to work. Nor is there any evidence that favourable credit terms used to move inventory to receivables on the balance sheets of construction firms helps them to lower inventory costs or avoid the expenses associated with altering plant capacities identified by Emery (1987). Instead, extending trade credit only seems to generate reduced liquidity and higher borrowing costs in this sample resulting in a drop in profits according to Barrot (2016) and Murfin and Njoroge (2015). The construction industry in the UK seems to thrive not on easy consumer credit terms, but on a strict cash payment schedule. Although sellers have greater recourse to compensation in case of bad debts arising out of credit sales as emphasised by Biais and Gollier (1997) and Cunat (2007), this does not seem to be the case in the construction industry in the UK. Here, firms seem only to face dwindling profits out of any overextended line of consumer credit.

Earlier work in TDTOTA is largely mixed in its findings. One set of scholars, notably Kumaraswamy (2016), Pakdel and Ashrafi (2019), Shah (2016) and Goncalves *et al.* (2018), find a significant and negative association between firm performance and either accounts receivables or accounts receivable period, as in this sample. However, other studies document either an insignificant association (Dissanayake and Mendis, 2019; Enqvist et al., 2013), a positive significant association (Pham and Pham, 2020; Bagh et al., 2016; Box et al., 2018), or even a linear positive and quadratic negative association (Hoang et al., 2019).

These mixed findings in earlier performance studies should, however, be read contextually although advancing credit to customers in the UK construction industry has a balance in credit received and credit given. It is the smaller and medium enterprises in the industry that have to make do with much less credit received when compared to credit that they advance. In such a context, the sample result is even more worrying. Now it is clear why the larger and more successful construction firms have little performance incentive to accommodate their distributors, retailers or customers. Such larger firms would squeeze their smaller budget clients who can ill afford to pay given their smaller budgets. At the same time, smaller construction firms would have to accept the lower profitability that comes along with higher consumer credit. That industry regulators are silent on how this flagrant inequality in consumer-based credit relationships are to be ameliorated is hardly helpful in this empirical context (Department for Business, Innovation and Skills, 2013: 52; Department for Business, Innovation and Skills, 2013).

6.1.7 TCTOTA

The association is negative and significant at 1%. Every unit increase in TCTOTA decreases the profit after tax of a UK construction firm by 47.6%. Credit received by the firm from its suppliers has a clear dampening effect on its profitability. This is somewhat counterintuitive, at least from the perspective of the incumbent firm. Although such a firm has vested cash preservation gains in obtaining the loosest credit terms from its input suppliers, such gains do not enhance its profitability. ISP theory's value chain argument (Porter, 1996; Miller and Friesen, 1986) comprising procurement efficiencies and inbound logistics is thus nuanced in this industry. The faster the cycle of input delivery and the quicker the payment of suppliers, the more profitable the construction firm despite losing cash early to supplier payments.

Here also is evidence of the unique nature of CD in the UK construction industry. The RBV (Barney, 1991; Rumelt, 1984) would possibly suggest that the incumbent UK construction firm would be well-advised to develop internal resources and capabilities to be able to withstand quick payments to suppliers. This is what would help such firms to become more profitable.

However, some echoes of narratives in the strategic alliance's cooperation and game theory literature can be seen in this result (Chen and Miller, 1994; Smith *et al.*, 1992; Ferrier *et al.*, 1999). Quicker payment terms for inputs would, after all, help a firm develop close and effective relationships with its suppliers and so the refrains of these scholars seem validated. At another level, the terms of trade in this industry between suppliers and firms are skewed towards the former. Fisman and Raturi (2004), Dass *et al.* (2015) and Fabbri and Klapper (2016) would point to this result as proof that suppliers in this industry have market power that they use to reduce the provision of trade credit. At the same time, the result may also support the contention of free-rider theorists such as Chod *et al.* (2019) that suppliers are wary of sharing the benefits of providing trade credit to this industry with the other suppliers.

From a different angle, this sample result is at odds with working capital management theory and literature which generally encourages a tighter cash conversion cycle; i.e. collecting payments faster from trade debtors but delaying payments to suppliers to improve profits. Deloof (2003), Wang (2002) and Lazaridis and Tryfonidis (2006) all concur that an elongated supplier payment schedule should help a firm to finance its other existing payments easily and thus reduce financing and related costs and improve working capital efficiency. But there is no evidence that this is the case in the UK construction industry. Instead, it is Deloof's (2003) other argument that delaying payments to suppliers might reduce the use of cash discounts, increase the price and reduce trust and timing in the relationship with suppliers that seems apposite.

Earlier scholars in industry performance studies documenting the association between TCTOTA or similar variables and firm performance report a wide mix of findings. At least seven studies – Shah (2016), Yusuf (2019), Xu and Dao (2020), Mweta and Kipronoh (2018), Kumaraswamy (2016), Bagh *et al.* (2016) and Pham and Pham (2020) – document a statistically significant and negative association like this sample result. Only one study – Asimakopoulos *et al.* (2017) – suggests a positive and significant association while several others like Enqvist *et al.* (2013), Pakdel and Ashrafi (2019) and Dissanayake and Mendis (2019) flag an insignificant association in their samples. Hoang *et al.* (2019) find a positive linear association between trade credit paid and gross or net operating profits but a negative quadratic association between the variables while Goncalves *et al.* (2018) see one year of positive associations but three years of negative associations.

Notwithstanding this mix of earlier findings, the sample result does reflect some important refrains in the normative policy and regulatory discourse of the UK construction industry. After all, there are persistent exhortations for reducing both the extent of fragmentation and adversarial relations in the construction supply chain across this literature (Egan, 1998; Wolstenholme, 2009; Department for Business, Innovation and Skills, 2013). Therefore this evidence that faster payments by the firm to its suppliers are performance-enhancing in this industry surely lends support to such exhortations. This is what will protect the smaller supplier firm at the end of the construction supply chain and thus improve the integrity of the industry as a whole (Department for Business, Innovation and Skills, 2013: 54). The normative voices of Hughes *et al.* (2006), Gruneberg and Francis (2019) Morledge and Smith (2013) and others urging collaborative and partnering approaches in the construction supply chain are not wrong. Such approaches are seen to yield direct performance benefits to the average firm in the industry.

6.1.8 Incremental technology and capital investment to total revenues (INCTECHCAPINVTOREV)

The association is positive and significant at 1%. Every unit increase in this variable increases the profit after tax of the UK construction firm by 5.5%. A firm's incremental investment in tangible and intangible assets as a proportion of its revenues has a direct positive effect on its profitability. This is an intuitive finding that generally fits expectations. From an RBV perspective, Dierickx and Cool (1989) and Barney (1986) underline how non-tradeable, idiosyncratic and innovative assets organically acquired by firms over years may help generate higher profits. From an ISP viewpoint, Porter's (1985; 1996) arguments about strategic mobility barriers erected through innovative technology investment can be read into this result. Systematic investment in an innovatively designed tangible and intangible asset portfolio year after year is hard to imitate or replicate. This is why it is seen to have a direct positive effect on the firm's profits.

At another level, the sample results can also be taken as proof that knowledge resources are critical and performance-enhancing in the UK construction industry as predicted by the knowledge-based view (KBV), an extension of the RBV. Scholars of this theory such as Sullivan (2000) Teece (2006) and Balogun and Jenkins (2003) predict that firms that invest in tangible and intangible knowledge capital over the years benefit from their stock of knowledge. This helps them to easily absorb and even create new methods of working and thus increase profitability. This seems to be what is seen in this sample. There is also scope to extend this sample result in other theoretical directions, especially that of organisational learning. The positive effect of incremental tangible and intangible investments seen here can surely be construed to be resultant of single loop double loop and deuteron learning regimes fostered in the firm by such consistent investments across time (Argyris and Schon, 1978; Mavondo *et al.*, 2005). It is these mechanisms that must be improving the profitability of UK construction firms.

The CD of incremental tangible and intangible investments in the UK construction industry in this result should also be interpreted using first-mover advantages arguments rife both in VBM theory and the related economics literature (Becerra, 2009; Smith *et al.*, 2001; Chen and Miller, 1994). At least two of the three major first-mover advantages underlined by Lieberman and Montgomery (1988) – technological leadership and pre-emption of scarce assets – can be seen at work in these sample results. By investing regularly in a portfolio of tangible and intangible assets, presumably ahead of its peers in the industry, the UK construction firm puts itself in a strategically unassailable position and thus earns higher profits.

Earlier investigations in the industry performance literature generally find a variety of associations between capital and technology investments and firm performance. At least seven studies – Grazzi *et al.* (2016), Bayraktaroglu *et al.* (2019), Rahman and Ferdaous (2020), Kim *et al.* (2017), Gui-long *et al.* (2017), Peng and Quan (2019) and Lee and Wu (2016) – document a significant and positive association between the variables. However, a negative and significant association is revealed by Shin *et al.* (2017), Zwaferink (2019) and Chappell and Jaffe (2018). Some scholars like Argilés-Bosch *et al.* (2018), Daghouri *et al.* (2019) and Alarcon and Pavlou (2017) uncover insignificant associations or even inverted U-shaped relationships between the variables. Kim *et al.* (2017) and Usman *et al.* (2017) find that while the immediate association between technology and capital investment and firm performance may be insignificant, there is a lag of one year after which the investment seems to yield performance benefits.

Notwithstanding this bewildering variety of findings in the literature, this sample's positive and significant association between the variables validates several elements of normative and policy-based discourse in the literature. Morledge and Smith (2013) argue that the large and one-time nature of technological and intangible investments in construction often necessitate joint and collaborative supply chain co-investment. The authors go on to suggest that where such joint investments are undertaken, both supply chain partners benefit. To the extent that this sample result is industry-wide, one can surely claim that it does support the idea that co-investments enhance firm performance.

The results here can be taken as a validation of the Infrastructure and Projects Authority (2017) and the Cabinet Office (2015) which repeatedly stress the importance of volumetric and pre-fabricated aspects of construction, both of which require higher levels of TCIs over time. Normative voices, notably Gruneberg and Francis (2019) and Hughes *et al.* (2015), opine that construction firms undertake the widest variety of tasks both on and offsite which offer the greatest scope for technology upgrading and innovation. That investment in technology and upgrading yields a significant positive effect on performance is therefore hardly unexpected. It is also a clear validation of such assertions.

6.1.9 GM

The association is positive and significant at 1%. Every unit increase in GMs increases the profits after tax of the UK construction firm by 261.5%. As expected, higher GMs of the firm contribute very strongly and positively to its profitability. A large theoretical literature in marketing including Day *et al.* (1979) and Dickson and Ginter (1987) underline the importance of effective segmentation of potential customers and their optimal targeting and proper positioning of products and services to improve firm performance. This sample result seems to confirm this. That GMs are such a significant determinant of firm performance in the industry also underlines the existence of significant amounts of product variety in the UK construction market. Dixit and Stiglitz (1977), Spence (1976) and Hart (1985) would argue that this positive effect of GMs on profits flags higher levels of competition in this market. This suggests that construction outputs are indeed easily substitutable. Therefore, the firm in this market needs to differentiate its product, thus generating higher GMs, if it wishes to earn higher profits.

The ISP would take this result as proof that in UK construction, product differentiation is a strategic driver of firm performance (Porter, 1996). But product differentiation derives from a robust research and development effort. Product innovation is dependent on R&D (Becerra, 2009; Peteraf, 1993). So, the inference that such R&D and product innovation are crucial in the UK construction industry is inescapable. Extending this theoretical argument further, a large innovation-based performance literature led by Rogers (1995), Davis (1989) and others emphasises that firms that innovate using information technology and related services may be able to achieve higher GMs than peers and thus enhance their profits. Such an argument seems fulfilled in this industry.

Earlier work on the associations of GM with firm performance largely confirms this sample result. At least four studies – Batchimeg (2017), Seetharaman *et al.* (2016), Vithessonthi (2016) and Shin *et al.* (2017) – find a positive and significant association in their different samples between GMs and different proxies of firm performance such as ROA, EPS, PAT and employee and financial sustainability. Three other studies – Ramadani *et al.* (2019), Chege *et al.* (2020) and Lee *et al.* (2016) – document positive and significant associations between ICT or R&D investments and firm performance.

Only Cordis and Kirby (2017) establish an insignificant association while Adachi-Sato and Vithessonthi (2019) prove a significant and negative association in their respective samples.

This confirmation from earlier industry firm performance studies also aligns with the general dynamics of the UK construction industry. Policy commentators including Gruneberg and Francis (2019) and Hughes *et al.* (2015) have often stressed how important robust margins are in this industry. Small wonder then that UK construction firms that have higher GMs outperform peers in this sample. But what is strikingly insightful is that every unit increase in GMs here has such a large positive effect (over 250%) on profits. Establishing a differentiated product position in this construction market yields very important dividends for the firm and firms would be well-advised to cultivate such market positions.

6.1.10 OM

The association is positive and significant at 1%. Every unit increase in OMs increases profits after tax of the UK construction firm by 603.6%. An even stronger positive effect is seen in this variable when compared to GMs. Being able to control operating costs is the most direct way of increasing OMs. ISP scholars like Porter (1996), Dess and Davis (1984) and Calori and Ardisson (1988) would highlight how this strong positive profit effect of OMs underlines cost leadership as an important strategy for UK construction firms. RBV scholars (Barney, 1991; Rumelt, 1984) might see a resonance between this result and the core premise of their theory. After all, it is the assiduous cultivation of valuable rare and inimitable resources that enables a firm to deliver products to the market at much lower cost while maintaining higher quality and other unique product attributes. This seems to be what the UK construction firm needs to cultivate. Similarly, TCEs (Teece, 1980; Spulber, 2009) argues that the effective bundling of resources in the firm should achieve a lower cost of producing and delivering to the market. This should help such a firm achieve higher OMs. Thus the positive profit effect of OMs in this sample is fulfilling TCE predictions.

Economists like Besanko *et al.* (2017), Penrose (1995) and Roberts (2004) often stress the importance of economies of scale, scope and learning in the cost efficiencies achieved by the firm. The highly positive association between OMs and profits after tax of the UK construction firms seen here can be construed as proof of the importance of these different types of economies in the business model of the average firm in this industry: being able to spread costs widely across the production function; achieving a much wider range of products on the chosen asset base; and reducing time effort and resources through experiential learning. All three might be at work behind the scenes in this result. The high positive association between the variables must be seen to reflect how cost structures and efficiencies are at the very core of profitability in the UK construction industry.

Five out of the eight studies investigating OM associations in the industry performance literature find positive significant associations just like in this UK construction sample (Chu, 2019; Chen *et al.*, 2017; Pham, 2020; Bai and Yan, 2020; Shin *et al.*, 2017). However, not all use OMs exactly as specified in this study. At least two studies document a significant and negative association while one finds an insignificant association between the variables.

The sample's positive and strong association fits narratives in the policy and normative literature. Kabiri *et al.* (2012), Hughes *et al.* (2015) and Ive and Murray (2013) repeatedly warn practitioners over the low and dwindling nature of OMs in this industry. They opine that such low margins are the single most important factor causing firms to underperform or fail. In the many policy-related discussion papers there is repeated reference to cost efficiencies (Department for Business, Innovation and Skills, 2013; Rhodes, 2019; Infrastructure and Projects Authority, 2017; HM Treasury, 2014). The importance of benchmarking costs especially in public infrastructure projects is a central narrative. Experts stress how cost-effectiveness is an important goal in public construction project procurement. A similar result in this private sector sample is thus a strong confirmation. UK construction firms that neglect operating efficiencies and economies of scale, scope and learning do so at great risk. In this industry, OMs are a very important driver of profits and must be carefully and assiduously cultivated.

6.1.11 SGATOTA

The association is negative and significant at 1%. A unit increase in SG&A expenditure proportions decreases the profits after tax of the UK construction firm by 17.9%. The result is counterintuitive and suggests that in this industry SG&A expenses harm the firm's profits. The entire theory of marketing is predicated on the argument that attracting customers and making them pay higher prices for the firm's products is driven by higher firm spending on marketing selling and promotion (Kotler and Armstrong, 2015; Lancaster, 1990; Rosen, 1974). Yet in this UK construction industry sample, this does not seem to be the case. Spending higher sums on promoting the product is wasteful here and reduces profits. From an ISP perspective (Porter, 1996; Beath and Katsoulacos, 1991) it seems that a construction firm's differentiation cannot be achieved through merely changing customer perceptions about its product. The durable long term and expensive nature of the construction firm's product offering might underlie this. This firm has to alter the fundamental features of its product. This is only possible through R&D, innovation, quality enhancement or design rather than through marketing spin, brand reputation or push-pull promotion. That is why SG&A has a negative profit effect in this industry.

The RBV perspective can be invoked in this result from a different angle. It appears that in this industry vertical and horizontal differentiation of the products and services of the firm are the more important lever of value creation and appropriation and firm performance (Holbrook, 1999; Miller, 1992; Kotha and Vadlamani, 1995). Pioneering new products and extending existing ones through better design and functionalities matter much more here than improving branding or customer reach. This strong negative association of SG&A with profitability can also be seen as proof of how only rare and inimitable resources, particularly those connected with actual product development and innovation, are critical in this industry (Barney, 1991). Marketing and promotional advantages simply do not work effectively.

It may also be inferred that UK construction appears to be an industry where fundamental shifts in the production function are needed and merely tinkering with peripheral aspects of the product such as those derived from SG&A cannot yield the firm significant performance benefits. This means that in this industry bundling together critical resources to achieve fundamental shifts in the production function as predicted by TCE appears to be vital (Spulber, 2009).

Marketing literature posits that SG&A should uncover under-served customer needs and market opportunities through research (Kotler and Keller, 2016). Sales prospecting developing the market through advertising, public relations, sales demonstrations, trials and sampling and getting orders through personal selling and direct marketing should also yield higher revenues. This should then translate to higher profits. But in this sample, that is clearly not the case. Instead, it appears that this marketing expenditure only increases total marketing costs and thus feeds through into a negative effect on profitability according to Kumar (2008) and Morgan (2012).

The work done by earlier industry firm performance scholars is largely in opposition to this sample result. At least four studies – Lee (2009), Seetharaman *et al.* (2016), Sun and Price (2016) and Silva *et al.* (2017) – independently verify that a significant and positive association exists in their respective samples between SGATOTA and firm performance and firm financial sustainability. Only Markovitch *et al.* (2020) find a negative significant association in their US sample while Haislip and Richardson (2015) document an insignificant association between the variables. Notwithstanding these mixed and contradictory indications, there is reason to anticipate such a negative significant association in the UK construction industry. In the policy-related discourses and the copious regulatory contextual and normative literature (Gruneberg and Francis, 2019; Morledge and Smith, 2013; Hughes *et al.*, 2015; Ive and Murray, 2013), there is hardly any mention of the importance of marketing or promotional expenditures in the business models of contractor firms. The nature of the built environment products and services delivered by the construction firm is such that it is tangible and observable. Word-of-mouth referral is the main conduit by which a firm gains more customers. Obvious workmanship defects cannot be concealed using marketing spin. Firms in this industry are therefore better off economising their spending on marketing and promotion and focusing managerial attention on the strategic determinants of performance that matter.

6.1.12 RG

The association is negative and significant at 1%. Every unit increase in this variable decreases the profits after tax of the UK construction firm by 3.2%. High growth firms are less profitable than their low growth peers, a fact that generally corresponds with the lifecycle theory of the firm. Fast-growing firms are often in the early life stage where costs exceed incomes and so profitability is low. By contrast, successful firms are generally in the mid-life period when profitability is high but growth is slow and stable. This is exactly what seems to be the case in this UK construction sample.

From a marketing perspective, Kotler and Keller (2015) and Lancaster (1990) argue that firms growing revenues faster are generally learning about segmenting the market, targeting the best types of customers and differentiating their product range. Therefore, they tend to be spending larger sums of money on market- and product-related costs and thus are less profitable. By contrast, lower RG firms are market leaders who have generally already mastered the market. Such firms use marketing economies of scale, scope and learning to reduce overall costs, thus enjoying higher profits. These arguments are corroborated by ISP theorists Scherer and Ross (1990), Anderson and Zeithaml (1984), Porter (1996) and Grant (2019), but from a structural perspective as different segments of any given industry grow revenues at different rates based largely on their emergent structural and competitive characteristics. The authors concur that high RG and low profitability occurs in industry segments still in the nascent phase of product development. Value creation and appropriation are still focal points of dispute amongst major segment players. However, low RG and high profitability occur in segments where large mature firms predominate. These firms have established business models and RG is hard to obtain but profits are high. Arguably, it is these theoretical contentions of both ISP and MT that are reflected in this UK construction sample.

TCE (Williamson, 1991; Coase, 1937; Spulber, 2009) would argue that the high RG low profitability pattern seen here may be driven by the higher levels of opportunism, asset specificity and sub-contracting present in this industry. However, this might also be proof that in the UK construction industry resources and capabilities are more imitable and substitutable than in most industries. High RG only attracts imitators who replicate the business model of the incumbent, bidding up prices of inputs, resources and operations (Barney, 1991; Rumelt, 1984). This then reduces the profits of the firm.

Earlier investigations in industry firm performance studies in this variable largely contradict these sample findings. Most authors, notably Yusuf (2019), Hoang *et al.* (2019), Dary and James (2019), Yazdanfar (2013), Asimakopoulos *et al.* (2017), Doan (2020) and Argilés-Bosch *et al.* (2018), find a significant and positive association between RG and various measures of firm performance (see Appendix 7). Only a handful such as Bokhari and Khan (2013), Ali *et al.* (2020) and Enqvist *et al.* (2013) find a negative and significant association between the variables and some document even insignificant associations (Pantea *et al.*, 2013; Pakdel and Ashrafi, 2019; Mazlan and Leng, 2018).

This largely puzzling sample result finds some support in the industry policy literature that often evidences huge efficiency differences between firms in the industry. Ive and Murray (2013) in particular note how difficult developing efficiency savings is in construction supply chains due to the complex links of financial interdependence. That growing faster in this industry comes only at the cost of significantly lower profits after tax corroborates this difficult efficiency gain. The result should also be located in the highly saturated nature of market dynamics in the industry due to excessive cost-based competition and an outmoded lowest cost tendering procedure that is still standard (Gruneberg and Francis, 2019; Ancell, 2007; Hughes *et al.*, 2015). Arguably, it is these aspects that place such a large stress on margins while making sales growth so hard and costly to come by.

6.2 Overall model statistics and *inter-se* magnitude of coefficients

Having discussed each coefficient and its association with firm performance, this section analyses the model as a whole econometrically. The two-way fixed effect model has an overall R-square of 67.3%, F-ratio of 206.192 with an associated p-value of 0.0000. The model is explanatory and significant. The 12 determinant variables along with the size control variable account for a large part of the variation in profits after tax of UK construction firms in the sample. Yet at least 32.7% of the variation in sample profits is not explained by the model, confirming that there are omitted unobservable or unmeasurable variables that may be at work.

From the highest to the lowest magnitudes of significant positive effects, the order of determinants in the two-way fixed effects model is OM (603.6%), GM (261.5%), CASHTOTA (137.7%), NCATOTA (107.9%) and INCTECHCAPINVESTOREV (5.5%). Similarly, from the highest to lowest magnitudes of significant negative effects the order of determinants is DBTOTA (-50.9%), TCTOTA (-47.6%), INVENTOTA (-31.1%), TDTOTA (-25.8%), SGATOTA (-17.9%) and RG (-3.2%). Positive associations are stronger in effect on average in this sample and vary much more widely than the negative ones.

6.3 Interrelationships between variables

Reading these full UK construction industry regressions must also take account of how the determinants in each concept vary in terms of their effect on firm performance. For example, in RM, it is CASHTOTA with a 137.7% positive effect, NCATOTA with a 107.9% positive effect and DBTOTA with a 50.9% negative effect that are the major determinants. This implies that internal resources in the firm need to be streamlined to ensure higher cash and working capital levels because they are critical to improving profits in this industry. However, firm managers need to be wary of accessing long-term debt in this industry which can seriously damage the firm. By contrast, in the two main two-way fixed effects regressions, LPFETOTA is insignificant in terms of its effect on profits. Such a result aligns neatly with the negative leverage effect on profits in this sample. Presumably, firms accessing debt are doing so not to invest in productive capacity (land, property, plant and equipment) but to meet survival needs. It is no wonder that leverage has such a negative effect on profits.

Similarly, in competitive advantage, it is TCTOTA with a 47.6% negative effect, INVENTOTA with a 31.1% negative effect, TDTOTA with a 25.8% negative effect and INCTECHCAPINVESTOREV with a 5.5% positive effect that affect profits. The UK construction firm requires to share important collaborative and partnering based advantages with inventory and input suppliers on priority by effectively reducing in-order-of-priority supplier outstanding payment levels and internal inventory levels. It also needs to encourage customers to pay early so that the cash conversion cycle (CCC) is effectively minimised and yields maximum profits after tax. Yet in these three separate components of CCC, it is supplier credit and inventory levels that need the most important strategic emphasis by firm managers as they have the largest negative effects. Letting customers pay late has the smallest negative effect on profits. Interestingly, technology and tangible and intangible asset investment have a tepid but positive effect in the UK construction industry. Perhaps this further corroborates why LPFETOTA is so insignificant or why long term debt has a predominantly negative effect on profits.

Finally, in MP, it is OM with a 603.6% positive effect, GM with a 261.5% positive effect, SGATOTA with a 17.9% negative effect and RG with a 3.2% negative effect that affect profits in this UK construction sample. It appears that operating efficiencies deriving from the firm’s mastery of economies of scale, scope and learning are the most important strategic performance determinant in this industry. Although achieving product differentiation and extracting GM is important in this industry, it is in no way as important as the achievement of lower unit and overall costs which has nearly three times as potent an effect on profits. This seems to fit neatly with the high positive effect of NCATOTA and the negative effects of trade credit received or given and increase in inventory levels discussed earlier. At another level, SG&A is a drain on the business of the UK construction firm. There is a direct and express need to reduce this item of expense. RG is hard to come by in this industry which is mature and saturated with many types of different firms.

6.4 Robustness of the model

A battery of tests and associated regressions are implemented to robustly validate the two-way fixed effects OLS model used as the basis for these interpretations. First, all standard errors used to compute the significances of the coefficients in the model are adjusted for potential heteroscedasticity, serial correlation and autocorrelation. Second, the Wooldridge test is implemented to ensure the absence of autocorrelations. Third, multicollinearity among the independent variables seems to be well within tolerance limits (see Appendix 6). Finally, Fisher type unit root tests based on augmented Dickey-Fuller estimations on the panels of the data set confirm that there is stationarity present in at least one panel.

After these test validations, four additional regressions are implemented: a pooled OLS, entity fixed effects, a GLS random effects and an MLE. The purpose of each of these regressions is specific. The pooled OLS shows the nature of average associations between the variables irrespective of firm or year in the sample. The entity fixed effects test takes account of firm-to-firm variations. The GLS random effects are shown for the purpose of comparison although the Hausman specification test done in the sample suggests the use of two-way fixed effects regression. Finally, the GLS MLE validates the relationships in the likely event that some or all of the variable distributions violate the normality requirements of classical regression analysis. The results are shown in Table 14. The signs of associations between dependent and independent variables are unchanged in all regressions except for INVENTOTA which only changes signs in the pooled OLS regression. This confirms the robust nature of associations between determinants and firm performance in the sample. LPFETOTA is the only variable that turns significant in three of these additional regressions and retains its positive sign of association with Ln(PAT). The variable also changes its magnitude by the highest amount across the regressions and so it seems that the earlier interpretation of the insignificance of this variable in the UK construction industry may have to be modified. There is more than one indication that LPFE levels have a positive and significant effect on profits after tax of the UK construction firm.

Endogeneity considerations are not completely unimportant in this UK construction industry sample. The nature of the variable set consisting of one dependent variable of profits along with eight variables scaled by total assets and four by total revenues of the firm is suggestive of several types of interlinked relationships. Clear theoretical indications for deciding exogeneity or endogeneity in such a conceptual model are not easy and obtaining the appropriate instruments to perform stage-wise regressions is also difficult. Yet, to ensure that the main two-way fixed effects results are statistically supported in Appendices 1 and 2, instrumental variable two-stage regressions using the size control variable of Ln(TOTR)[4] are presented for comparison with the main model.

6.5 Chapter summary

This chapter analysed the overall UK construction industry regression results. A rich panoply of revealing insights has emerged, of which at least five should be highlighted. First, from an RM perspective, the profitability of the average UK construction firm in this sample is highly dependent on the systematic maintenance of a positive working capital gap and cash position at all times. This liquidity-orientated business model seems to lend much credence to policy and normative concerns about the fragility of UK construction firms' business model and its inability to access either trade-based or alternative financing. After all, the criticality of holding a positive working capital gap or cash on the balance sheet must be driven by this necessity to avoid any dependence on external financing. The negative leverage effect and insignificant influence of non-current assets also seen in the sample seem to further accentuate and amplify such policy-based concerns.

Second, in this sample, the UK construction industry is seen to require performing firms to be able to reduce all three aspects of their operating cash cycle: time spent in inventory, in customer credit and supplier credit. This is a singular aspect of the CD of this industry and is at odds with most peer industries. In most other industries, obtaining

[4] The results do suggest some kinds of reverse causality but its exact nature is unclear especially as the revenue control variable is used ubiquitously in the 2SLS regressions. This is obviously suboptimal but given the wider scope of this thesis seems entirely appropriate.

extended credit terms from suppliers generally improves performance but this is not so in the UK construction industry. The average firm here is better off paying its suppliers promptly. A tight cash cycle seems to be the overall imperative for all construction firms but this naturally has its share of negatives for the performance of at least the smaller client and contractor firms. Such firms may not be able to honour such onerous terms of credit.

Yet from another angle, this need for a tighter CCC seems to substantiate important conclusions of anecdotal and policy-based scholars who repeatedly stress that UK construction firms ought to strive for a balanced collaborative and partnership-based supply chain. Such arguments seem substantiated in these results that underline the need to reduce cash conversion cycles across the industry. This is only possible if firms suppliers and distributors work in tandem to achieve it through close collaboration and partnership.

Third, TCIs are positive drivers of firm performance in this sample. This is intuitive, yet when read jointly with the lack of effect of non-current assets on firm performance in this industry, it seems to flag an argument. The nature of capital asset investment is more important than any mere investment in such assets. The intelligent choice of capital assets that aid the efficiency of project site operations and supply chain integration and efficiency are what matters.

Fourth, this UK construction sample underlines the importance of MP strategies. The construction firm needs to differentiate its products and services and simultaneously use economies of scale, scope and learning across its business model. The sample results show how firms in this industry need to be able to raise prices without losing custom and thus sustain higher GMs. Simultaneously, they need to develop expertise in lowering all kinds of operational costs to ensure higher OMs. In an industry that is physically involved in delivering a built environment, this has to derive from effective research and development and innovation both in service and product development and in their delivery. The growing number of regulatory initiatives that encourage such innovation and R&D seem to be recognising this important aspect of the industry. This quantitative result now supports such initiatives.

Finally, the UK construction industry is seen in these results to be one where sales growth is costly and hard to come by. Firms have to outspend rivals, especially in the early stages of their life cycle to capture market share and this is why their profitability is so poor during that time. Yet once the firm has survived this early growth period, spending is easier to control. The firm now enjoys high levels of profits but RG is naturally hard to come by, especially on its larger revenue levels. When read together with the importance of margins to profitability, this costly RG pattern captures the challenge of firm performance.

These five rather striking and peculiar firm performance dynamics set the UK construction industry apart from its peers. They are the first robust confirmation of why a theoretically derived but quantitatively detailed analysis is so important.

Chapter 7. UK Construction Industry Intra-Sector Regression Analyses

Having discussed the full industry regression results, Chapter 7 moves to the ISFP focus posed in research objective two. The main VBMA model is now re-estimated in each of the three key sectors of the UK construction industry. The regression coefficients are compared between the building (SIC 41), civil engineering (SIC 42) and the specialist construction trades (SIC 43) sectors. The results are presented in Tables 15 to 17.

7.1 Intra-sector regressions

The dependent variable as before is LN(PAT) while the same set of 12 independent determinants and one size control are used. The focus here is essentially on evaluating how the model differs in each sector and the industry as a whole.

7.1.1 NCATOTA

A highly unusual pattern of associations between this variable and profits after tax emerges in the three sectors of the UK construction industry. Although the associations remain positive and significant at 1% across all three sectors, it is the 41-sector comprising largely builder and tier-1 contractor firms that shows the lowest magnitude of positive associations with firm performance in the sample. A unit increase in NCATOTA increases profits after tax of the 41-firm by only 76.6% as compared with 156.8% for the 42-firm or 136.1% for the 43-firm. Thus, it is this 41-sector firm that is significantly less sensitive to changes in net working capital than peer firms in the industry.

One theoretical interpretation of this result is that the internal RM of the 41-sector firm does not need to emphasise a positive working capital gap – the net current assets – as much as its 42- or 43-sector peers. The internal RM of the building firm can underemphasise a positive working capital gap (Barney, 1991; Becerra, 2009; Grant, 2019). Its business model is different from its civil engineering or specialist trades firms. This firm can still achieve profits despite some marshalling of assets for the long rather than short-term.

Table 15: Dependent Variable: Ln (PAT). Sector: Construction of Buildings. SIC Code (41)

Independent Variables (Model)	Pooled OLS			Entity FE			Two-way FE			GLS RE			MLE RE		
	b	se	exp(b)-1	b	se	exp(b)-1	b	se	exp(b)-1	b	se	exp(b)-1	b	se	exp(b)-1
NCATOTA	0.967***	(0.096)	1.63	0.585***	(0.112)	0.795	0.569***	(0.112)	0.766	0.779***	(0.093)	1.179	0.785***	(0.058)	1.192
LPFETOTA	0.333*	(0.162)	0.395	-0.117	(0.162)	-0.11	-0.108	(0.160)	-0.102	0.028	(0.145)	0.028	0.035	(0.088)	0.036
CASHTOTA	0.425**	(0.136)	0.53	0.791***	(0.120)	1.206	0.774***	(0.116)	1.168	0.586***	(0.104)	0.797	0.580***	(0.081)	0.786
DBTOTA	-0.879***	(0.154)	-0.585	-0.767***	(0.158)	-0.536	-0.642***	(0.153)	-0.474	-0.812***	(0.123)	-0.556	-0.815***	(0.081)	-0.557
INVENTOTA	0.380***	(0.095)	0.462	-0.327*	(0.131)	-0.279	-0.339**	(0.122)	-0.288	0.126	(0.089)	0.134	0.137*	(0.063)	0.147
TDTOTA	-0.411***	(0.124)	-0.337	-0.544***	(0.103)	-0.42	-0.450***	(0.106)	-0.362	-0.570***	(0.095)	-0.434	-0.567***	(0.070)	-0.433
TCTOTA	-1.225***	(0.132)	-0.706	-0.640***	(0.134)	-0.473	-0.641***	(0.127)	-0.473	-1.010***	(0.116)	-0.636	-1.018***	(0.084)	-0.639
INCTECHCAPINVESTOREV	0.038**	(0.014)	0.039	0.034**	(0.012)	0.035	0.028**	(0.011)	0.028	0.043***	(0.012)	0.044	0.043***	(0.004)	0.044
GM	1.659***	(0.193)	4.254	1.181***	(0.191)	2.258	1.078***	(0.186)	1.939	1.423***	(0.174)	3.15	1.432***	(0.078)	3.187
OM	2.150***	(0.320)	7.585	1.686***	(0.316)	4.398	1.628***	(0.302)	4.094	1.914***	(0.308)	5.78	1.920***	(0.065)	5.821
SGATOTA	-0.225**	(0.075)	-0.201	-0.128	(0.077)	-0.12	-0.121	(0.076)	-0.114	-0.216***	(0.065)	-0.194	-0.218***	(0.038)	-0.196
RG	-0.040***	(0.012)	-0.039	-0.014	(0.009)	-0.014	-0.019*	(0.009)	-0.019	-0.024**	(0.009)	-0.024	-0.024**	(0.008)	-0.024
Ln (TOTR)	0.937***	(0.016)	1.552	0.884***	(0.029)	1.421	0.812***	(0.035)	1.252	0.904***	(0.022)	1.469	0.904***	(0.011)	1.469
Constant	-3.157***	(0.235)	-0.957	-2.375***	(0.344)	-0.907	-1.654***	(0.381)	-0.809	-2.699***	(0.275)	-0.933	-2.709***	(0.124)	-0.933
Time FE	NO			NO			YES			NO			NO		
Observations	9696			9696			9696			9696			9696		
N Groups				1446			1446			1446			1446		
In R-squared				0.416			0.44			0.409					
Between R-squared				0.684			0.687			0.734					
Overall R-squared	0.709			0.669			0.673			0.704					
Chi-sq.										3955.394			6323.046		
Log likelihood	-14371.534			-11147.85			-10941.426						-13248.054		
Null log likelihood	-20356.108			-13752.469			-13752.469						-16409.577		
F	618.384			128.163			84.194								

Notes: All the regressions in the table are with robust standard errors (VCE Cluster). The regressions are defined as follows: pooled Ordinary Least Square (pooled OLS); entity fixed effects (Entity FE); two-way fixed effects (Two-way FE); generalised least square random effects (GLS RE); and maximum likelihood estimation random effects (MLE RE). The interpretation of the model is based on the two-way fixed effects regression presented in column 3. The b column presents the coefficients of the variables and the star signs next to the variables (*, **, ***) indicate the significance at 5, 1, and 0.1 per cent levels, respectively. The exp(b)-1 column presents the exponential coefficient values to explain the effect on profit after tax rather than the effect on the Ln (profit after tax).

Table 16: Dependent Variable: Ln (PAT). Sector: Civil Engineering. SIC Code (42)

Independent Variables (Model)	Pooled OLS			Entity FE			Two-way FE			GLS RE			MLE RE		
	b	se	exp(b)-1	b	se	exp(b)-1	b	se	exp(b)-1	b	se	exp(b)-1	b	se	exp(b)-1
NCATOTA	1.472***	(0.233)	3.358	0.977***	(0.229)	1.656	0.943***	(0.231)	1.568	1.163***	(0.205)	2.2	1.169***	(0.120)	2.219
LPFETOTA	0.714***	(0.207)	1.042	0.456*	(0.227)	0.578	0.567*	(0.236)	0.763	0.569**	(0.192)	0.766	0.572***	(0.141)	0.772
CASHTOTA	0.415*	(0.200)	0.514	1.139***	(0.188)	2.124	0.994***	(0.185)	1.702	0.894***	(0.151)	1.445	0.886***	(0.141)	1.425
DBTOTA	-1.061***	(0.316)	-0.654	-0.583	(0.449)	-0.442	-0.435	(0.380)	-0.353	-0.847**	(0.323)	-0.571	-0.853***	(0.200)	-0.574
INVENTOTA	-0.605*	(0.238)	-0.454	-0.480	(0.277)	-0.381	-0.421	(0.259)	-0.344	-0.477	(0.243)	-0.379	-0.477*	(0.199)	-0.379
TDTOTA	-0.636***	(0.191)	-0.471	-0.238	(0.140)	-0.212	-0.210	(0.147)	-0.189	-0.301*	(0.140)	-0.26	-0.304**	(0.109)	-0.262
TCTOTA	-0.562*	(0.253)	-0.43	-0.668**	(0.248)	-0.487	-0.567*	(0.248)	-0.433	-0.634**	(0.213)	-0.47	-0.634***	(0.148)	-0.47
INCTECHCAPINVESTOREV	0.153	(0.098)	0.165	0.135	(0.082)	0.145	0.123	(0.077)	0.131	0.133	(0.087)	0.142	0.133***	(0.017)	0.142
GM	1.651***	(0.302)	4.212	1.704**	(0.573)	4.496	1.639**	(0.562)	4.15	1.695***	(0.489)	4.447	1.695***	(0.200)	4.447
OM	1.823	(1.148)	5.19	2.773	(1.550)	15.007	2.696	(1.478)	13.82	2.527	(1.374)	11.516	2.519***	(0.194)	11.416
SGATOTA	-0.108	(0.068)	-0.102	-0.074	(0.089)	-0.071	-0.067	(0.088)	-0.065	-0.122	(0.080)	-0.115	-0.123*	(0.054)	-0.116
RG	-0.049*	(0.020)	-0.048	-0.010	(0.015)	-0.01	-0.022	(0.015)	-0.022	-0.020	(0.015)	-0.02	-0.021	(0.014)	-0.021
Ln (TOTR)	0.942***	(0.031)	1.565	0.990***	(0.049)	1.691	0.866***	(0.065)	1.377	0.961***	(0.039)	1.614	0.961***	(0.022)	1.614
Constant	-3.267***	(0.381)	-0.962	-4.062***	(0.569)	-0.983	-2.882***	(0.686)	-0.944	-3.678***	(0.472)	-0.975	-3.669***	(0.243)	-0.974
Time FE	NO			NO			YES			NO			NO		
Observations	2538			2538			2538			2538			2538		
N Groups				345			345			345			345		
In R-squared				0.498			0.521			0.496					
Between R-squared				0.62			0.624			0.631					
Overall R-squared	0.609			0.594			0.604			0.602					
Chi-sq.										1395.779			1850.22		
Log likelihood	-3419.033			-2631.097			-2571.481						-3131.899		
Null log likelihood	-4611.435			-3505.495			-3505.495						-4057.009		
F	106.788			77.705			51.427								

Notes: All the regressions in the table are with robust standard errors (VCE Cluster). The regressions are defined as follows: pooled Ordinary Least Square (pooled OLS); entity fixed effects (Entity FE); two-way fixed effects (Two-way FE); generalised least square random effects (GLS RE); and maximum likelihood estimation random effects (MLE RE). The interpretation of the model is based on the two-way fixed effects regression presented in column 3. The b column presents the coefficients of the variables and the star signs next to the variables (*, **, ***) indicate the significance at 5, 1, and 0.1 per cent levels, respectively. The exp(b)-1 column presents the exponential coefficient values to explain the effect on profit after tax rather than the effect on the Ln (profit after tax).

Table 17: Dependent Variable: Ln (PAT). Sector: Specialised Construction Activities. SIC Code (43)

Independent Variables (Model)	Pooled OLS			Entity FE			Two-way FE			GLS RE			MLE RE		
	b	se	exp(b)-1	b	se	exp(b)-1	b	se	exp(b)-1	b	se	exp(b)-1	b	se	exp(b)-1
NCATOTA	1.011***	(0.101)	1.748	0.813***	(0.136)	1.255	0.859***	(0.135)	1.361	0.912***	(0.106)	1.489	0.911***	(0.062)	1.487
LPFETOTA	0.331*	(0.162)	0.392	0.014	(0.148)	0.014	0.205	(0.151)	0.228	0.204	(0.133)	0.226	0.202*	(0.086)	0.224
CASHTOTA	0.431***	(0.110)	0.539	0.719***	(0.142)	1.052	0.747***	(0.142)	1.111	0.615***	(0.111)	0.85	0.617***	(0.077)	0.853
DBTOTA	-0.694**	(0.240)	-0.5	-0.684*	(0.273)	-0.495	-0.667*	(0.279)	-0.487	-0.660**	(0.239)	-0.483	-0.660***	(0.116)	-0.483
INVENTOTA	-0.365**	(0.135)	-0.306	-0.310	(0.167)	-0.267	-0.350*	(0.162)	-0.295	-0.342**	(0.121)	-0.29	-0.341**	(0.104)	-0.289
TDTOTA	-0.401***	(0.114)	-0.33	-0.260**	(0.087)	-0.229	-0.183*	(0.092)	-0.167	-0.300***	(0.084)	-0.259	-0.299***	(0.058)	-0.258
TCTOTA	-0.403**	(0.139)	-0.332	-0.400**	(0.139)	-0.33	-0.356**	(0.136)	-0.3	-0.355**	(0.122)	-0.299	-0.355***	(0.082)	-0.299
INCTECHCAPINVESTOREV	0.354*	(0.147)	0.425	0.272*	(0.114)	0.313	0.267*	(0.110)	0.306	0.293*	(0.125)	0.34	0.292***	(0.011)	0.339
GM	2.018***	(0.336)	6.523	2.967***	(0.428)	18.434	2.858***	(0.409)	16.427	2.613***	(0.354)	12.64	2.617***	(0.111)	12.695
OM	5.126***	(1.252)	167.342	4.284***	(1.054)	71.53	4.138***	(1.013)	61.677	4.584***	(1.110)	96.905	4.581***	(0.126)	96.612
SGATOTA	-0.143*	(0.057)	-0.133	-0.199**	(0.073)	-0.18	-0.198**	(0.071)	-0.18	-0.188***	(0.057)	-0.171	-0.188***	(0.029)	-0.171
RG	-0.050***	(0.010)	-0.049	-0.039***	(0.009)	-0.038	-0.041***	(0.009)	-0.04	-0.043***	(0.009)	-0.042	-0.043***	(0.008)	-0.042
Ln (TOTR)	1.000***	(0.017)	1.718	1.041***	(0.032)	1.832	1.004***	(0.045)	1.729	1.017***	(0.021)	1.765	1.017***	(0.012)	1.765
Constant	-4.155***	(0.236)	-0.984	-4.724***	(0.365)	-0.991	-4.283***	(0.459)	-0.986	-4.431***	(0.263)	-0.988	-4.433***	(0.137)	-0.988
Time FE	NO			NO			YES			NO			NO		
Observations	7466			7466			7466			7466			7466		
N Groups				1043			1043			1043			1043		
In R-squared				0.518			0.533			0.516					
Between R-squared				0.714			0.72			0.724					
Overall R-squared	0.672			0.662			0.67			0.667					
Chi-sq.										5064.103			6076.742		
Log likelihood	-9236.494			-7432.468			-7309.353						-8691.93		
Null log likelihood	-13394.104			-10153.391			-10153.391						-11730.301		
F	416.239			245.394			124.864								

Notes: All the regressions in the table are with robust standard errors (VCE Cluster). The regressions are defined as follows: pooled Ordinary Least Square (pooled OLS); entity fixed effects (Entity FE); two-way fixed effects (Two-way FE); generalised least square random effects (GLS RE); and maximum likelihood estimation random effects (MLE RE). The interpretation of the model is based on the two-way fixed effects regression presented in column 3. The b column presents the coefficients of the variables and the star signs next to the variables (*, **, ***) indicate the significance at 5, 1, and 0.1 per cent levels, respectively. The exp(b)-1 column presents the exponential coefficient values to explain the effect on profit after tax rather than the effect on the Ln (profit after tax).

From the liquidity angle, 41-sector firms seem least affected by lack of liquidity in their business models. Covering their current liabilities is of distinctly less importance for the profits of such building firms. Reducing their NCA proportion by one unit will reduce after tax profits by much less in these firms than peers in the 42- and 43-sectors. Deloof's (2003) argument that liquidity improves the firm's ability to meet short-term obligations does not translate to as effective a profit response in this sector of the industry. Perhaps the reason for this could lie in the smaller liquidity constrained nature of firms in the 42- and 43-sectors.[5] Such firms need to expressly ensure the maintenance of significant working capital. At another level, this seems to suggest intra-sector nuances in the liquidity contentions of Goddard *et al.* (2005) and Fagiolo and Luzzi (2006). It appears that higher liquidity is a much stronger buffer against rapidly changing business conditions for civil engineering and specialist trades firms. Buildings firms, by contrast, are large enough to manage changes in business conditions even without excessive coverage of their short-term obligations and liabilities.

Empirical work in ISFP in UK construction is rare but there are several discussions in the related normative and policy-based literature that help explain and to an extent corroborate this sample result. Ive and Murray (2013) find in their UK contractor firm sample that for tier-1 firms the need for working capital to finance operations is usually negative. For their tier-2 counterparts, this need is generally positive. This is very much in synch with the lower sensitivity of profits to net working capital seen among 41-sector firms in this sample. These building firms are largely generalist contractors classified in tier 1.

But where this result seems to add to the authors' arguments in that even the 41-sector firms differ from their 42 counterparts in this sensitivity to NCA. Although both sets of firms are generally classified as tier-1 contractors, UK building firms are less sensitive to this. By contrast, 42-sector civil engineers, although tier-1, seem to display the highest sensitivity to net working capital. This suggests the completely different nature of business model of this firm in the industry.

Normative scholars such as Morledge and Smith (2013), Hughes *et al.* (2015) and Gruneberg and Francis (2019) point to significant differences in the liquidity-based

[5] The significant difference in the sizes of 41 versus 42 or 43-firms is confirmed in the univariate statistics analysed in section 5.3 of this thesis.

imperatives of the business models of typical UK construction firms. It is these differences that, according to the authors, make partnering and collaborative relationships in and across the value chain so important in this industry. The significant differences in NCA sensitivity recorded in this sample across 41, 42 and 43-sector firms seem to accord with such arguments. In that sense, the results here can be interpreted to imply that supply-chain-based collaborative and partnering relationships are important in the industry. But such importance is significantly higher among civil engineering (42) and specialist construction (43) firms in that descending order but less so to building firms (41).

7.1.2 LPFETOTA

A different variation is seen here across the three sectors of the UK construction industry. Only sector 42 shows a significant and positive association (+76.3% effect) between the variable and firm after tax profits. Thus, it is the civil engineering firms that display an after tax profit sensitivity to plant, machinery, equipment and facilities spend. The 41 and 43-sector specialist construction trades display insignificant associations.

This 42-sector result seems to fit with the expectations of the RBV (Barney 1991: Rumelt, 1984) and the VBM (Becerra, 2009; Lieberman *et al.*, 2017). Productive and unique long term assets acquired by civil engineering construction firms do seem to generate options for division of labour and economies of scale, scope and learning and thus improve profits. Owning rather than hiring such assets seems to create a value-appropriating advantage for this engineering firm, unlike its generalist contractor or specialist trading peer. Similarly, the result also seems to validate Kogut and Zander's (1996) contentions that building an owned unique non-current asset portfolio helps the civil engineering construction firm facilitate communication coordination and learning, thus enabling its profitability over a significantly long sample period. It can thus be argued that for this type of UK construction firm plant, machinery and equipment decisions are critical and can mean the difference between success and failure.

Industry experts have long argued that the UK construction industry is heterogeneous with several different types of business models in vogue in different sectors of the industry (Gruneberg and Francis, 2019; Morledge and Smith, 2013; Hughes *et al.*, 2015). The sample result showing the clear divergence between sectors 41 and 43 and sector 42 seems to corroborate such arguments. For the civil engineering firm, decisions on plant equipment and other such non-current assets cannot be lightly taken. This seems intuitive given that the complex project work undertaken by this sector's firms is often dependent on highly complicated sophisticated machinery and equipment. Such equipment is better owned than hired. By owning these assets, the firm gains direct performance benefits of enhanced efficiency in operations. But such ownership also engenders expertise in asset operation, maintenance and development that cannot be easily otherwise acquired or replicated. Perhaps this is why the 42-sector civil engineer gains a distinct profit advantage from this ownership.

7.1.3 CASHTOTA

All three sectors of the UK construction industry are cash sensitive and the sample results clearly document this positive and significant association between the variable and after tax profits in each case. But the nature of sensitivity varies across each sector. The 42-sector firms exhibit the highest magnitude of effect with 170.2% on PAT. Profitable civil engineering-based construction firms seem to require significantly higher levels of cash on their balance sheets. Every unit increase in cash levels in this sector yields a 170.2% increase in after tax profits unlike the 116.8% increase seen in sector 41 or the 111.1% in sector 43.

Explaining this higher after tax profit sensitivity of civil engineering firms to cash levels must rely on both transaction cost arguments (Spulber, 2009) and industry structure ones (Stabell and Fjeldstadt, 1998). For example, the TCE suggestion that cash levels reduce the burdens of cash mismatch between buyers and sellers in a firm-less market is truer in the civil engineering segment. That civil engineering projects tend to be of longer duration and require the contractor to keep working to a schedule irrespective of the arrival of cash from the client may underlie this important need to remain cash positive. Similarly, applying the ISP value chain analyses to the civil engineering firm it can be flagged that in such a firm value chain links and processes tends to change much more from stage to stage in the production process. This is what imposes higher cash needs on this firm when compared to its building or specialist trade counterpart.

But other theoretical interpretations may also be inferred. The civil engineer's business model necessitates higher cash levels to enable the firm to grasp investment and production opportunities as and when they arise. This may be traced to the rather wider range of inputs and other procurement made by this firm. Adequate cash buffers are the only way this firm can tackle emergent investment and production opportunities. By contrast, such a diverse cash buffer is not required in the other two sectors.

Aside from these theoretical explanations, cash is indeed seen to have a heterogeneous effect on profits in the three sectors of the UK construction industry. That civil engineering firms are the ones whose profits are most affected by cash levels corroborates concerns voiced in different parts of the policy-based discourse, particularly Department for Business, Innovation and Skills, (2013). Experts warn about cash flow obstacles across the value chain in the civil engineering sector. This firm faces difficulties in accessing ready finance. Perhaps this is why the best firms in this sector hold larger cash and benefit from it.

By contrast, the specialist trades 43-sector firm exhibits the lowest profit sensitivity to cash in the industry. The nature of the business model of this firm sequesters it from fluctuating economic conditions. Therefore larger cash buffers are not needed. Trade credit in this sector is generally more readily available and so the firm does not need to hold on to cash to ensure profitability.

7.1.4 Debt to total assets (DBTOTA)

Leverage seems to have a negative significant effect on profits after tax only in the buildings 41 and specialist trades 43 firms. In the 42-sector civil engineering sector, the coefficient loses significance and drops in magnitude while displaying a negative sign. This is a noteworthy occurrence. Debt does not have the same significant negative effect on after tax profits in the civil engineering sector that it has in other parts of the UK construction industry. In addition, it is the 43-sector specialist trading firm that displays the highest magnitude of negative effect. Every unit increase in DBTOTA of this firm decreases its after tax profits by 48.7% when compared to the decrease of 47.4% in its 41-sector building firm counterpart.

These leverage profit differences need careful theoretical interpretation. The question of how they finance their resource bundle remains an important determinant of the performance of building and specialist trade firms as predicted by VBM (Becerra, 2009). Such firms are better off using equity rather than debt, but this is not so for their civil engineering 42-sector counterpart which could finance itself using either equity or debt and it would not make any significant difference to its profitability. Similarly, while leverage does not create any operational synergies or reduce transaction costs for 41- and 43-sector firms as predicted by Spulber (2009), the case of 42-firms is not as clear-cut. One cannot rule out the potential presence of operational synergies or reduction of transaction costs due to leverage in this sector.

From the ISP (Porter, 1996; Stabell and Fjeldstadt, 1998), gaining scale through leverage does not generate any vertical integration benefits or bargaining advantages for the 41- and 43-sector firms but one cannot conclude the same for the 42-sector civil engineering counterpart. Since leverage does not have a discernible negative influence on the profits of such a firm, one can only infer that there is no evidence discouraging the use of leverage in this industry sector. There is a chance that the civil engineering firm might gain bargaining advantages or vertical integration benefits from using leverage. One is simply unable to either support or reject such a possibility in this sample.

The sample result should also be read in conjunction with the interesting variation in LPFETOTA significance and effect above. Only 42-sector civil engineering firms show a significant positive association between LPFETOTA and after tax profits. Yet these firms also show an insignificant association in respect of DBTOTA. Therefore in this civil engineering sector leverage used for acquiring non-current property, plant and equipment assets may yield positive profit. One simply cannot be sure of this either way. This is in stark contrast to other 41- or 43-sector firms in the industry. For such firms, leverage use is a clear drag on performance. Even if this leverage is used to acquire non-current assets in these sectors, profits only decline. The comparative analysis seems to flag important leverage profit differences thus clearly in the business models of civil engineering construction firms. These firms are the only ones in this industry where the use of leverage for improving productive capacities in non-current assets might have some performance advantage. Everywhere else in the industry leverage has only a negative performance effect.

Interpreted another way, an intricacy of ISFP in the UK construction industry is revealed. The highest profit sensitivity to leverage is displayed by the specialist trades construction firm in sector 43 followed closely by building contractors in sector 41. Ive and Murray (2013) point to findings in Ive and Yu (2011) that many firms classified in the 43 SIC code may operate mainly as tier-1 contractors but have a business channel dealing in specialist trades. Perhaps this is why 43-firm profits are so negatively affected by leverage. It simply does not pay for such firms to borrow at all and the few firms that do access debt generally turn out to be underperformers. At another level, the building segment of the UK construction industry is very competitive. This explains why leverage may be a risky proposition for such firms as leverage-fuelled business investments may fail due to competitors grabbing market share.

7.1.5 INVENTOTA

All three sector coefficients are negative but only the building firms (41) and the specialist trades firms (43) remain significant. Once again, the civil engineering firms (42) display an insignificant association. Surprisingly, and rather counter-intuitively, inventory pile-ups negatively affect firm after tax profits only in building and specialist trade firms but do not so affect their civil engineering peers. Every unit increase in INVENTOTA decreases the profit after tax of the 41- and 43-firms by 28.8% and 29.5% respectively but does not significantly affect the PAT of the 42-firms.

The 41 and 43 results suggest that ISP-based arguments of effective bargaining power vis-à-vis suppliers and distributors significantly matter among these building and specialist trades firms (Porter, 1996; Geroski *et al.*, 1990). Unless these firms keep inventory levels under check through negotiating down lead times, they face a serious after tax profit deterioration. By contrast, 42-sector civil engineering firms can afford some inventory slack. The result seems to suggest that such firms can hold higher inventory without a profit disadvantage.

Similarly, intra-sector dynamics in terms of both property rights ambiguities and social embeddedness (Barney, 1991; Grant, 2005) show a difference between the 41- and 43-sectors and the 42-sector. Building contracts and specialist equipment and trade contracts seem to exhibit a much higher degree of adversarial elements when compared to the more standard civil engineering project contracts. These higher levels of adversarial elements lead to property rights ambiguities and disputes in these sectors. This is perhaps why these sectors' tighter bargaining abilities to keep inventory levels down are so critical to firm performance.

From the angle of economic theory, it does seem that in this sample it is in the 41- and 43-sectors that the marginal cost curve of inventory holding is significantly more instrumental than the marginal cost curve of inventory stock-out (Besanko *et al.*, 2017;

Banos-Caballero, *et al.*, 2010; Howorth and Westhead, 2003; Blinder and Maccini, 1991). The building or specialist trade firm has to pay significantly more attention to avoid inventory pile-up, even to the extent of risking stock-outs because the former has such a significant negative effect on its profits. By contrast, it appears that for the UK civil engineering firm the keenness of the trade-off is blunted. Inventories can be held at least to the extent that they help the firm meet tight project scheduling requirements and avoid last-minute procurement.

This rich pattern of differing associations in ISFP in INVENTOTA brings into sharp relief the many exhortations by construction sector policy experts and researchers. Gruneberg and Francis (2019), Morledge and Smith (2013) and Hughes *et al.* (2015) have stressed the need for a higher work ethic and better on- and offsite management in the industry. Yet this is easier said than done. Department for Business, Innovation and Skills, (2013). notes how building contractors critically need JIT delivery of flooring, failing which there might be incorrect or inefficient scheduling of the workforce leading to as high as 50% higher labour costs. Such problems are what this sample result seems to be flagging especially in the 41- and 43-sectors.

Yet the contrarian indications in the 42-sector civil engineering sector highlight the challenge of inventory management in the industry. It is quite plausible to conceive that 41- and 43-firms might employ each other or 42-firms as a part of their contractual supply chain obligations. When both supply chain partners need to reduce inventory levels (a 41 or 43-firm) or when one partner does not have any such need (a 42-firm), it might prove a highly contentious and unresolvable issue. This is why many narratives in the policy literature argue for developing benchmarks for supply chain coordination and accommodation in the UK construction industry (Hughes *et al.*, 2015; Morledge and Smith, 2013; Ive and Murray, 2013).

7.1.6 TDTOTA

In this variable, coefficient significances and magnitudes show a similar pattern as in INVENTOTA. The 41- and 43-sector firm shows a negative significant effect while the 42-sector firm remains uninfluenced by this variable. Yet unlike the result above, it is the significant coefficient in the 41-sector (-0.367) that is more than twice that of its counterpart in the 43-sector (-0.167). Thus, extending credit to customers is significantly more profit destructive for the building sector construction firm than it is for its specialist construction trades firm. For the civil engineering firm,[6] this determinant simply does not matter.

ISP theory (Porter, 1985; Besanko *et al.*, 2017) would argue that customers in the building sector (41) of the UK construction industry are least able to bargain with incumbent firms. The strong profit imperatives of the latter make it difficult for these customers to expect any leeway from the firm. Such imperatives are much lower in the specialist trades sector (43). Both these sector firms, but particularly the former, can and should enforce quicker payments from customers as predicted by theory to enhance profits after tax. A more level playing field must be inferred for the 42-sector firm. This firm gains no discernible performance benefits from insisting on tighter credit terms. At another level, insisting on faster payments from the informed and sophisticated government and quasi-government institutional customers could only drive them away. The result thus fits the general CD of this sector of UK construction.

One can perceive in the result echoes of RBV tenets of contextual uncertainty in managerial beliefs (Kirzner, 1997; Barney, 1986; Shane and Venkataraman, 2000). Higher profit 41 and 43-sector firms in this sample seem to implement trial and error strategies risking a potential loss in custom by insisting that their customers pay early. By contrast, their 42-sector peers have no option but to play safe, especially in the context of their distinctly larger customers.

The consumer credit literature might have other explanations for this result. Sartoris and Hill (1983), Kulp (2002) and Cachon and Fisher's (2000) predictions that giving credit to financially constrained customers should enhance profits is contradicted in the 41- and 43-sectors of UK construction. Only in the case of the civil engineering 42-sector firm in this industry is one simply unable to conclude either way. For this firm, there may be some imperceptible benefits of maintaining an effective credit line for customers.

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[6] Perhaps this is why the univariate statistics of TDTOTA shows that sector 41 firms seem to choose the lowest levels of consumer credit with mean and median levels of 17.08% and 5.69% respectively. Managers of the average firm in this sector seem to be consciously aware of the negative impact of consumer credit on their profitability. It is worth noting that in sector 42 firms on average seem to choose much higher mean/median levels of 28.55%/26.9% respectively although this is marginally less than their 43-firm counterparts (mean 31.12% median 29.92%).

It does seem that, although informational asymmetries between sellers and buyers are most pronounced in the 41- followed by the 43-sector, advancing consumer credit does not help resolve this or result in higher profitability (Lee and Stowe, 1993; Long *et al.*, 1993). These firms seem unable to extract reductions in inventory costs by moving goods faster into receivables as expected by Emery (1987). Instead, it seems that firms in these two sectors only suffer the adverse consequences of reduced liquidity and increased leverage costs by giving consumer credit as predicted by Barrot (2016) and Murfin and Njoroge (2015).

These sector-based differences in TDTOTA's effect on PAT in UK construction only seem to corroborate existing debates in the policy narrative of the industry. Scholars like Morledge and Smith (2013), Hughes *et al.* (2015) and Ancell (2007) stress that the industry is characterised by adversarial relationships and contractual disputes. This sample result shows that, at least in these two important sectors of building and specialist trades, firms suffer profit deterioration due to extending consumer credit. These firms would thus naturally not extend such credit. While this will undoubtedly improve these firms' profitability, the effect of such actions on the supply chain and consumers, especially those with fragile balance sheets, can only be negative. It will only further strengthen adversarial and fragmentary tendencies that are already a bane in this industry. These results seem to highlight the importance of regulatory institutional and policy prescriptive actions to correct and modify intra-sector firm behaviours in consumer credit

7.1.7 TCTOTA

Another kind of variation is seen in the magnitudes of the coefficients in the three sectors although all three display uniformly negative and significant associations. A unit increase in trade creditor levels decreases PAT of the 41-, 42- and 43-sector firms by 47.3%, 43.3% and 30%, respectively. Clearly and rather counter-intuitively, in all three sectors, taking credit from suppliers has a distinctly negative effect on profits after tax of the firm. However, this negative effect is the least in the specialist trades sector (43) and the highest in the buildings sector (41). Supplier lines of credit are at least 36% less harmful to profits in the former when compared to the latter.

Across the industry, there is nothing to be gained in terms of cash preservation by insisting on longer supplier payment terms but there are significant nuances.

Particularly among building and civil engineering firms, JIT input deliveries need to be matched with prompt supplier payments to improve profits (Porter, 1996; Miller and Friesen, 1986). Specialist trades firms can afford some slack although there is still a 30% negative effect. Yet the uniformly negative association should at least have salutary implications for the CD in the industry as a whole. It is quite likely that 41- and 42-firms share a firm-supplier relationship with the 43-firms in this industry. Given the larger size of the former groups, the intra-sector variation in this result is advantageous to the latter (smaller) construction firms.[7]

Yet again, it does appear that the negative and significant association in all three key sectors of the UK construction industry seems to highlight the need for close partnership and collaboration in the industry supply chain. prompt payment of suppliers revolves around a trustworthy relationship between both partners. The result thus supports the need for such a relationship. At another level, one can read some elements of proactive gaming in this result (Chen and Miller, 1994; Smith *et al.*, 1992; Ferrier *et al.*, 1999). Firms in the entire industry must pay their suppliers promptly and this requirement is most severe among building and civil engineering firms. By paying early, these firms demonstrate their fidelity and engender trust in their suppliers.

From the supply side, these results seem to advantage suppliers. These supplier firms in every key sector of this industry face incumbent firms that need to pay them promptly to stay profitable themselves. Thus, they have a bargaining advantage (Fisman and Raturi, 2004; Dass *et al.*, 2015; Fabbri and Klapper, 2016). For once then these sample results favour the smaller and competitively disadvantaged firm.

What stands out in a theoretical sense is that none of the three key sectors of UK construction fit with the general expectation in working capital literature (Deloof, 2003; Wang, 2002 and Lazaridis and Tryfonidis, 2006). Most theory predicts that delaying payments to suppliers will help the firm enhance its profitability. In this UK construction sample, it appears that trust, timing, pricing and discounting issues are what matter between firms and suppliers. Whether in the building sector or the civil engineering and specialist trades sectors, paying for input supplies in cash is the

[7] The univariate statistics in the firm size control i.e. Ln (TOTR) shows this pattern clearly with mean and median in the 41-sector being the highest at 10.33891 and 10.24313 followed by the 42-sector at 10.25192 and 10.13848 and last by the 43-sector at 10.01454 and 9.942443.

performance-enhancing option, a fact underlined in at least some industries by Deloof (2003).

In totality, these TCTOTA sector-based results in the UK construction industry provide strong ratification for the broader narrative of supply chain collaboration and partnership. Here is proof of Morledge and Smith's (2013) and Gruneberg and Francis's (2019) exhortations for better and closely aligned partnerships between firms and suppliers at every stage of the industry value chain. Similarly, Department for Business, Innovation and Skills, (2013). findings about the criticality of cooperation levels and supply chain integration in this industry are fully substantiated. This uniform requirement for firms to pay suppliers promptly across the industry is a positive for the generally smaller (43) firm but also encourages greater efficiencies in its larger customer (41 and 42) firm. Thus, a holistic and beneficial industry-wide performance-enhancing pattern is clearly at work in these results.

7.1.8 Incremental technology and capital investment to total revenues (INCTECHCAPINVTOREV)

Just like the three variables discussed above, the pattern of significance in this variable also shows up only in the buildings (41) and specialist trades (43) sectors. The civil engineering sector (42) as before remains insignificant. In all sectors, the signs of the coefficient are positive with every unit increase in the variable associating with a 2.8%, 13.1% and 30.6% increase in firm PAT in the 41-, 42- and 43-sectors respectively. Investments in tangible and intangible technology assets across time thus have a positive effect on profitability only in the buildings and the specialist trades sectors of the UK construction industry. Such investments surprisingly have no effect in the highly technological civil engineering sector.

The RBV prediction (Dierickx and Cool, 1989; Barney, 1986) that non-tradeable, idiosyncratic and innovative assets acquired incrementally by the firm over years tend to increase its profitability is confirmed both among building (41) and specialist trade (43) firms. Surprisingly it seems that in this sample only the civil engineering firm (42) does not significantly benefit from steady incremental tangible and intangible investments. This is even more puzzling since this 42-firm is the only one in the industry that shows a positive association between PAT and land, property, plant and equipment. The only way to explain this result is based on the rarity, inimitability and non-substitutability argument of the RBV (Rumelt, 1984; Barney, 1991). In a civil engineering sector where almost all firms are investing in technology upgrades continuously, this investment is neither rare nor inimitable nor even non-substitutable.[8] Thus, small wonder that it does not provide a value-based sustainable competitive advantage. PAT of the firm is simply unaffected by such investment.

ISP would possibly point to the value of strategic mobility barriers erected out of a continuous programme of technology investments (Porter, 1985; 1996). Any new challenger firm in the 41- and 43-sectors would find it difficult to mimic the sustained technology upgrades in these sectors where such investment is uncommon. This technological capital expenditure is rarest and creates the greatest value in the specialist trades sector 43. By contrast, such technology investment is the norm among civil engineering firms and so would not unduly concern an entrant who would arguably come well prepared for it. This is one way of explaining the result.

A knowledge-based explanation may also be advanced. Sullivan (2000), Teece (2006) and Balogun and Jenkins (2003) representing the KBV would opine that in at least the 41- and 43-sectors of the UK construction industry a well-crafted and executed programme of technology investments really does produce higher profits. The salutary benefits of well-executed investment regimes create single- and double loop and deuteron learning in building and specialist trade firms (Argyris and Schon, 1978; Mavondo *et al.*, 2005). This is what may be underlying the strongly positive profits of firms.

The VBM would argue that technological leadership and pre-emption of scarce assets gained from a steady and sustained tangible or intangible asset investment schedule is what is reflected in the results (Becerra, 2009; Smith *et al.*, 2001; Chen and Miller, 1994; Lieberman and Montgomery, 1988). Specialist trades and building firms in the industry pre-empt the competition by investing steadily in technology assets. This allows them to outperform the competition and generate superior PAT. Perhaps there is also evidence of a first or second mover advantage. The building and specialist trade firm, by investing tenaciously in technology assets across business cycles, becomes a first- or second mover in the sector. Naturally, profit gains accrue to this firm. By

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[8] Such an argument seems to be reflected in the middling mean value of INCTECHCAPINVESTOREV in 42-sector and its middling kurtosis as well when compared with the other two sectors.

contrast, the ubiquity of technology assets in the civil engineering sector makes for a very different effect in this sector. There is no first or second mover gain, as every firm implements technology upgrading programmes.

To close the discussion, INCTECHCAPINVESTOREV as a first difference investment variable shows some nuanced patterns of positive effects on profits in the UK construction industry. The 43-sector specialist trades firms benefit the most from a systematic technology investment programme followed by their 41-sector building peers while 42-sector civil engineering firms do not show any performance benefit from this. Department for Business, Innovation and Skills, (2013) studies and Ive and Murray (2013) document that generalist contractors constitute the bulk of 41- and 43-firms. It is arguable that for such a generalist contractor, systematic technology investment confers a strategic advantage. It distinguishes the firm from its in sector peers. However, specialist service delivering civil engineering firms are generally technology imbued already and so in this sector, such investments do not yield a performance advantage.

7.1.9 GM

All three sectors of UK construction display a significant and positive association between GMs and profits after tax as anticipated. A unit increase in GM results in a 193.9%, 415% and 1642.7% increase in after tax profits of sector 41, 42- and 43-firms, respectively. The result is entirely intuitive but does have aspects that need theoretical explanation. It is noteworthy how the magnitude of profit effect of GMs is the greatest in the specialist trades 43-sector of the industry.[9] These smaller construction firms seem to benefit the most from an intelligent segmentation of their markets or an intelligent positioning of their products (Day *et al.*, 1979; Dickson and Ginter, 1987). Scholars such as Dixit and Stiglitz (1977), Spence (1976) and Hart (1985) argue that this heightened effect of GMs on profits in the specialist trades sector could reflect the higher levels of product variety and product substitutability in this sector; specialist trades such as carpentry, plumbing, electrics and so on are widely differentiated easily

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[9] Note how the sector 43 coefficient is nearly 4 times that of its sector 42 and nearly 8 times that of its sector 41 equivalents.

available yet monopolistically competitive. Hughes *et al.* (2015)[10] identify more than 200 types of firms in this sector with a wide variety of substitutable services and products. This explains why GMs are so very important for the profits of these firms. Such substitutability and availability of products and services are distinctly lower in both the civil engineering and buildings sector of the industry and that is why GMs have a lower profit effect.

The RBV (Peteraf, 1993), VBM (Becerra, 2009) and ISP (Porter, 1996) would concur that product differentiation strategies yielding higher GMs are most likely to generate the highest profits after tax in the specialist trades (43) sector construction firm. It is in this sector that the firm strongly benefits from a product differentiation strategy based on research and development and product innovation. Such a strategy would help the firm to distinguish its services and products. This product differentiation strategy, despite being important in the civil engineering and the buildings sector, is nowhere near as important as in their 43-sector peers.

One must read this high magnitude of GM-PAT association in the 43-sector as a replicated pattern from the highly similar INCTECHCAPINVESTOREV-PAT result above. Rogers (1995) and Davis (1989) would agree that technology and capital investment that yields innovative product differentiation is instrumental to generating higher profits in this sector.

GM as an MP device is seen to be a strong positive determinant of firm performance across all three key sectors of the UK construction industry, but the 43-sector's strongest positive effect is a salient feature of this result. Perhaps this is why firms in this sector across the two decades exhibit the highest levels of GMs.[11] Perhaps the average firm in this sector is well aware of the profit-enhancing effect of higher GM and therefore strives to maintain higher margins than its peers in the civil engineering or buildings sector.

Among the many narratives of the normative and regulatory discourse in the UK construction industry, there are concerns that price-based competition is extensive

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[10] The smaller size of firms and the fact the density of such firms is greatest in 43-sector implies that trading margins should matter much more to firm performance here and this is exactly what the sample result seems to suggest.

[11] The univariate statistics of GM in the three sectors shows that the 43-sector has the highest mean/median i.e. 19.448%/18.149%.

(Gruneberg and Francis, 2019; Morledge and Smith, 2013; Kabiri *et al.*, 2012), especially among smaller (43-sector) firms. One could argue that this price-based competition is at odds with the higher GM needs of these firms. If lowering the price is essential to winning contracts in the industry, then the winning firm is consigned to lower GMs. This would harm profits as seen in the sample result. There seems to be a need for greater research, both academic and professional, into how UK construction firms in general and smaller 43-firms, in particular, can be made to imbibe product innovation to differentiate their products and avoid price-based competition.

7.1.10 OM

Once again, a standard pattern seen in previous variables is repeated. Only the buildings (41) and the specialist trades (43) sectors display positive and significant associations while the civil engineering sector (42) stays insignificant, albeit positive. A unit increase in the variable increases after tax profits of the 41- and 43-firms by 409.4% and 6167.7%, respectively. This 15-fold increased sensitivity of after tax profits of the UK specialist trades construction firm compared to its building sector peer stands out in this sample. Cost leadership as stressed in the ISP research by Porter (1996), Dess and Davis (1984) and Calori and Ardisson (1988) seems to be a magnified source of after tax profits for this firm (43) when compared to its building contractor peer (41). However, such cost leadership does not seem to matter at all for the profitability of the civil engineering firm (42). Explaining this relative insensitivity of this firm to OMs is difficult. Yet it does make the task of 42-firm managers operationally less difficult; they do not need to find ways to reduce costs. This is a sector where business templates are standardised, technology is intensive and the scope to reduce costs is decidedly lower.

The RBV (Barney, 1991; Rumelt, 1984) would argue that in both the 43 specialist trades and the 41 buildings sector the significant effect of OM on PAT is a direct confirmation of core elements of the theory. Seen is the salutary effect of marshalling rare and valuable resources enabling firms to deliver products to the market at much lower costs while maintaining higher quality and other unique product attributes. In a similar vein, the TCEs paradigm would trace this result to disintermediation effects (Spulber, 2009). The high-profit specialist trade and building firms in this sample can lower their operating costs only because of their effective bundling of resources that allow them to disintermediate other market-based product delivery alternatives to customers. Neither theoretical explanation is at work in the civil engineering 42-sector of the UK construction industry.

In the micro-economist perspectives (Besanko *et al.*, 2017; Penrose, 1995; Roberts, 2004), this positive OM-PAT association in two of three sectors in the industry would be traced to economies of scale, scope and learning. In the 41- and 43-sectors, this research would point to the importance of spreading costs widely across the production function, achieving a much wider range of products on a given asset base and reducing time effort and resource use through experiential learning. These theoretical mechanisms must be at work in these two sectors, distinguishing the high profits firm from its peer. By contrast, for the civil engineering firm lowering operating costs through scale, scope and learning mechanisms is simply unimportant.

This nuanced pattern of OM-PAT associations in the key sectors of the UK construction industry further accentuates the striking difference between the business models of civil engineering 42-sector firms and their building (41) or specialist trades (43) counterparts. Cost economies seem to produce the least significant positive profit effect among the former. This is worrying, especially in the context of a fairly large and growing government publications literature (Cabinet Office, 2015; HM Treasury, 2014; Rhodes, 2018; Prime Minister's Office, 2009) that has been focused on cost benchmarking and cost improvement. This normative and anecdotal literature suggests how important it is for the civil engineering firm to reduce costs and achieve greater value for money in public infrastructure projects. But this intra-sector result clearly shows that this firm lacks a profit incentive to reduce costs or achieve value for money. There is a need for creative policy-based interventions in the 42-sector to catalyse firms to take action to reduce operational costs despite this lack of an OM-PAT direct incentive.

7.1.11 SGATOTA

A completely different pattern of significances intra-sector emerges in this variable. Only specialist trades construction firms (43) display a significant and negative association, while their building or civil engineering peers exhibit insignificant associations. Every unit increase in SG&A expense proportions leads to an 18% decline in profits after tax of the 43-firm. In this intra-sector regression for the building and civil engineering firm, SG&A expenses are not entirely wasteful. Thus, at least in these sectors, one is unable to completely reject the main predictions of MT (Kotler and Armstrong, 2015; Lancaster, 1990; Rosen, 1974). Effective promotion and marketing do not directly reduce the profits of the firms. Similarly, ISP predictions must be modified (Porter, 1996; Beath and Katsoulacos, 1991). No longer can one opine that marketing, branding or customer relationship-based spending are invariably harmful in UK construction. At least in the buildings and civil engineering sectors, there is no direct proof that SG&A reduces PAT. Some amount of marketing initiatives may not be harmful to after tax profits and could yield some intangible performance benefits.

Another interpretation of this intra-sector result should distinguish the instrumentality of horizontal and vertical differentiation strategies that alter the intrinsic characteristics of a product (Holbrook, 1999; Miller, 1992: Kotha and Vadlamani, 1995). Such strategies are highly important only in the 43 specialist trades sector where marketing and branding have a decidedly negative profit effect. In the industry, altering the intrinsic characteristics of the product is not as essential. Marketing and branding could have a salutary influence. Bundling together critical resources to fundamentally shift the production function of the firm and thus reduce transaction costs (Spulber, 2009) seems essential only in the specialist trades construction firm. In the UK construction industry, a building or civil engineering firm might be able to differentiate its MP even by expanding its customer reach through effective marketing and promotion and not be so dependent on intrinsic product development alone.

Kotler and Keller's (2016) conception that SG&A should uncover under-served customer needs and market opportunities and thus increase profits is directly appropriate only to the building and civil engineering firms in this UK sample. In these sectors marketing, sales prospecting, advertising, promotion and trialling of customers are not seen to yield any direct negative consequences. By contrast, SG&A has a deleterious profit effect in the 43-sector. Therefore marketing-based initiatives are best avoided by firms. Kumar (2008) and Morgan's (2012) arguments about the negative consequences of marketing expenses seem directly relevant only to the specialist trades UK construction firm.

SGATOTA-PAT associations display a curious intra-sector pattern in this UK sample. That only the profits of specialist trades construction firms are negatively affected by SG&E expenses may have some links with the commodity nature of the goods and services delivered by these firms. Hughes *et al.* (2015), Morledge and Smith (2013) and Gruneberg and Francis (2019), among other policy commentators, often locate specialised construction activities like carpentry, plumbing and electrics as commodity trades. These services are no more than commodities up for exchange in a market. For these goods and services, it is word-of-mouth referrals rather than marketing or promotion that generates profits. No wonder that this intra-sector regression substantiates this. By contrast, neither the building nor the civil engineering sector is anywhere near as commoditised, and their products and services are more customised. Probably this more than anything else explains the lack of a clear and negative association in these sectors.

7.1.12 RG

The oft-repeated pattern of significances among the three key sectors of UK construction once again emerges in this variable. Only specialist trades firms (43) and building firms (41) display a significant and negative association in that descending order of effect. Every unit increase in RG reduces profits after tax of the 43-firm of 4% and the 41-firm of 1.9%. By contrast, the civil engineering 42-sector firm's profitability is unaffected by its RG. On the surface, it does seem as though the standard life cycle pattern of the inverse relationship between RG and profitability only prevails in the 41- and 43-sectors of the UK construction industry.

Explaining this association from the marketing perspective (Kotler and Keller, 2015; Lancaster, 1990), it does appear that building and specialist trade construction firms in the UK that grow fast display clear signs of higher product development and positioning costs. This is what shows in their reduced after tax profitability. Their slower-growing peers seem to be the ones that have mastered the economies of their business models and thus display higher profits. But in the 42-sector civil engineering sector, RG does not come from higher product development or positioning spending. Here the average firm's RG does not seem to come at the price of its lower profits.

From the structural perspectives of the ISP (Scherer and Ross, 1990; Anderson and Zeithaml, 1984; Porter, 1996; Grant, 2019), it does seem that the building and specialist trades sectors are the only ones in construction where nascent phases of product development are still occurring. Value creation and appropriation among such firms is still fiercely competitive and RG is difficult to come by. By contrast, the civil engineering sector 42 is a more established and mature industry segment. Firms do not face costly product development or positioning interventions to grow revenues.

The TCEs paradigm (Williamson, 1991; Coase, 1937; Spulber, 2009) would point to the higher levels of sub-contracting in the 43- and 41-sectors as one significant factor underlying this intra-sector result.[12] Being part of such an intensively sub-contracted value chain makes RG costly. The 42-firm sub-contracting levels, by contrast, are significantly lower and so RG is less constrained. VBM scholars (Becerra, 2009) would extend these arguments further by suggesting that the volatility in asset specificity and opportunism levels in both these sectors makes RG so difficult.

This intra-sector result is intriguing. The costly nature of RG among builders and specialist trades contractors in UK construction can be linked to the nature of economic contractual models seen in these sectors. The sub-contracting driven model of most firms combined with the intense competition for contracts dependent on price makes RG notoriously difficult. This pattern seems to echo repeated refrains by scholars such as Ive and Murray (2013), Gruneberg and Francis (2019) and Ancell (2007) of an outmoded bidding system for construction projects based entirely on least-cost tendering in these sectors. By contrast, it seems that the civil engineering firm (42) is protected from these inverse growth profit associations due to its more standardised template and general position as a 'contractee' rather than a 'contractor'.

7.2 Relationships between variables and their ISFP effect[13]

Table 18 shows the rich and complex pattern of associations between the determinants and ln(PAT) in each of the three key sectors of UK construction at a glance. At the very outset, it should be noted how sector 42 consisting of civil engineering firms stands apart from its peers. It is the only sector where seven of the 12 determinant variables of firm performance (two positive and five negative) display insignificant coefficients. As repeatedly noted in the earlier discussions, the UK civil engineering firm (42) seems to exhibit a business model that is strategically different from its building (41) or specialist trades (43) counterpart. For this firm, the generally positive effect of technology and

[12] Ive and Murray (2013) and Hughes et al. (2015) locate 41 and parts of the 43-sectors as constituting main contractor firms who generally employ many sub-contractors to fulfill their project obligations.

[13] All significant coefficients are listed in the descending order of magnitude of impact on the dependent variable. Insignificant coefficients are bundled together at the bottom of each list and their magnitudes are omitted but they are grouped based on the signs of their respective associations.

tangible capital investment or OM improvements simply do not matter to its profits after tax. However, even leverage or SG&A expenses which generally depress profits in the industry do not materially alter the profitability of this firm. For this civil engineering firm, it does seem that inventory holdings or customer credit do not reduce profits. Finally, this firm is the only one in the UK construction industry in which RG and profitability are not inversely related.

Table 18: Positive associations in descending order of magnitude

Construction of buildings (41)		**Civil engineering (42)**		**Specialised construction activities (43)**	
Independent Variables	**exp(b)-1**	**Independent Variables**	**exp(b)-1**	**Independent Variables**	**exp(b)-1**
OM	4.094	GM	4.15	OM	61.677
GM	1.939	CASHTOTA	1.702	GM	16.427
CASHTOTA	1.168	NCATOTA	1.568	NCATOTA	1.361
NCATOTA	0.766	LPFETOTA	0.763	CASHTOTA	1.111
INCTECHCAPINVESTOREV	0.028	OM		INCTECHCAPINVESTOREV	0.306
		INCTECHCAPINVESTOREV		LPFETOTA	

Table 19: Negative associations in descending order of magnitude

Construction of buildings (41)		**Civil engineering (42)**		**Specialised construction activities (43)**	
Independent Variables	**exp(b)-1**	**Independent Variables**	**exp(b)-1**	**Independent Variables**	**exp(b)-1**
DBTOTA	-0.474	TCTOTA	-0.433	DBTOTA	-0.487
TCTOTA	-0.473	DBTOTA		TCTOTA	-0.3
TDTOTA	-0.362	INVENTOTA		INVENTOTA	-0.295
INVENTOTA	-0.288	TDTOTA		SGATOTA	-0.18
RG	-0.019	SGATOTA		TDTOTA	-0.167
SGATOTA		RG		RG	-0.04
LPFETOTA					

Yet many other rich variegations need delineation in these intra-sector regression results. Using the concepts of the VBM to parse these results, a keener insight is obtained. For example, only the civil engineering firm's (42) resources management seems to be a monotonic positive function of at least three determinants that for the first time include LPFETOTA. The PPE that such a firm buys has a strong (76.3%) positive effect on its profits after tax, unlike its 41 building or 43 specialist trades counterpart.

While for these latter firms leverage has a negative effect, the civil engineering firm seems immune. Overall, resources management in 41 and 43 display a strikingly similar positive and negative mix of determinants while the sector 43 firm is the only one with just positive determinants and importantly including the property, plant and equipment component.[14] From another angle, working capital and cash show a different priority of positive effect only in the 43 specialist trades sector of the industry. While in the building and civil engineering firm cash levels are the more important influence, it is only in the specialist trades (43) firm that net working capital is the bigger positive influence. Perhaps this is a reflection of how ensuring a positive net working capital is more important than merely holding higher cash levels in this sector.[15]

In terms of CD, the three sectors of UK construction display other insightful nuances. As usual, the civil engineering sector 42 stands out from its peers. The dynamics of competitive bargaining with suppliers, distributors and other supply chain partners seem not to make any difference to the profitability of the construction firm in this sector. Any reduction in the CCC in its operations does not yield this firm any profit advantage. In stark contrast to both the building firm (41) and the specialised trades firm (43), the bargaining inherent in trade creditor, inventory and customer relationships matter significantly to performance. Yet the exact priorities of effects are decidedly different in each of these sectors. While for both types of firms trade creditor levels have the highest negative effect on profits for the building firm (41), it is trade debtors that reduce profits the most whereas for the specialised trades firm (43) it is inventory levels that require the greatest attention. Perhaps one could read into these differences stylised features of the business models of each type of firm. Close and effective supplier relationships in which the firm pays the supplier promptly is invariably the most important prerequisite of firm performance in all three sectors of UK construction. However, the building firm (41) must as a priority insist on faster payments from its customers while its specialist trades counterpart (43) is better off reducing inventory holding periods through effective management of lead times with

[14] Only in this 42-sector LPFETOTA is positive significant and that too when DBTOTA becomes insignificant. Perhaps an inference that the average civil engineering 42-firm in this sample might be utilising its leverage to invest in productive assets that produce a positive after-tax profits impact and mitigate any negative debt influence may not be far wrong.

[15] The predominance of working capital influences over cash levels in the 43-sector of UK construction might also suggest how the specialist trade firms need a much higher positive liquidity gap than just cash levels to improve their profitability after tax.

input suppliers.[16] The only positive coefficient is INCTECHCAPINVESTOREV once again. While the 42-sector displays insignificance, the specialist trades 43-firm shows a much higher positive effect on after tax profits than its 41-building peer. This result seems to suggest how tangible and intangible technology investment is at least ten times more positive in its performance effect on this firm when compared with its building sector counterpart.[17]

Evaluating these intra-sector results using the final concept of MP reveals other complex insights. The ubiquitous importance of profit margins in the UK construction industry across all three sectors is fully evident in these results but what is interesting is how the 42-sector civil engineering sector is the only one where OMs are insignificant in their profit effect. In both the building 41 and specialist trades 43-sectors there is the same near four-fold positive post-tax profit effect of OMs when compared to GMs.[18] In both these sectors, using scale, scope and learning efficiencies to reduce operating costs is the more important strategic lever of firm performance and the firm can achieve much greater performance by focusing its efforts there. Merely achieving a higher trade-based surplus through GMs is a second level priority. In terms of SG&A expenses in which both the building and civil engineering firm display insignificant associations, such promotions are not as harmful in their business models as they are to their specialist trades counterparts. Finally, RG appears to be the least expensive in profit terms in the 42-sector civil engineering sector. For the building firm and the specialist trades firm such growth is quite expensive, the latter much more than the former.

Table 20 presents the results from the four additional sensitivity testing regressions in each key sector of this UK construction industry sample. At the very outset, the results are largely robust with only two changes in the signs of association of LPFETOTA and INVENTOTA both in sector 41, the building firms-sector of the industry. However, even in these only the INVENTOTA sign change is significant in both the GLSRE and the MLE panel-based regressions. Therefore, it must be interpreted. It does seem that at least in this UK sample some building firms (41) increase their profits after tax at

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[16] The variation in magnitudes of these three coefficients is clustered together in the 43-sector whereas it is more widespread in the 41-sector.

[17] The coefficient for the building firm is only 0.028 while that of its specialist trades counterpart is 0.306.

[18] Notice this rather similar four-fold increase in PAT impact in the coefficients in both sector 41 i.e. OM 4.094 versus GM 1.939 and in sector 43 i.e. OM 61.677 versus GM 16.427.

times from holding larger inventories, especially when the strict normality of residual assumptions of OLS classical regressions is relaxed and heteroscedasticity rigorously accounted for in the GLS random effects specifications this positive association becomes apparent among such firms. The positive association in the variable among at least these firms remains so even under the maximum likelihood estimation (MLE) approach that accommodates several different classes of variable distributions, not just the normal one assumed in the OLS. From an economic theory perspective (Banos-Caballero, *et al.*, 2010; Howorth and Westhead, 2003; Blinder and Maccini, 1991) it can be argued that at least in some building firms (41) in UK construction the marginal cost curve of inventory stock-out is significantly more instrumental than the marginal cost curve of inventory holdings. Such firms need to guard against inventory stock-out situations especially in raw material inputs that may not be available at crucial times in their project implementation and delivery schedules. Thus, holding larger than usual inventory levels may be a sensible option at least for some firms in the 41-sector. It might be worth pointing out in this context that many critical narratives in the policy and regulatory literature (Hughes *et al.*, 2015; Gruneberg and Francis, 2019; Morledge and Smith, 2013; BIS: 145, 2013) have often underlined site-based raw material stocking difficulties especially among building firms as a singular bottleneck impeding their performance. The reason why such building firms nevertheless continue overloading sites with inventory can be now traced to their overwhelming fear of missing crucial project deadlines due to unavailability of raw materials or higher priced inputs in the market at the appropriate juncture in their project schedule. The second set of LPFETOTA sign changes are significant only in the pooled OLS where entity and time fixed effects are not accounted for. In that sense, this variable's sign change in the sample is not serious and does not count. The other ten determinants do not change signs across the suite of different regressions. Apart from the sign changes, the orders of effects of the determinants on ISFP are largely similar. A few variables move up or down the orders of magnitude, but this is not materially significant. Endogeneity considerations in these intra-sector results are mixed and remain important (see Appendices 1 and 2). Once again this is hardly surprising given the interlinked and single-source nature of the variable set and the strong likelihood of reverse causality between performance and determinants noted in Chapter 6. Instrumental two-stage regressions performed in the key sectors confirm this but the use of a simple unsophisticated instrument of the control variable Ln (TOTR) is hardly sufficient for such an exercise. Yet given the larger scope of this research, it is inappropriate to investigate this any further.

Table 20: Robustness of the models – Sensitivity Regressions

Independent Variables		Construction of buildings (41)					Civil engineering (42)					Specialised construction activities (43)				
		Pooled OLS	Entity FE	Two-way FE	GLS RE	MLE RE	Pooled OLS	Entity FE	Two-way FE	GLS RE	MLE RE	Pooled OLS	Entity FE	Two-way FE	GLS RE	MLE RE
NCATOTA	Significance	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
	Sign	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
LPFETOTA	Significance	√	X	X	X	X	√	√	√	√	√	√	X	X	X	√
	Sign	+	-	-	-	-	+	+	+	+	+	+	+	+	+	+
CASHTOTA	Significance	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
	Sign	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
DBTOTA	Significance	√	√	√	√	√	√	X	X	√	√	√	√	√	√	√
	Sign	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
INVENTOTA	Significance	√	√	√	X	√	√	X	X	X	√	√	X	√	√	√
	Sign	+	-	-	+	+	-	-	-	-	-	-	-	-	-	-
TDTOTA	Significance	√	√	√	√	√	√	X	X	√	√	√	√	√	√	√
	Sign	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TCTOTA	Significance	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
	Sign	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
INCTECHCAPINVESTOREV	Significance	√	√	√	√	√	X	X	X	X	√	√	√	√	√	√
	Sign	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
GM	Significance	√	√	√	√	√	√	√	√	√	√	√	√	X	√	√
	Sign	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
OM	Significance	√	√	√	√	√	X	X	X	X	√	√	√	√	√	√
	Sign	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
SGATOTA	Significance	√	X	X	√	√	X	X	X	X	√	√	√	√	√	√
	Sign	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RG	Significance	√	X	√	√	√	√	X	X	X	X	√	√	√	√	√
	Sign	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ln (TOTR)	Significance	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
	Sign	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

The *Significance* row shows whether the variable is consistent in its significance across all types of regressions in the table. In this row when the sign is √ it means that the variable is significant in the corresponding regression and when the sign X it means that it is insignificant. The *Sign* row shows whether the effect of the variable on the dependent variable is consistent across all types of regressions in the table. Therefore, the + sign means that the variable has a positive effect on the dependent variable and the – sign means that it has a negative effect

7.3 Summary of discussions and preliminary findings

This chapter analysed the intra-sector regression results in the UK construction industry. Although the same conceptual regression model is applied, the results reveal nuanced insights that show how performance determination differs across the three sectors of the industry. Twelve important findings need to be elaborated and summarised.

First, the buildings sector 41 of the UK construction industry stands apart from its peers in terms of the reduced effect of a positive working capital gap on profits in sector firms. The overall interpretation must be traced to the unique nature of the business model of buildings construction firms. Maintaining a positive working capital gap is not as important in this firm arguably due to its larger and more self-sufficient nature.

Second, a highly intuitive intra-sector result is evidenced in terms of non-current asset influences on firm performance. The civil engineering 42-sector firm displays how important plant machinery equipment and related spending are to its profitability in stark contrast to its building or specialist trades peers. This is an important differentiated element of this sector and fits neatly with intuitive understandings of the nature of civil engineering as also the standardised technology template of the business model. Owning rather than hiring specialised equipment is an important performance enhancer in this sector presumably due to expertise gains in operation, maintenance and development of such assets that grant the civil engineer significant competitive advantages.

Third, heightened cash sensitivity of after tax profits in this UK sample is exhibited once again by the civil engineering 42-sector firm. This firm seems to benefit significantly more from holding cash than its building sector or specialist trades peers. This could have much to do with the operational construct of such a firm and its higher need for cash throughout its operating cycle.

Fourth, long-term debt seems to negatively affect the performance of only building 41 and specialist trades 43-firms. Their civil engineering 42 counterpart once again stands unaffected by leverage. When read with the significant positive after tax profits influence of plant and equipment assets, only in this firm is it evident that the business model of this firm is a complete contrast to its industry peers. Here leverage influence is ambiguous and indications suggest that the civil engineering firm might benefit from taking debt provided the debt funds are used intelligently in improving productive capacity by acquiring specialised equipment.

Fifth, there is evidence in the results of the sample of the asymmetry of inventory level influences on profitability in this industry. Once again for the civil engineering firm, such inventory levels simply do not matter while for its building and specialist trades peer a clear negative effect is seen. Either way, such asymmetry in the profit inventory level relationship among the sectors only adds to likely contestation and dispute in the sector-based and interlinked supply chain of the industry with obvious negative implications for firm performance.

Sixth the difficult question of consumer credit highlights yet another challenge across the sectors of the UK construction industry in this sample. In keeping with the usual pattern in the intra-sector results, 41- and 43-firm performances deteriorate if such firms advance more liberal credit. However, the civil engineering firm's performance as usual is the only one that is insulated from any such negative effect. Thus, the 42-sector firm can still extend liberal credit terms to its customers without suffering a profit reduction. This highlights yet another difference in its business model. From another angle the overall intra-sector pattern in this result is especially difficult for 41- and 43-firms that generally share a buyer-seller B2B relationship in this industry. Any move to reduce trade credit by one would create a win-lose for its customer firm in the other sector.

Seventh, levels of supplier credit are uniformly negative in their effect on firm performance across all three sectors of the UK construction industry and this is a significant departure from all other intra-sector regression results. Building, civil engineering and specialist trade firms all benefit by tightening their own belts and paying suppliers early or in cash. The intra-sector performance picture favours a collaborative partnership-orientated supplier-buyer relationship in the industry's supply chain and this result is a singular quantitative vindication of the many normative arguments in the policy and regulatory discourse.

Eighth, TCIs exercise a positive effect on profits only in the buildings and specialist trades sector of this UK construction sample while as usual in the civil engineering sector there is no evidence of any such effect. Such a result highlights two separate salient features. Systematic capital investment in technology creates a competitive advantage only for 41- and 43-firms.

Intriguingly for their 42-sector counterparts, such investment confers no significant strategic benefit. That technology investment is ubiquitous in this sector disables 42-firms from gaining any extra mileage from such technology and capital investment.

Ninth, the uniformly positive performance effect of gross trading margins across all three sectors of the UK construction industry seen in these regression results underlines the importance of product differentiation strategies whether in building, civil engineering or specialist trade firms, but the highest GM performance effect is in the specialist trades 43-sector. This contrasts with the large drops in magnitudes of positive performance effects in the 42 and 41-sectors. This suggests lower degrees of substitutability and ranges of product varieties in these two sectors when compared to their specialist trades peers. Yet the result also adds fuel to policy-based concerns that the smaller construction firm in the 43-sector is ironically the one with the greatest need to ensure higher GMs.

Tenth, as with many other results, it is for the civil engineering firm that OMs do not matter to profitability. Both the UK buildings firm and its specialist trades counterpart show positive performance effects out of OMs. Thus, it is only the operating template of the 42-firm in this industry that seems not to benefit from improvements in OMs. This confirms quantitatively why policymakers are right to be worried about cost efficiency improvements, especially among civil engineering firms.

Eleventh, an important sample finding is that marketing and promotion expenses reduce profitability only among specialist trades sector firms. There is no evidence of any such direct negative effect in the case of either the building or the civil engineering counterpart. A clear link may be inferred between this unique intra-sectoral pattern of marketing-profit effects and the level and nature of the commoditisation inherent in each sector. Buildings and civil engineering firms in this UK sample show many fewer commodity-like characteristics and this explains why marketing and promotion may still be partially beneficial in these firms. By contrast, the specialist trades firm is highly commoditised and commercial relationships in this sector are based largely on person-to-person communication that does not require marketing or promotion expenditure. This is a novel insight that provides a quantitative basis for intra-sector marketing-based performance differentiation.

Finally, the lack of any effective relationship between RG levels and profitability in the 42-sector civil engineering firms in this UK construction sample is a singular contrast to their 41- and 43-sector counterparts. The latter firms display the standard business lifecycle-based relationship pattern with RG coming only at the expense of profitability. The civil engineering firm's difference might lie in the lower levels of volatility in asset specificities and opportunism in its sector. Although specific technological assets abound the operating template of the civil engineering firm, as pointed out earlier, is more settled. At another level, the sample result validates the repeated criticism of policymakers that building and specialist trade firms need to step out of their comfort zone. They must not allow themselves to be forced into chasing contract revenues by bidding low as this would eventually only reduce their profitability.

Chapter 8. UK Construction Industry Time-Based Regression Analyses

Having analysed the sample in terms of firm performance in the UK construction industry as a whole and its constituent key sectors, this chapter moves to address the third key research objective of the thesis. The intention is to critically analyse how the relationships between the determinants and firm performance have changed over the sample time horizon between 2000 and 2019. As usual, there are two separate regressions. The first divides the entire UK construction industry sample data using 2010 as the structural break. The second differentiates each of the three key sectors using the same year as the structural break. The choice of 2010 as the break is based on economic reasoning. This was the year of the credit crisis and so performance determinant relationships would have changed at this juncture. Although statistical tests of structural breaks in the determinant performance relationships are conducted in the overall sample (shown in Appendix 10), there are no conclusive results. Therefore, the economic basis is preferred.

8.1 Overall UK construction industry pre- and post-credit crisis regressions

Tables 21 and 22 show the same regression model implemented in the two periods, 2000 to 2010 and 2011 to 2019, respectively. At the very outset, it is useful to note how the two-way fixed effects OLS model displays an R-square value above 65% with F ratios above 59 and the total number of observations (N) well above 8,500 in each of the two sub-samples. Both sets of regressions are robust significant and explanatory in their respective sub-samples.

8.1.1 NCATOTA

The direction of significant association between net current asset proportions and profits after tax of the average UK construction firm does not change pre- and post-credit crisis but the magnitude of the positive association does decline by nearly 48.01%. Thus, every unit increase in NCATOTA that used to enhance profits after tax of the UK construction firm by 153.7% before 2010 only enhances it by 79.9% after 2010. This drop in the positive effect of net working capital after the credit crisis seems to suggest a drastic transformation of the business model. Now well-planned AAs as predicted by the VBM and RBV (Becerra, 2009; Barney, 1991; Rumelt, 1984; Besanko *et al.*, 2017) that allow this firm to cover current liabilities

Table 21: Dependent Variable: Ln (PAT), Period: 2000-2010, Overall industry

Independent Variables (Model)	Pooled OLS			FE			Two-way FE			GLS RE			MLE RE		
	b	se	exp(b)-1	b	se	exp(b)-1	b	se	exp(b)-1	b	se	exp(b)-1	b	se	exp(b)-1
NCATOTA	1.029***	(0.096)	1.798	0.893***	(0.131)	1.442	0.931***	(0.132)	1.537	0.978***	(0.096)	1.659	0.984***	(0.064)	1.675
LPFETOTA	-0.025	(0.146)	-0.025	0.047	(0.142)	0.048	0.109	(0.144)	0.115	0.040	(0.124)	0.041	0.036	(0.088)	0.037
CASHTOTA	0.378**	(0.120)	0.459	0.696***	(0.113)	1.006	0.776***	(0.114)	1.173	0.497***	(0.096)	0.644	0.486***	(0.082)	0.626
DBTOTA	-0.768***	(0.142)	-0.536	-0.685***	(0.187)	-0.496	-0.683***	(0.191)	-0.495	-0.707***	(0.137)	-0.507	-0.713***	(0.093)	-0.51
INVENTOTA	0.085	(0.088)	0.089	-0.344*	(0.156)	-0.291	-0.369*	(0.154)	-0.309	-0.028	(0.090)	-0.028	-0.016	(0.070)	-0.016
TDTOTA	-0.629***	(0.102)	-0.467	-0.438***	(0.101)	-0.355	-0.324**	(0.104)	-0.277	-0.543***	(0.084)	-0.419	-0.548***	(0.069)	-0.422
TCTOTA	-1.350***	(0.117)	-0.741	-0.768***	(0.138)	-0.536	-0.806***	(0.139)	-0.553	-1.137***	(0.108)	-0.679	-1.154***	(0.084)	-0.685
INCTECHCAPINVESTOREV	0.076***	(0.021)	0.079	0.047*	(0.018)	0.048	0.048**	(0.018)	0.049	0.070***	(0.020)	0.073	0.071***	(0.005)	0.074
GM	1.331***	(0.162)	2.785	0.905***	(0.213)	1.472	0.863***	(0.210)	1.37	1.151***	(0.165)	2.161	1.167***	(0.087)	2.212
OM	1.795***	(0.424)	5.019	1.638***	(0.431)	4.145	1.621***	(0.423)	4.058	1.818***	(0.406)	5.16	1.822***	(0.080)	5.184
SGATOTA	-0.129**	(0.040)	-0.121	-0.246***	(0.057)	-0.218	-0.264***	(0.057)	-0.232	-0.208***	(0.038)	-0.188	-0.203***	(0.030)	-0.184
RG	-0.032**	(0.011)	-0.031	-0.046***	(0.009)	-0.045	-0.041***	(0.009)	-0.04	-0.038***	(0.009)	-0.037	-0.038***	(0.008)	-0.037
Ln (TOTR)	0.922***	(0.016)	1.514	0.763***	(0.034)	1.145	0.776***	(0.045)	1.173	0.873***	(0.019)	1.394	0.878***	(0.011)	1.406
Constant	-2.785***	(0.215)	-0.938	-1.135**	(0.393)	-0.679	-1.322**	(0.469)	-0.733	-2.325***	(0.238)	-0.902	-2.375***	(0.121)	-0.907
Time FE	NO			NO			YES			NO					
Observations	8550.000			8550.000			8550.000			8550.000			8550.000		
N Groups				2063.000			2063.000			2063.000			2063.000		
In R-squared				0.294			0.305			0.291					
Between R-squared				0.716			0.717			0.728					
Overall R-squared	0.696			0.681			0.682			0.695					
Chi-sq.										5148.305			5006.086		
Log likelihood	-12186.460			-8619.660			-8556.096						-11313.984		
Null log likelihood	-17283.235			-10109.762			-10109.762						-13817.027		
F	575.009			85.993			59.268								

Notes: All the regressions in the table are with robust standard errors (VCE Cluster). The regressions are defined as follows: Pooled Ordinary Least Square (pooled OLS); Entity fixed effects (Entity FE); Two-way fixed effects (Two-way FE); Generalised Least Square Random Effects (GLS RE); and Maximum Likelihood Estimation Random Effects (MLE RE). The interpretation of the model is based on the two-way fixed effects regression presented in column 3 of the above table. The b column is presenting the coefficients of the variables and the star signs next to the variables (*, **, ***) indicate the significance at 5, 1, and 0.1 per cent levels, respectively. The exp(b)-1 column presents the exponential coefficient values to explain the effect on the profit after tax rather than the effect on the Ln (profit after tax).

Table 22: Dependent Variable: Ln (PAT), Period: 2011-2019, Overall industry

Independent Variables (Model)	Pooled OLS			FE			Two-way FE			GLS RE			MLE RE		
	b	se	exp(b)-1	b	se	exp(b)-1	b	se	exp(b)-1	b	se	exp(b)-1	b	se	exp(b)-1
NCATOTA	1.084***	(0.084)	1.956	0.653***	(0.125)	0.921	0.587***	(0.119)	0.799	0.943***	(0.091)	1.568	0.949***	(0.051)	1.583
LPFETOTA	0.848***	(0.117)	1.335	-0.394*	(0.162)	-0.326	-0.261	(0.154)	-0.23	0.392**	(0.125)	0.48	0.412***	(0.086)	0.51
CASHTOTA	0.476***	(0.096)	0.61	0.955***	(0.118)	1.599	0.913***	(0.112)	1.492	0.718***	(0.086)	1.05	0.710***	(0.068)	1.034
DBTOTA	-0.727***	(0.119)	-0.517	-0.725***	(0.186)	-0.516	-0.609***	(0.176)	-0.456	-0.801***	(0.124)	-0.551	-0.800***	(0.074)	-0.551
INVENTOTA	0.187*	(0.082)	0.206	-0.274*	(0.135)	-0.24	-0.317*	(0.128)	-0.272	0.129	(0.076)	0.138	0.133*	(0.062)	0.142
TDTOTA	-0.334**	(0.102)	-0.284	-0.261*	(0.105)	-0.23	-0.195*	(0.097)	-0.177	-0.319***	(0.085)	-0.273	-0.320***	(0.059)	-0.274
TCTOTA	-0.818***	(0.107)	-0.559	-0.871***	(0.138)	-0.581	-0.751***	(0.130)	-0.528	-0.904***	(0.097)	-0.595	-0.903***	(0.071)	-0.595
INCTECHCAPINVESTOREV	0.017	(0.021)	0.017	0.090**	(0.028)	0.094	0.070**	(0.025)	0.073	0.048*	(0.022)	0.049	0.047***	(0.004)	0.048
GM	1.976***	(0.177)	6.214	1.882***	(0.299)	5.567	1.642***	(0.271)	4.165	1.978***	(0.220)	6.228	1.981***	(0.076)	6.25
OM	2.718***	(0.436)	14.15	2.194***	(0.401)	7.971	2.107***	(0.375)	7.224	2.307***	(0.413)	9.044	2.316***	(0.065)	9.135
SGATOTA	-0.224***	(0.055)	-0.201	-0.209**	(0.078)	-0.189	-0.137	(0.074)	-0.128	-0.232***	(0.053)	-0.207	-0.232***	(0.030)	-0.207
RG	-0.061***	(0.009)	-0.059	-0.025***	(0.007)	-0.025	-0.036***	(0.007)	-0.035	-0.037***	(0.007)	-0.036	-0.038***	(0.006)	-0.037
Ln (TOTR)	0.970***	(0.015)	1.638	1.053***	(0.035)	1.866	0.831***	(0.046)	1.296	0.988***	(0.020)	1.686	0.986***	(0.011)	1.68
Constant	-3.662***	(0.210)	-0.974	-4.367***	(0.398)	-0.987	-2.295***	(0.487)	-0.899	-3.810***	(0.245)	-0.978	-3.797***	(0.122)	-0.978
Time FE	NO			NO			YES			NO					
Observations	12551.000			12551.000			12551.000			12551.000			12551.000		
N Groups				2975.000			2975.000			2975.000			2975.000		
In R-squared				0.434			0.459			0.426					
Between R-squared				0.658			0.659			0.701					
Overall R-squared	0.684			0.647			0.651			0.678					
Chi-sq.										6358.841			9033.663		
Log likelihood	-17402.808			-11709.214			-11430.122						-15884.860		
Null log likelihood	-24634.215			-15285.161			-15285.161						-20401.692		
F	754.154			153.996			162.685								

Notes: All the regressions in the table are with robust standard errors (VCE Cluster). The regressions are defined as follows: Pooled Ordinary Least Square (pooled OLS); Entity fixed effects (Entity FE); Two-way fixed effects (Two-way FE); Generalised Least Square Random Effects (GLS RE); and Maximum Likelihood Estimation Random Effects (MLE RE). The interpretation of the model is based on the two-way fixed effects regression presented in column 3 of the above table. The b column is presenting the coefficients of the variables and the star signs next to the variables (*, **, ***) indicate the significance at 5, 1, and 0.1 per cent levels, respectively. The exp(b)-1 column presents the exponential coefficient values to explain the effect on the profit after tax rather than the effect on the Ln (profit after tax).

easily do not have as strong a positive profit effect as before. If anything, the profit buttressing effects of higher levels of liquidity in the firm seem to have declined across the business cycle in this industry (Deloof, 2003; Goddard *et al.*, 2005; Fagiolo and Luzzi, 2006). Nevertheless, such a development may reflect some positives. That the UK construction firm does not have to depend so much on a positive working capital gap might reflect an improving environment of supply chain integration collaboration and partnership in the industry (Morledge and Smith, 2013; Hughes *et al.*, 2015). This is what a host of normative policy narratives have been stressing for some time.

8.1.2 LPFETOTA

There is no change in LPFE associations pre- and post-crisis. Rather counter-intuitively, non-current asset proportions (LPFE) remain insignificant in their profit effect even after the economic decline. One would have expected that firms would have re-evaluated their business models after the credit crisis. This should have led to a positive association between LPFE and PAT as managers invested in sophisticated machinery and equipment to stem the decline in the firm's strategic position, but this does not seem to have happened. The lack of significance in this variable across two very different periods seems to corroborate why under-capitalisation remains rife in the industry, something underlined by scholars like Ive and Murray (2013).

8.1.3 CASHTOTA

In stark contrast to NCATOTA, but rather more intuitively, cash levels of the UK construction firm seem to have become more important for profits since the credit crisis. Every unit increase in CASHTOTA which used to increase profits after tax of the firm by 117.3% before 2010 now increase them by 149.2%, a 27.19% increase. As expected, the credit crisis seems to have increased the cash sensitivity of the business model of the UK construction firm just as in other industries firms have been forced to hold more cash on their balance sheet and this has helped them to stave off operational and liquidity glitches and thus generate higher profits.

The glue-like characteristics of cash as stressed by the TCE (Spulber, 2009) seems to have become a central characteristic of the intermediating ability of the UK firm especially after this period of economic distress. Similarly, calibrating cash levels to the requirements of each stage of production in the value chain as stressed in the industry structure research (Stabell and Fjeldstadt, 1998) now seems to be an even more important prerequisite for profits in the industry. It does seem as though the credit crisis has proved particularly burdensome for the UK construction industry with its fragmented supply chain. It lacks effective access to alternative means of trade-based financing (Department for Business, Innovation and Skills, 2013; HM Government, 2013). Consequently, an extended period of credit scarcity from 2008 to 2010 has hit this industry particularly hard. Top profit earners in the industry have hoarded more cash than usual to safeguard against running out of it. This is what is showing up in the heightened cash sensitivity in the post-crisis regression.

8.1.4 Total long-term debt to total assets (DBTOTA)

Surprisingly, and rather counter-intuitively, debt levels on the balance sheet of the UK construction firm after the credit crisis exhibit a somewhat lower level of negative association with after tax profits than before. Every unit increase in DBTOTA results in a 45.6% decline in after tax profits when compared to the earlier 49.5% decline. One would have expected that the negative effect of debt on firm performance should have increased after the credit crisis but this does not seem to have happened in this sample. Instead, after the credit crisis, it seems more likely that the construction firm stands a better chance of deriving operational synergies or lowering transaction costs (Spulber, 2009) or even acquiring the greater bargaining power of larger asset and resource structures due to leverage than it did before (Becerra, 2009; Porter, 1996).

The result validates normative narratives that caution against leverage in the UK construction industry (Ive and Murray, 2013; Gruneberg and Francis, 2019). The reduced profit penalty for leverage after the crisis seen will only impel more firms in the industry to take on debt. This is not salutary in an industry where revenues are volatile and firms can face bankruptcy in a very short time. Regulators may be well-advised to monitor debt levels even more closely now than before.

8.1.5 INVENTOTA

Inventory proportions have a slightly reduced negative effect on PAT of the average firm in the UK construction industry after the credit crisis than they had before. Every unit increase in INVENTOTA reduced PAT by 27.2% after the crisis when compared to the 30.9% reduction before it. It appears that the bargaining power of the construction firm to drive a tighter inventory scheduling position vis-à-vis its supply chain partners is somewhat less effective in enhancing its profits now than it used to be before the crisis (Porter, 1996; Geroski *et al.*, 1990). The ambiguities of property rights in the UK construction industry seem to have been slightly reduced by this period of economic distress. Consequently, legal restructurings to facilitate this lower need for better bargaining and tighter inventory scheduling (Barney, 1991; Grant, 2005) seem to have become widespread throughout the industry after the crisis.

From an economic theory perspective, the result can also be interpreted in marginal cost terms (Banos-Caballero, *et al.*, 2010; Howorth and Westhead, 2003; Blinder and Maccini, 1991). After the credit crisis, the marginal cost curve of inventory shortage has become slightly more important than the marginal cost curve of inventory holding in the UK construction industry. Perhaps this period of economic uncertainty led to increasing inventory lead times. Firms have thus begun to distrust their raw materials suppliers and to hoard inputs. Such a development must be viewed with some alarm as this would only clutter the project site even more and reduce operational efficiency, a fact repeatedly stressed in the policy and normative literature (Hughes *et al.*, 2015; Morledge and Smith, 2013).

8.1.6 TDTOTA

The negative effect of consumer credit on after tax profits of the UK construction firm in this sample is reduced by more than 36% due to the credit crisis. Every unit increase in TDTOTA reduces after tax profits of the firm by only 17.7% when compared to the 27.7% decline before the crisis. One can infer that business conditions in the industry have changed drastically due to the credit crisis. No longer can firms in the industry be as secure in the belief that they will not lose custom due to tightening credit terms (Kirzner, 1997; Barney, 1986; Shane and Venkataraman, 2000). The extended period of trading uncertainty in the credit crisis seems to have blunted the bargaining capacities of the UK firm vis-à-vis its customers (Porter, 1985; Besanko *et al.*, 2017).

The reduced negative effect of carrying trade debt on the balance sheet may also reflect a heightened dynamic of competition in the UK construction market since the crisis. This period of economic distress may have caused several economic problems for the clients of this industry. They are now displaying clear signs of post-crisis evaluation and reconsideration. It appears that these customers now demand greater flexibility in payment. This is reflected in the reduced sensitivity to consumer credit seen in the post-crisis period. Now there is some partial evidence of the veracity of Cunat's (2007) argument that optimal levels of consumer credit might alleviate some of the negatives of economic storms. Yet, surprisingly, even after such a severe period of credit uncertainty, Barrot (2016) and Murfin and Njoroge's (2015) prediction of reduced liquidity and increased credit costs do not seem to have materialised among UK construction firms.

From an industry perspective, this can be construed as a welcome development. That consumer credit levels are not as strongly negative in their effect on after tax profits as they were before the crisis might work to the advantage of smaller clients. These firms would otherwise struggle to make the faster payments demanded by construction firms. This result suggests a salutary reduction in the adversarial and unproductive relationships in the industry (Ive and Murray, 2013; Gruneberg and Francis, 2019).

8.1.7 TCTOTA

There is hardly any change in the negative association in this variable after the credit crisis. Every unit increase in TCTOTA decreases profits after tax of the UK construction firm by 52.8% compared to 55.5% before 2010. This is a very small (5.4%) decline in the magnitude of the association. Thus, the credit crisis does not seem to have altered the rather counterintuitive CD of the UK construction industry. The firms in this industry still seem to lose profits by demanding more credit from their suppliers.

The inbound logistics of raw materials in the industry (Porter, 1996; Miller and Friesen, 1986) still seem to require incumbents to pay suppliers faster. Tighter operational efficiency, even at the expense of earlier cash outflow, still seems to improve profits. Thus, effective partnering and collaboration between the firm and its many suppliers predicated on a quick payment cycle still seems to be the dominant theme (Chen and Miller, 1994; Smith *et al.*, 1992; Ferrier *et al.*, 1999). Overall, despite the economic upheaval of the credit crisis, there is still evidence that normative voices urging partnering and collaboration among value chain partners in the UK construction industry remain valid (Gruneberg and Francis, 2019; Morledge and Smith, 2013).

8.1.8 Incremental technology and capital investment to total revenues (INCTECHCAPINVTOREV)

There is a 48.97% increase in the magnitude of the positive association in this variable post-2010. Every unit increase in the variable increases profits after tax of the UK construction firm by 7.3% when compared with the 4.9% increase before 2010. The CD in the industry have acquired a distinct technology and capital investment orientation post this economic storm.

This higher sensitivity of profits to incremental investments in tangible and intangible assets seems to fortify predictions of both the RBV (Dierickx and Cool, 1989; Barney, 1986) and the ISP (Porter, 1985; 1996). The credit crisis seems to have magnified the need for UK construction firms to invest steadily in a portfolio of innovative idiosyncratic assets that guarantee them a superior competitive position in the industry. Knowledge-based tangible and intangible asset investments made by the firm are now more than ever the catalyst for learning and innovation in this industry according to Sullivan (2000), Teece (2006) and Balogun and Jenkins (2003). The wiser among UK construction firms are seen in these results to be reaping the benefits of their wise and systematically scheduled technological investments.

There is some evidence in these pre- and post-crash regression results of the growing importance of pre-emption of scarce technologically sophisticated asset structures in the UK construction industry, especially after the credit crisis. VBM scholars such as Lieberman and Montgomery (1988), Smith *et al.* (2001), Chen and Miller (1994) and Becerra (2009) underline this fact even in normal times but what is significant in this sample is that a near doubling of the positive effect of such investments is evident in the post-2010 period. UK construction firm business models have been in ferment since the credit crisis. Firms have had to differentiate themselves and technology and capital investment has become the main channel for this. No wonder that INCTECHCAPINVESTOREV shows such a magnified positive effect on profits in this post-crisis period.

8.1.9 GM

A near quadrupling of the magnitude of the positive association between GMs and profits after tax of the UK construction firm is seen post-2010. Every unit increase in GM now results in a 416.5% increase in after tax profits of the firm when compared to the 137% increase seen in the pre-2010 period. The trading margin seems to have become four times as potent; a determinant of firm performance in this industry after the credit crisis.

MT arguments about the need for effective segmentation, product differentiation and correct targeting of the customer base (Day *et al.*, 1979; Dickson and Ginter, 1987; Kotler and Armstrong, 2013) seem to have been amplified, especially after the crisis. This is hardly surprising. In the turmoil in the markets from 2008 to 2010, market churn would have led to a rapid rise in product variants as predicted by Dixit and Stiglitz (1977), Spence (1976) and Hart (1985). This would have required construction firms to actively reposition themselves in this market. The higher potency of GM-PAT associations in the post-crisis period seen flag this.

Product differentiation as stressed by the ISP (Porter, 1996) has become many times more important as a performance determinant for the UK construction firm in the post-crisis period. In the changed business environment after the crisis, how well this firm adds features and attributes to its products and services has become critical. This is what helps it extract higher GMs and, in these results, these margins have a magnified positive effect on profits. Similarly, the voices of Petaraf (1993) and Becerra (2009) from the RBV and VBM literature would echo that technological innovation and associated product differentiation have become more important after the crisis.

The credit crisis period seems to have accentuated the margin dependence of the average UK construction firm. Now more than ever a firm's profits are dependent on its trading margins. This has created more fragility in the business model of this firm and has strengthened concerns about this in the policy-related normative research in the industry (Gruneberg and Francis, 2019; Hughes *et al.*, 2015: Kabiri *et al.*, 2012).

8.1.10 OM

This variable also shows a near doubling of the magnitude of its positive association with PAT of the UK construction firm post-2010. Every unit increase in OMs increases the PAT of the firm by 722.4% in the post-2010 period when compared to the 405.8% before the crisis. It seems that the extended period of economic distress has amplified the operating cost-related efficiency considerations in the business models of UK construction firms. Now more than ever in this industry the ISP arguments of cost leadership being invaluable to performance appear central (Dess and Davis, 1984;

Calori and Ardisson, 1988). Acquiring rare and inimitable resources that allow the firm to maintain lower costs while delivering an expanded set of product attributes with higher quality is now an important prerequisite for the construction firm in this sample (Barney, 1991; Rumelt, 1984). The intermediating advantage of an effective bundle of resources that allow the UK firm to lower its transaction costs and deliver a product to its customer at a compelling value seems to be the cornerstone of its performance, especially after the credit crisis.

Similarly, there seems to be an increased need to extract economies of scale, scope and learning in the business model of the construction firms in this sample. Besanko *et al.* (2017), Penrose (1995) and Roberts (2004) would commend these results as reflective of the stressed nature of cost dynamics induced by the fairly long period of economic decline. It would be expected that the need to drive greater volumes on a given asset base, expand product ranges through intelligent use of existing product facilities and create greater cost efficiencies through an effective operational learning protocol would have been amplified by this economic disaster. The results thus corroborate all the predictions from the VBM based conceptual framework.

8.1.11 SGATOTA

Since the crisis, the marketing and promotional expenses of the UK construction firm have been significantly less harmful to its profitability. Every unit increase in SG&E expenses now reduces profit after tax of the firm by only 12.8% as compared to the much larger 23.2% pre-2011. This nearly halved negative profitability effect is an indication to industry firms that their marketing efforts are less futile than before.

Marketing theorists such as Kotler and Armstrong (2015), Lancaster (1990) and Rosen (1974) would point to this result as a vindication of their core theory. Spending on marketing or promoting services and products effectively since the credit crisis is far less harmful than it was before. Kotler and Keller (2016) would probably add that the period of severe economic decline has increased the need for discovering under-served customers through effective marketing research or pushing products and services through trials and promotions in this market. No longer can marketing and branding expenditures be considered as entirely without merit in this industry.

8.1.12 RG

A slight decline is apparent in the RG profit negative association in the post-crisis period. A unit increase in RG now only reduces PAT by 3.5% when compared to the 4.1% reduction in the period to 2010. The reduced profit penalty of RG in the UK construction industry after the crisis has at least one positive implication. Not only can the profit-based outperformer firms now grow their revenues at a slightly faster pace, but their newer peers may not suffer as much in profit terms because they are in the revenue-chasing period of their economic lives.

The narrowing of PAT differences between high growth construction firms and their low growth peers in this UK sample can be interpreted in two other ways. Kotler and Keller's (2016) and Lancaster's (1990) arguments that RG is costly in profit terms are seen to have been dampened by the crisis. Newer firms are now either able to extract segmentation, targeting and differentiation benefits by intelligent spending that is far lower than before, or the market for the industry itself has changed structurally to make this easier for them. This latter argument corroborates ISP tenets (Scherer and Ross, 1990; Anderson and Zeithaml, 1984; Porter, 1996; Grant, 2019). It also suggests that a fundamental shift has occurred in the industry in the degree of volatility in asset specificity and opportunism, an argument that Williamson (1991), Coase (1937) and Spulber (2009) might concur with. From another angle, stable high-profit UK construction firms after the crisis can grow revenues far more easily because clients are willing to pay more for quality assurance given their less-than-satisfactory experience during the crisis.

The inverse RG profitability relationship among UK construction firms seems to have become much less pronounced since the credit crisis. Questions remain as to whether this could be taken as a sign that excessive price-based competition and over-reliance on lowest-price-based tendering procedures in this industry are now declining.

8.2 Intra-sector – two-period regressions

Tables 23 to 28 present model regression results in each of the three sectors in two time-divided samples: from 2000 to 2010 and from 2011 to 2019. The intention is to analyse how the ISFP determination -hanged in the industry through the credit crisis.

Table 23: Dependent variable: Ln (PAT), period: 2000-2010, sector: construction of buildings. SIC code 41

Independent Variables (Model)	Pooled OLS			FE			Two-way FE			GLS RE			MLE RE		
	b	se	exp(b)-1	b	se	exp(b)-1	b	se	exp(b)-1	b	se	exp(b)-1	b	se	exp(b)-1
NCATOTA	1.071***	(0.139)	1.918	0.805***	(0.200)	1.237	0.806***	(0.197)	1.239	0.976***	(0.150)	1.654	0.991***	(0.096)	1.694
LPFETOTA	0.046	(0.210)	0.047	-0.086	(0.183)	-0.082	-0.127	(0.181)	-0.119	0.049	(0.171)	0.05	0.053	(0.123)	0.054
CASHTOTA	0.418*	(0.191)	0.519	0.656***	(0.161)	0.927	0.719***	(0.159)	1.052	0.458**	(0.143)	0.581	0.447***	(0.127)	0.564
DBTOTA	-0.877***	(0.221)	-0.584	-0.507*	(0.249)	-0.398	-0.445	(0.252)	-0.359	-0.714***	(0.205)	-0.51	-0.738***	(0.134)	-0.522
INVENTOTA	0.321**	(0.121)	0.379	-0.124	(0.207)	-0.117	-0.171	(0.203)	-0.157	0.148	(0.123)	0.16	0.166	(0.094)	0.181
TDTOTA	-0.571**	(0.173)	-0.435	-0.483**	(0.162)	-0.383	-0.329*	(0.163)	-0.28	-0.628***	(0.139)	-0.466	-0.630***	(0.119)	-0.467
TCTOTA	-1.433***	(0.175)	-0.761	-0.866***	(0.197)	-0.579	-0.931***	(0.196)	-0.606	-1.249***	(0.158)	-0.713	-1.268***	(0.127)	-0.719
INCTECHCAPINVESTOREV	0.076***	(0.020)	0.079	0.030	(0.015)	0.03	0.029	(0.015)	0.029	0.060***	(0.018)	0.062	0.063***	(0.006)	0.065
GM	1.324***	(0.244)	2.758	0.847**	(0.284)	1.333	0.793**	(0.275)	1.21	1.122***	(0.237)	2.071	1.143***	(0.126)	2.136
OM	1.482***	(0.448)	3.402	1.149**	(0.432)	2.155	1.117**	(0.416)	2.056	1.396**	(0.435)	3.039	1.414***	(0.104)	3.112
SGATOTA	-0.144	(0.077)	-0.134	-0.203	(0.109)	-0.184	-0.232*	(0.113)	-0.207	-0.218**	(0.069)	-0.196	-0.213***	(0.053)	-0.192
RG	-0.027	(0.017)	-0.027	-0.048***	(0.013)	-0.047	-0.042**	(0.013)	-0.041	-0.037**	(0.013)	-0.036	-0.036**	(0.013)	-0.035
Ln (TOTR)	0.921***	(0.022)	1.512	0.694***	(0.049)	1.002	0.696***	(0.059)	1.006	0.841***	(0.028)	1.319	0.851***	(0.017)	1.342
Constant	-2.830***	(0.308)	-0.941	-0.274	(0.553)	-0.24	-0.399	(0.621)	-0.329	-1.954***	(0.354)	-0.858	-2.065***	(0.183)	-0.873
Time FE	NO			NO			YES			NO					
Observations	3958.000			3958.000			3958.000			3958.000			3958.000		
N Groups				954.000			954.000			954.000			954.000		
In R-squared				0.271			0.291			0.266					
Between R-squared				0.713			0.710			0.729					
Overall R-squared	0.709			0.691			0.690			0.708					
Chi-sq.										2293.125			2176.494		
Log likelihood	-5867.846			-4090.831			-4035.376						-5442.763		
Null log likelihood	-8313.240			-4715.139			-4715.139						-6531.010		
F	344.760			32.527			26.678								

Notes: All the regressions in the table are with robust standard errors (VCE Cluster). The regressions are defined as follows: Pooled Ordinary Least Square (pooled OLS); Entity fixed effects (Entity FE); Two-way fixed effects (Two-way FE); Generalised Least Square Random Effects (GLS RE); and Maximum Likelihood Estimation Random Effects (MLE RE). The interpretation of the model is based on the two-way fixed effects regression presented in column 3 of the above table. The b column is presenting the coefficients of the variables and the star signs next to the variables (*, **, ***) indicate the significance at 5, 1, and 0.1 per cent levels, respectively. The exp(b)-1 column presents the exponential coefficient values to explain the effect on the profit after tax rather than the effect on the Ln (profit after tax).

Table 24: Dependent variable: Ln (PAT), period: 2000-2010, sector: civil engineering. SIC code 42

Independent Variables (Model)	Pooled OLS			FE			Two-way FE			GLS RE			MLE RE		
	b	se	exp(b)-1	b	se	exp(b)-1	b	se	exp(b)-1	b	se	exp(b)-1	b	se	exp(b)-1
NCATOTA	1.281***	(0.280)	2.6	1.003*	(0.389)	1.726	1.064*	(0.419)	1.898	1.136***	(0.265)	2.114	1.142***	(0.198)	2.133
LPFETOTA	0.240	(0.377)	0.271	0.520	(0.336)	0.682	0.740*	(0.355)	1.096	0.250	(0.334)	0.284	0.245	(0.253)	0.278
CASHTOTA	0.274	(0.278)	0.315	0.584	(0.312)	0.793	0.616	(0.317)	0.852	0.386	(0.249)	0.471	0.376	(0.236)	0.456
DBTOTA	-0.959*	(0.473)	-0.617	-0.148	(0.551)	-0.138	-0.316	(0.556)	-0.271	-0.904*	(0.394)	-0.595	-0.908**	(0.301)	-0.597
INVENTOTA	-0.654*	(0.280)	-0.48	-0.826	(0.470)	-0.562	-0.819	(0.475)	-0.559	-0.674*	(0.325)	-0.49	-0.673*	(0.281)	-0.49
TDTOTA	-0.579**	(0.216)	-0.44	-0.312	(0.229)	-0.268	-0.191	(0.231)	-0.174	-0.456*	(0.208)	-0.366	-0.463**	(0.176)	-0.371
TCTOTA	-1.145***	(0.277)	-0.682	-0.862*	(0.360)	-0.578	-0.914*	(0.365)	-0.599	-1.064***	(0.261)	-0.655	-1.072***	(0.238)	-0.658
INCTECHCAPINVESTOREV	0.117	(0.108)	0.124	0.136*	(0.060)	0.146	0.133*	(0.057)	0.142	0.058	(0.077)	0.06	0.060*	(0.026)	0.062
GM	0.962**	(0.333)	1.617	1.618	(0.900)	4.043	1.718*	(0.830)	4.573	0.937*	(0.477)	1.552	0.927**	(0.311)	1.527
OM	1.529	(1.388)	3.614	3.202	(2.074)	23.582	3.224	(2.037)	24.128	2.304	(1.527)	9.014	2.273***	(0.285)	8.708
SGATOTA	-0.113	(0.099)	-0.107	-0.163	(0.167)	-0.15	-0.164	(0.165)	-0.151	-0.215	(0.115)	-0.193	-0.212*	(0.083)	-0.191
RG	-0.012	(0.029)	-0.012	0.018	(0.029)	0.018	0.018	(0.031)	0.018	0.005	(0.026)	0.005	0.004	(0.024)	0.004
Ln (TOTR)	0.890***	(0.045)	1.435	0.798***	(0.097)	1.221	0.790***	(0.118)	1.203	0.860***	(0.057)	1.363	0.861***	(0.034)	1.366
Constant	-2.536***	(0.523)	-0.921	-2.085	(1.121)	-0.876	-2.123	(1.258)	-0.88	-2.335***	(0.661)	-0.903	-2.343***	(0.357)	-0.904
Time FE	NO			NO			YES			NO					
Observations	1002.000			1002.000			1002.000			1002.000			1002.000		
N Groups				236.000			236.000			236.000			236.000		
In R-squared				0.300			0.313			0.286					
Between R-squared				0.555			0.563			0.685					
Overall R-squared	0.608			0.526			0.533			0.600					
Chi-sq										660.803			537.806		
Log likelihood	-1380.434			-1008.067			-999.223						-1301.918		
Null log likelihood	-1850.205			-1186.949			-1186.949						-1570.821		
F	55.186			16.041			11.923								

Notes: All the regressions in the table are with robust standard errors (VCE Cluster). The regressions are defined as follows: Pooled Ordinary Least Square (pooled OLS); Entity fixed effects (Entity FE); Two-way fixed effects (Two-way FE); Generalised Least Square Random Effects (GLS RE); and Maximum Likelihood Estimation Random Effects (MLE RE). The interpretation of the model is based on the two-way fixed effects regression presented in column 3 of the above table. The b column is presenting the coefficients of the variables and the star signs next to the variables (*, **, ***) indicate the significance at 5, 1, and 0.1 per cent levels, respectively. The exp(b)-1 column presents the exponential coefficient values to explain the effect on the profit after tax rather than the effect on the Ln (profit after tax).

Table 25: Dependent variable: Ln (PAT), period: 2000-2010, sector: specialised construction activities. SIC code 43

Independent Variables (Model)	Pooled OLS			FE			Two-way FE			GLS RE			MLE RE		
	b	se	exp(b)-1	b	se	exp(b)-1	b	se	exp(b)-1	b	se	exp(b)-1	b	se	exp(b)-1
NCATOTA	0.765***	(0.097)	1.149	0.832***	(0.187)	1.298	0.928***	(0.195)	1.529	0.749***	(0.104)	1.115	0.749***	(0.094)	1.115
LPFETOTA	-0.112	(0.230)	-0.106	0.015	(0.258)	0.015	0.279	(0.258)	0.322	-0.092	(0.181)	-0.088	-0.088	(0.170)	-0.084
CASHTOTA	0.430**	(0.140)	0.537	0.755***	(0.196)	1.128	0.812***	(0.205)	1.252	0.544***	(0.141)	0.723	0.553***	(0.116)	0.738
DBTOTA	-1.005***	(0.227)	-0.634	-0.702*	(0.325)	-0.504	-0.770*	(0.336)	-0.537	-0.711**	(0.224)	-0.509	-0.700***	(0.162)	-0.503
INVENTOTA	-0.195	(0.169)	-0.177	-0.245	(0.269)	-0.217	-0.309	(0.261)	-0.266	-0.220	(0.166)	-0.197	-0.220	(0.145)	-0.197
TDTOTA	-0.350**	(0.131)	-0.295	-0.356*	(0.151)	-0.3	-0.259	(0.157)	-0.228	-0.298*	(0.117)	-0.258	-0.297**	(0.093)	-0.257
TCTOTA	-0.554**	(0.177)	-0.425	-0.313	(0.239)	-0.269	-0.328	(0.243)	-0.28	-0.464**	(0.176)	-0.371	-0.460***	(0.122)	-0.369
INCTECHCAPINVESTOREV	0.534***	(0.072)	0.706	0.358***	(0.081)	0.43	0.371***	(0.082)	0.449	0.468***	(0.076)	0.597	0.463***	(0.021)	0.589
GM	1.606***	(0.236)	3.983	1.796***	(0.409)	5.025	1.839***	(0.430)	5.29	1.804***	(0.255)	5.074	1.813***	(0.147)	5.129
OM	6.086***	(0.870)	438.659	4.640***	(1.098)	102.544	4.702***	(1.100)	109.167	5.494***	(0.940)	242.228	5.457***	(0.209)	233.393
SGATOTA	-0.066	(0.049)	-0.064	-0.190**	(0.071)	-0.173	-0.211**	(0.072)	-0.19	-0.110*	(0.048)	-0.104	-0.113**	(0.038)	-0.107
RG	-0.031*	(0.013)	-0.031	-0.046***	(0.014)	-0.045	-0.033*	(0.014)	-0.032	-0.035**	(0.012)	-0.034	-0.036**	(0.012)	-0.035
Ln (TOTR)	0.981***	(0.021)	1.667	0.947***	(0.049)	1.578	1.025***	(0.068)	1.787	0.981***	(0.023)	1.667	0.981***	(0.017)	1.667
Constant	-3.970***	(0.283)	-0.981	-3.620***	(0.574)	-0.973	-4.360***	(0.723)	-0.987	-4.025***	(0.309)	-0.982	-4.023***	(0.194)	-0.982
Time FE	NO			NO			YES			NO					
Observations	2983.000			2983.000			2983.000			2983.000			2983.000		
N Groups				729.000			729.000			729.000			729.000		
In R-squared				0.388			0.397			0.383					
Between R-squared				0.760			0.759			0.777					
Overall R-squared	0.706			0.694			0.694			0.704					
Chi-sq										3235.130			2215.976		
Log likelihood	-3648.043			-2705.783			-2684.838						-3474.807		
Null log likelihood	-5475.893			-3439.142			-3439.142						-4582.795		
F	266.650			57.155			35.922								

Notes: All the regressions in the table are with robust standard errors (VCE Cluster). The regressions are defined as follows: Pooled Ordinary Least Square (pooled OLS); Entity fixed effects (Entity FE); Two-way fixed effects (Two-way FE); Generalised Least Square Random Effects (GLS RE); and Maximum Likelihood Estimation Random Effects (MLE RE). The interpretation of the model is based on the two-way fixed effects regression presented in column 3 of the above table. The b column is presenting the coefficients of the variables and the star signs next to the variables (*, **, ***) indicate the significance at 5, 1, and 0.1 per cent levels, respectively. The exp(b)-1 column presents the exponential coefficient values to explain the effect on the profit after tax rather than the effect on the Ln (profit after tax).

Table 26: Dependent variable: Ln (PAT), period: 2011-2019, sector: construction of buildings. SIC code 41

Independent Variables (Model)	Pooled OLS			FE			Two-way FE			GLS RE			MLE RE		
	b	se	exp(b)-1	b	se	exp(b)-1	b	se	exp(b)-1	b	se	exp(b)-1	b	se	exp(b)-1
NCATOTA	0.907***	(0.104)	1.477	0.589***	(0.154)	0.802	0.518***	(0.150)	0.679	0.803***	(0.108)	1.232	0.808***	(0.073)	1.243
LPFETOTA	0.690**	(0.210)	0.994	-0.676*	(0.266)	-0.491	-0.428	(0.245)	-0.348	0.013	(0.216)	0.013	0.037	(0.154)	0.038
CASHTOTA	0.477**	(0.148)	0.611	0.910***	(0.181)	1.484	0.834***	(0.173)	1.303	0.654***	(0.134)	0.923	0.647***	(0.103)	0.91
DBTOTA	-0.852***	(0.153)	-0.573	-0.794***	(0.208)	-0.548	-0.666***	(0.200)	-0.486	-0.876***	(0.142)	-0.584	-0.877***	(0.097)	-0.584
INVENTOTA	0.452***	(0.111)	0.571	-0.214	(0.161)	-0.193	-0.298	(0.153)	-0.258	0.293**	(0.099)	0.34	0.300***	(0.079)	0.35
TDTOTA	-0.234	(0.150)	-0.209	-0.277	(0.163)	-0.242	-0.244	(0.154)	-0.217	-0.401**	(0.133)	-0.33	-0.398***	(0.096)	-0.328
TCTOTA	-1.048***	(0.146)	-0.649	-0.597**	(0.199)	-0.45	-0.491**	(0.187)	-0.388	-0.972***	(0.138)	-0.622	-0.978***	(0.109)	-0.624
INCTECHCAPINVESTOREV	0.003	(0.014)	0.003	0.022	(0.015)	0.022	0.011	(0.014)	0.011	0.019	(0.013)	0.019	0.019***	(0.006)	0.019
GM	1.930***	(0.234)	5.89	1.416***	(0.338)	3.121	1.176***	(0.304)	2.241	1.707***	(0.281)	4.512	1.715***	(0.101)	4.557
OM	2.785***	(0.344)	15.2	2.260***	(0.428)	8.583	2.116***	(0.404)	7.298	2.488***	(0.382)	11.037	2.495***	(0.085)	11.122
SGATOTA	-0.366***	(0.096)	-0.306	-0.197	(0.118)	-0.179	-0.106	(0.111)	-0.101	-0.325***	(0.087)	-0.277	-0.328***	(0.053)	-0.28
RG	-0.046***	(0.014)	-0.045	-0.007	(0.011)	-0.007	-0.020	(0.011)	-0.02	-0.024*	(0.010)	-0.024	-0.024*	(0.010)	-0.024
Ln (TOTR)	0.965***	(0.017)	1.625	1.031***	(0.045)	1.804	0.827***	(0.059)	1.286	0.990***	(0.025)	1.691	0.989***	(0.015)	1.689
Constant	-3.637***	(0.249)	-0.974	-4.118***	(0.510)	-0.984	-2.131***	(0.631)	-0.881	-3.803***	(0.315)	-0.978	-3.791***	(0.171)	-0.977
Time FE	NO			NO			YES			NO					
Observations	5738.000			5738.000			5738.000			5738.000			5738.000		
N Groups				1418.000			1418.000			1418.000			1418.000		
In R-squared				0.445			0.468			0.434					
Between R-squared				0.669			0.673			0.728					
Overall R-squared	0.718			0.669			0.669			0.713					
Chi-sq										3767.160			4366.265		
Log likelihood	-8382.405			-5590.662			-5470.750						-7624.505		
Null log likelihood	-12016.018			-7279.916			-7279.916						-9807.637		
F	508.422			81.356			82.852								

Notes: All the regressions in the table are with robust standard errors (VCE Cluster). The regressions are defined as follows: Pooled Ordinary Least Square (pooled OLS); Entity fixed effects (Entity FE); Two-way fixed effects (Two-way FE); Generalised Least Square Random Effects (GLS RE); and Maximum Likelihood Estimation Random Effects (MLE RE). The interpretation of the model is based on the two-way fixed effects regression presented in column 3 of the above table. The b column is presenting the coefficients of the variables and the star signs next to the variables (*, **, ***) indicate the significance at 5, 1, and 0.1 per cent levels, respectively. The exp(b)-1 column presents the exponential coefficient values to explain the effect on the profit after tax rather than the effect on the Ln (profit after tax).

Table 27: Dependent variable: Ln (PAT), period: 2011-2019, sector: civil engineering. SIC code 42

Independent Variables (Model)	Pooled OLS			FE			Two-way FE			GLS RE			MLE RE		
	b	se	exp(b)-1	b	se	exp(b)-1	b	se	exp(b)-1	b	se	exp(b)-1	b	se	exp(b)-1
NCATOTA	1.527***	(0.277)	3.604	0.630*	(0.309)	0.878	0.494	(0.305)	0.639	1.171***	(0.233)	2.225	1.176***	(0.159)	2.241
LPFETOTA	0.689*	(0.318)	0.992	-0.390	(0.367)	-0.323	-0.275	(0.333)	-0.24	0.233	(0.305)	0.262	0.240	(0.205)	0.271
CASHTOTA	0.353	(0.255)	0.423	1.270***	(0.345)	2.561	1.126***	(0.315)	2.083	0.982***	(0.218)	1.67	0.976***	(0.185)	1.654
DBTOTA	-1.079***	(0.284)	-0.66	0.283	(0.623)	0.327	0.420	(0.537)	0.522	-0.832*	(0.357)	-0.565	-0.838**	(0.263)	-0.567
INVENTOTA	-0.357	(0.358)	-0.3	-0.439	(0.422)	-0.355	-0.185	(0.383)	-0.169	-0.311	(0.350)	-0.267	-0.311	(0.315)	-0.267
TDTOTA	-0.797**	(0.286)	-0.549	-0.130	(0.264)	-0.122	-0.028	(0.261)	-0.028	-0.316	(0.224)	-0.271	-0.321*	(0.163)	-0.275
TCTOTA	-0.105	(0.311)	-0.1	-0.823	(0.434)	-0.561	-0.708	(0.404)	-0.507	-0.485	(0.306)	-0.384	-0.482*	(0.192)	-0.382
INCTECHCAPINVESTOREV	0.211*	(0.101)	0.235	0.443**	(0.160)	0.557	0.441**	(0.144)	0.554	0.302**	(0.093)	0.353	0.301***	(0.026)	0.351
GM	1.785***	(0.390)	4.96	1.747***	(0.435)	4.737	1.345***	(0.403)	2.838	1.735***	(0.355)	4.669	1.736***	(0.271)	4.675
OM	2.469**	(0.888)	10.811	4.312*	(1.828)	73.59	4.828**	(1.639)	123.961	2.971***	(0.892)	18.511	2.961***	(0.302)	18.317
SGATOTA	-0.060	(0.104)	-0.058	0.160	(0.102)	0.174	0.164	(0.096)	0.178	0.008	(0.103)	0.008	0.007	(0.074)	0.007
RG	-0.073**	(0.025)	-0.07	-0.018	(0.017)	-0.018	-0.032	(0.017)	-0.031	-0.040*	(0.017)	-0.039	-0.041*	(0.017)	-0.04
Ln (TOTR)	0.967***	(0.035)	1.63	1.117***	(0.075)	2.056	0.781***	(0.101)	1.184	1.020***	(0.047)	1.773	1.019***	(0.033)	1.77
Constant	-3.582***	(0.507)	-0.972	-5.489***	(0.912)	-0.996	-2.340*	(1.111)	-0.904	-4.375***	(0.630)	-0.987	-4.361***	(0.388)	-0.987
Time FE	NO			NO			YES			NO					
Observations	1536.000			1536.000			1536.000			1536.000			1536.000		
N Groups				341.000			341.000			341.000			341.000		
In R-squared				0.491			0.525			0.478					
Between R-squared				0.541			0.468			0.605					
Overall R-squared	0.597			0.525			0.482			0.582					
Chi-sq										925.122			1077.438		
Log likelihood	-1995.040			-1261.189			-1209.078						-1787.951		
Null log likelihood	-2692.477			-1780.137			-1780.137						-2326.670		
F	81.325			38.716			31.515								

Notes: All the regressions in the table are with robust standard errors (VCE Cluster). The regressions are defined as follows: Pooled Ordinary Least Square (pooled OLS); Entity fixed effects (Entity FE); Two-way fixed effects (Two-way FE); Generalised Least Square Random Effects (GLS RE); and Maximum Likelihood Estimation Random Effects (MLE RE). The interpretation of the model is based on the two-way fixed effects regression presented in column 3 of the above table. The b column is presenting the coefficients of the variables and the star signs next to the variables (*, **, ***) indicate the significance at 5, 1, and 0.1 per cent levels, respectively. The exp(b)-1 column presents the exponential coefficient values to explain the effect on the profit after tax rather than the effect on the Ln (profit after tax).

Table 28: Dependent variable: Ln (PAT), period: 2011-2019, sector: specialised construction activities. SIC code 43

Independent Variables (Model)	Pooled OLS			FE			Two-way FE			GLS RE			MLE RE		
	b	se	exp(b)-1	b	se	exp(b)-1	b	se	exp(b)-1	b	se	exp(b)-1	b	se	exp(b)-1
NCATOTA	1.164***	(0.144)	2.203	0.910***	(0.252)	1.484	0.840***	(0.249)	1.316	1.088***	(0.169)	1.968	1.085***	(0.086)	1.959
LPFETOTA	0.435*	(0.219)	0.545	-0.003	(0.321)	-0.003	-0.011	(0.296)	-0.011	0.330	(0.225)	0.391	0.325*	(0.131)	0.384
CASHTOTA	0.393**	(0.137)	0.481	0.739***	(0.208)	1.094	0.731***	(0.198)	1.077	0.605***	(0.139)	0.831	0.611***	(0.105)	0.842
DBTOTA	-0.477	(0.352)	-0.379	-0.591	(0.648)	-0.446	-0.528	(0.615)	-0.41	-0.571	(0.418)	-0.435	-0.575***	(0.167)	-0.437
INVENTOTA	-0.428*	(0.170)	-0.348	-0.356	(0.295)	-0.3	-0.259	(0.288)	-0.228	-0.421*	(0.170)	-0.344	-0.419**	(0.148)	-0.342
TDTOTA	-0.444**	(0.145)	-0.359	-0.177	(0.167)	-0.162	-0.131	(0.154)	-0.123	-0.367**	(0.126)	-0.307	-0.363***	(0.087)	-0.304
TCTOTA	-0.193	(0.152)	-0.176	-0.682**	(0.210)	-0.494	-0.619**	(0.203)	-0.462	-0.315*	(0.146)	-0.27	-0.321**	(0.108)	-0.275
INCTECHCAPINVESTOREV	0.276	(0.150)	0.318	0.245*	(0.099)	0.278	0.214*	(0.096)	0.239	0.253*	(0.122)	0.288	0.252***	(0.012)	0.287
GM	2.332***	(0.510)	9.299	4.937***	(0.658)	138.352	4.645***	(0.582)	103.063	3.379***	(0.519)	28.341	3.412***	(0.162)	29.326
OM	4.924**	(1.527)	136.552	3.510**	(1.209)	32.448	3.501**	(1.175)	32.149	4.154**	(1.379)	62.688	4.132***	(0.165)	61.302
SGATOTA	-0.204*	(0.086)	-0.185	-0.172	(0.141)	-0.158	-0.108	(0.137)	-0.102	-0.235**	(0.090)	-0.209	-0.236***	(0.042)	-0.21
RG	-0.067***	(0.013)	-0.065	-0.038**	(0.012)	-0.037	-0.044***	(0.012)	-0.043	-0.052***	(0.012)	-0.051	-0.052***	(0.010)	-0.051
Ln (TOTR)	1.027***	(0.024)	1.793	1.185***	(0.051)	2.271	0.947***	(0.070)	1.578	1.066***	(0.029)	1.904	1.068***	(0.019)	1.91
Constant	-4.482***	(0.292)	-0.989	-6.509***	(0.581)	-0.999	-4.320***	(0.725)	-0.987	-5.046***	(0.335)	-0.994	-5.071***	(0.221)	-0.994
Time FE	NO			NO			YES			NO					
Observations	4483.000			4483.000			4483.000			4483.000			4483.000		
N Groups				1028.000			1028.000			1028.000			1028.000		
In R-squared				0.487			0.508			0.476					
Between R-squared				0.637			0.631			0.678					
Overall R-squared	0.641			0.607			0.612			0.634					
Chi-sq										2451.663			3428.848		
Log likelihood	-5482.678			-3859.647			-3764.692						-5144.933		
Null log likelihood	-7777.531			-5354.780			-5354.780						-6859.357		
F	214.561			95.912			81.485								

Notes: All the regressions in the table are with robust standard errors (VCE Cluster). The regressions are defined as follows: Pooled Ordinary Least Square (pooled OLS); Entity fixed effects (Entity FE); Two-way fixed effects (Two-way FE); Generalised Least Square Random Effects (GLS RE); and Maximum Likelihood Estimation Random Effects (MLE RE). The interpretation of the model is based on the two-way fixed effects regression presented in column 3 of the above table. The b column is presenting the coefficients of the variables and the star signs next to the variables (*, **, ***) indicate the significance at 5, 1, and 0.1 per cent levels, respectively. The exp(b)-1 column presents the exponential coefficient values to explain the effect on the profit after tax rather than the effect on the Ln (profit after tax).

8.2.1 NCATOTA

While all three sectors of UK construction display significant positive coefficients across the structural break just as in the overall industry results above, there is an interesting difference. NCATOTA nearly halves in its effect on PAT in 41- and 42-sectors (67.9% from 123.9% and 63.9% from 189.8%) but in the 43-sector the magnitude of the association drops by less than 15% (131.6% from 152.9%) after the credit crisis. Thus positive working capital has a much reduced effect on PAT only among building and civil engineering firms. A structural change in the business model of these firms cannot be ruled out.

Barney (1991), Becerra (2009) and Grant's (2019) arguments would suggest that firms in these two sectors can now afford to take a long-term strategic perspective while marshalling resources for operations. The period of economic decline between 2009 and 2011 seems to have reduced working capital intensity in the business models of these sectors. This is a drastic change. The civil engineering 42-sector in the intra-sector results in the previous chapter displayed the highest sensitivity to this variable. Similarly, building firms also drastically changed their profit sensitivities to NCA from pre-crisis to post-crisis. These firms displayed the lowest sensitivities in the full sample earlier. By contrast, the profitability of the specialist trades firm remains unaffected by the credit crisis. This firm remains critically dependent on ensuring a positive working capital gap.

Interpreted differently, building and civil engineering firms have become less liquidity-orientated after this period of economic distress. Liquid assets and their coverage of short-term liabilities do not seem to matter as much to these firms now. They may slant AAs more judiciously towards long-term strategic performance objectives (Deloof, 2003). Goddard *et al.*'s (2005) and Fagiolo and Luzzi's (2006) arguments seem less appropriate for these firms. The economic distress of the crisis has made the firm's holding of working capital in these sectors less effective as a profit-enhancing device. The specialist trades construction firm is the only one in the industry that still retains its former liquidity-orientated profit imperatives.

Working capital sensitivities in the three different sectors of the UK construction industry are drastically different since the crisis. Policy and normative voices like those of Ive and Murray (2013), Morledge and Smith (2013) and Gruneberg and Francis

(2019) resonate. After the crisis, 43-firms remain liquidity-orientated while their 41 and 42 peers can make do with less coverage of current liabilities. Collaborative and partnering approaches among the three sectors seem to be even more essential now. B2B relationships among the sectors need greater intra-sector firm coordination than before.

8.2.2 LPFETOTA

Of the three sectors of UK construction, only the civil engineering firms before the credit crisis display a positive and significant association with this variable. After the crisis, counter-intuitively all three sectors display insignificant associations. Yet such insignificance in these sectors of the industry after the crisis seems to align well with earlier results. This is what the lack of significance seen across the full sample earlier would suggest.

Yet, the switch from significance to insignificance of the 42-firm needs some elaboration. It does seem that a structural change has occurred in the business model of civil engineers since the economic storm. Even specialist plant equipment and related long-term assets that used to generate division of labour and economies of scale, scope and learning benefits before the crisis no longer seem to do so (Becerra, 2009; Lieberman *et al.*, 2017). No longer does owning rather than hiring assets provide even this technologically-orientated construction firm with any value-appropriating advantage in the changed business conditions.

Communication, coordination and learning benefits that used to emanate from the ownership of tangible equipment-based assets in this civil engineering sector no longer do. Kogut and Zander (1996) would therefore most likely agree that the fundamental features of the civil engineering firm in the sample have changed due to the economic distress during the two years of decline between 2009 and 2010. Now managers in this firm need not be as concerned about the ‘buy or make’ decision as they were before. Perhaps the market space of specialist equipment leasing firms that supply civil engineering firms has become more cost-competitive making the hiring of equipment that much more convenient and cheaper.

The results highlight credit crisis-based changes in LPFE sensitivities in sector 42 of UK construction. The steep contraction in economic output during the credit crisis seems to have fundamentally altered only these civil engineering firms’ RM. Now, just like their 41- and 43-sector peers, their profits are no longer affected by LPFE decisions. Yet such a result poses difficult questions for policy and firm practice in this civil engineering sector. It is a technology-laced business that would gain experiential wisdom from owning non-current technologically sophisticated assets. So, if a civil engineering firm has lost the performance incentive to own specialist equipment and learn and improve the delivery of projects due to such ownership, this is not necessarily a positive development. Further investigation is vital to understand how exactly the performance dynamics of the civil engineering firm have changed due to the credit crisis and why. Such investigations would also reveal how policies and practices in the industry can be changed to redress the likely negative effects of such performance dynamics.

8.2.3 CASHTOTA

A nuanced intra-sector pattern is once again seen in the pre- and post-crash regression results. A positive association is on display both before and after the crisis for sectors 41 and 43 in this variable[19] but surprisingly, in the case of the civil engineering sector, an insignificant association in the pre-2010 period turns positive and significant after the crisis. Even more intriguingly, the jump in the magnitude of the coefficient in the sector is enormous. A unit increase in cash proportions in the sector now increases PAT by 208.3%, almost 78% higher than even the closest peer sector, sector 41. Thus, the cash sensitivity of the civil engineer's business model seems to have been steeply accentuated by the credit crisis.

The result is proof that the glue-like qualities of higher cash levels help civil engineers to cope with long-duration projects where they have to wait longer for cash to arrive from clients (Spulber, 2009). The credit scarcity experienced during the crisis seems to have further destabilised the links and processes in the value chain of this firm. This requires it to hold higher levels of cash or face severe profit penalties, an explanation that ISP scholars like Stabell and Fjeldstadt (1998) would endorse. The intricate, interlinked production stages in a civil engineer's project have become ever more

[19] The magnitude of the coefficient increases in the case of the 41-sector firm but decreases in its 43 peer. This seems to align with the overall increase in the potency of the cash impact on PAT in the full industry already documented in the previous time regression results.

vulnerable to price changes as a consequence of the crisis and the firm now needs higher levels of cash buffers to ride out these stages without disruption.

A fundamental shift in the production function of this sector is unmistakable in this time-divided intra-sector result. The need to exploit production and investment opportunities as and when they arise by maintaining a high enough cash buffer seems now to be an essential prerequisite among civil engineers. It appears that those firms that are unable to maintain these buffers face a heightened risk of agency-based conflicts or marginal costs, arguments often advanced by macroeconomists such as Keynes (1936) and Jensen (1986).

In all, cash sensitivity of profits seems to show the greatest variation in the 42-sector of the UK construction industry. While cash sensitivity has increased even among building firms and remained positive amongst specialist trades counterparts, this period of economic contraction seems to have fundamentally altered business cash dependency only in this civil engineering sector. Since 2011, the civil engineering firm has become highly cash sensitive as a business which it decidedly was not before.

8.2.4 Total long-term debt to total assets (DBTOTA)

A curious pattern of intra-sector associations is revealed in this variable. Only sector 42 firms show an insignificant association that remains unchanged through the credit crisis. Leverage associations with PAT change from insignificant to significant for the building firm but from significant to insignificant for the specialist trades. Any significant association among the three sectors is invariably negative. Surprisingly, it seems that after the crisis only the building firm displays a significant negative 48.6% leverage effect on its profits. The credit crisis seems to have made the business model of the specialist trades firms insensitive to leverage while its civil engineering counterpart remains insensitive before and continues to be so after.

Leverage and its negative influence on the profitability of the UK building firm after the crisis seem to underline that such a firm is better off financing through equity, especially in the changed credit environment after the crisis. Becerra (2009) of the VBM school would maintain such a recommendation for this sector. However, it appears that such a recommendation has no meaning for either the civil engineer or specialist trades firm in the industry. Leverage neither has a discernible negative nor a positive performance effect for this type of firm. Scholars of the TCE like Spulber

(2009) would point to this result as proof that 42- and 43-firms are leverage-neutral in this industry. Such firms might gain operational synergies or reduce transaction costs by choosing a resource bundle financed through debt. After the crisis, only the buildings firm is firmly required to eschew debt altogether.

This result also seems to suggest that scale-based vertical integration benefits or bargaining advantages simply do not accrue to the building sector construction firm after the crisis (Porter, 1996; Stabell and Fjeldstadt, 1998). A fundamental change wrought in its sector by the credit crisis seems to have made equity financing the sole channel for firms. Those firms in the sector that still raise external debt do so in desperation to meet contingent expenditures rather than planned asset-based acquisitions. This naturally affects their performance. By contrast, in the same industry in the 42- and 43-sectors there is no clear evidence of whether vertical integration through debt financing is positive or negative for profits.

Leverage has an undefined influence on profits in large parts of the UK construction industry comprising the 42- and 43-sectors after the credit crisis. It is only in the 41-sector that firms are better off avoiding debt. The economic contraction of the crisis has significantly changed the leverage profit relationship in this sector towards the negative side.

8.2.5 INVENTOTA

Inventory levels of the firm in each of the three sectors of the UK construction industry show insignificant associations with profits both before and after the crisis. Inventory levels do not seem to matter at all to profits anywhere in the industry. The policy and normative literature are right to be concerned about project site efficiencies in the industry and the role of inventory management across its supply chain (Hughes *et al.*, 2015; Morledge and Smith, 2013). There is simply no clarity in these results whether a firm should or should not hold higher levels of inventory. Managers must rely on their individual experiences to decide. Yet it is a known fact in the UK construction literature that project site inventory practices are rudimentary and lack the sophistication of peer industries. The absence of a data-based normative for managers is thus an issue to be flagged for future policy analysis.

8.2.6 TDTOTA

The building sector 41 firm is the only one that displays a negative and significant association with PAT before the credit crisis period. After the period of economic stress, however, this firm also seems to lose its sensitivity to debtor levels displaying an insignificant association. However, the other UK construction sectors do not change their insignificant association that remains before and after the crisis.

Levels of customer credit that used to harm sector 41 firms' after tax profits no longer do. Since the crisis, these building firms can now alter the credit advanced to their customers more flexibly. They do not need to enforce faster payment terms. They now join the mainstream industry in peer sectors 42 and 43 in this regard. Thus, after the crisis, being able to bargain down customer credit levels does not seem to matter to profitability in any sector of the industry (Porter, 1985; Besanko *et al.*, 2017).

The dynamics of competition in the supply and distribution chains of the 41-firm have changed due to the credit crisis. The keenness of the trade-off between advancing credit and retaining custom or insisting on faster payment and losing potential custom is oft-cited by RBV and ISP scholars (Kirzner, 1997; Barney, 1986; Shane and Venkataraman, 2000) but has been severely blunted in this sector. Since the crisis, managers in all three sectors of the industry have been left to their own devices in this respect. Trial and error is now the only way they can decide whether they should grant customers credit or not.

This lack of clear direction in the intra-sector results after the crisis does have some positive performance connotations. For now, in all three sectors of the industry Sartoris and Hill's (1983), Kulp's (2002) and Cachon and Fisher's (2000) theoretical arguments may not be entirely rejected. Extending credit to at least financially constrained customers might sustain turnover in difficult times and improve profits. Similarly, one cannot completely reject the suggestions of asymmetric information theory in any sector (Lee and Stowe, 1993; Long *et al.*, 1993). Credit advanced by the firm might still enable buyers and sellers to resolve the information asymmetry between them and thus help conclude deals in all sectors of the industry.

Since the crisis, the three sectors of the industry are now on an even keel. Choosing to extend consumer credit does not necessarily increase inventory costs or credit expenses as predicted by Barrot (2016) and Murfin and Njoroge (2015) in any part of the industry. Finally, that there is no direct negative performance effect of consumer credit levels in any sector of the industry might be interpreted to be a sign that advancing credit now somewhat ameliorates the economic harms caused by the crisis (Cunat, 2007).

All sectors in the industry now face an uncertain future. Clients everywhere in the industry are re-evaluating the value they derive from the firm. This may mean that credit line decisions are no longer straightforward. Whether it be the 41-sector buildings or the 42-sector civil engineering or even the 43-sector specialist trades, the challenge of advancing credit and retaining custom or reducing credit and losing it is not straightforward. Each manager has to make a considered judgement based on the peculiarities of the firm's internal and external conditions.

8.2.7 TCTOTA

The building firm coefficient in this variable is the only one that remains significant both in the pre- and post-crisis samples, displaying a negative association with PAT. By contrast, the SIC 42-firm's significant negative coefficient before the crisis turns insignificant after the crisis while its SIC 43 counterpart displays the exact opposite pattern. This is a curious result, especially in the 42- and 43-sectors. The economic storm in 2010 seems to have heightened the need for specialist trades construction firms to reduce their use of trade credit from their suppliers while this need has become redundant for their civil engineering peers. For the buildings firm, while this need remained relevant through the crisis and after, there has been a near 36% drop (from -0.606 pre-crisis to -0.388 post-crisis) in the magnitude of the coefficient after 2011 suggesting that this firm suffers significantly less now due to availing of such credit than it did before. Another important aspect that stands out from the intra-sectoral angle is that after the crisis it is now the specialist trades firm that displays the highest negative sensitivity (-46.2%) to trade credit levels in the industry.

The intra-sectoral results in the previous chapter are now enriched with important caveats. Strategic cash preservation in the operating cash cycle of firms (Porter, 1996; Miller and Friesen, 1986) has become insignificant in the 42-sector while reducing in importance in the 41-sector after the crisis. However, such preservation has become more important in the specialist trades 43-sector. Insisting on delayed supplier payments to help preserve cash on the balance sheets could now prove disastrous to the profits of these firms. Such a significant shift among the sectors and especially this important larger negative effect of supplier credit to smaller firm performances needs interpretation. The smallest 43-firm in the industry with potentially the most fragile of balance sheets may still have to pay its own suppliers in cash to maintain profits. This is especially ironic when considering that the crisis would have deteriorated the balance sheet of this firm the most.

Using game theory and strategic alliances literature (Chen and Miller, 1994; Smith *et al.*, 1992; Ferrier *et al.*, 1999) to decode the result yields other narratives. The firm with the likely lowest ability to sustain low cash levels – the 43 specialist trades firm – is the one that needs to proactively pay suppliers early to maintain profits. For its building peer, such proactive supplier payments have a much reduced yet positive profit effect. However, it is only for the 42-firm that such a proactive stance has no discernible effect. This game theory intra-sector result flags the likelihood of unequal cash flow burdens in the industry. Larger 41-firms often use smaller 43-specialist trade firms as their suppliers. For the former, there is less profit incentive to pay promptly while these 43 suppliers have a greater profit incentive to pay their own suppliers. There is thus a clear negative cash flow burden on this smaller 43-firm that is not salutary to the overall industry's evolution and development.

At the same time, this intra-sector result does underline how supplier bargaining advantages have changed after the crisis (Fisman and Raturi, 2004; Dass *et al.*, 2015; Fabbri and Klapper, 2016). Suppliers to the 43- and 41-sectors can now drive the hardest bargains because the firms have a clear incentive to pay them quickly. Delaying supplier payments reduces their profits and is not in their interests. Therefore, what is burdensome for larger incumbent firms in these two sectors now and at least has a salutary benefit for smaller value chain partners who are their suppliers.

8.2.8 Incremental technology and capital investment to total revenues (INCTECHCAPINVTOREV)

Another curious twist can be seen. The association in this variable remains significant pre- and post-crisis only in sectors 42 and 43 while staying insignificant in the building firms 41-sector when it had been significant in full sample earlier across both periods. What is noteworthy is that the civil engineering coefficient that was insignificant in intra-sector regression results in Chapter 7 now jumps in value four times from 0.142

pre-crisis to 0.554 post-crisis, while its specialist trades peer reduces by nearly half from 0.449 pre-crisis to 0.239 post-crisis. It does seem as though the industry sectors have changed radically in terms of their profit sensitivities to incremental investments in tangible and intangible assets. The building firm seems to have always been insensitive to incremental asset investment while the civil engineering firm's sensitivity to such investment quadrupled after the crisis.

The full sample intra-sector picture in the previous chapter is thus at complete odds with this time-divided intra-sector one. It seems that 41-firms have never been affected by TCIs while their 42 and 43 counterparts have always been positively affected by such investments. The difficult economic period between 2009 and 2011 has magnified this effect in the 42-sector while it has reduced such effect in the 43-sector. Now RBV predictions (Dierickx and Cool, 1989; Barney, 1986) seem most relevant in this civil engineering 42-sector of the industry followed by the specialist trades 43-sector. In both sectors non-tradeable idiosyncratic and innovative assets acquired incrementally over years give firms a competitive advantage and profits. By contrast, the building firm of the 41-sector gains no such competitive advantage. Similarly, strategic mobility barriers erected out of a systematic technology investment programme according to the ISP (Porter, 1985; 1996) seem to help civil engineering and specialist trade firms reap steady profit improvements but do nothing for their building firm peers. Sullivan (2000), Balogun and Jenkins (2003) and Teece (2006) would agree that these time-divided results underline the importance of single- and double loop and deuteron learning arising out of systematic investment in tangible and intangible technology investments in both these sectors. Such investment also seems to allow these firms to pre-empt their peers from acquiring scarce assets and thereby achieve a level of technological leadership that sustains higher profitability levels (Becerra, 2009; Smith *et al.*, 2001; Chen and Miller, 1994; Lieberman and Montgomery, 1988).

INCTECHCAPINVESTOREV as a first difference investment variable shows its true profit effect among the key sectors of the UK construction industry only in these time-divided intra-sector results. The earlier findings in Chapter 7 do not hold up to scrutiny. The building sector general contractor firms reveal themselves as being completely insensitive to technological investment either before the crisis or after. Instead, it is the civil engineering sector that consistently shows a positive sensitivity to this variable followed closely by its specialist trades peer.

8.2.9 GM

The intra-sector patterns of PAT associations in this variable once again reveal a deeper understanding of how the crisis and its economic re-calibration in the industry have affected each sector differently. The specialist trade 43-sector firms display the highest positive effect both before and after the crisis while their building sector 41 peers display the lowest effect. The steep drop in the positive effect of the coefficient in the civil engineering 42-sector after the crisis (nearly half that of its pre-crisis coefficient) stands out among the sectors.

The economic period of decline between 2009 and 2011 seems to have altered the relative efficacies of MP strategies in the three key sectors of the UK construction industry. While smaller specialist trade 43-firms continue to benefit the most from an intelligent segmentation of their markets and intelligent positioning of their products (Day *et al.*, 1979; Dickson and Ginter, 1987), the civil engineering 42-firms now do not seem as much in need of such segmentation and positioning or even product differentiation as before. Now the profits after tax of these 42-firms are increased by only 283.8% per unit increase in trading margins, not far different from their building sector peers and their 224.1% increase. A logical inference would be that the degree of product variety (Dixit and Stiglitz, 1977; Spence, 1976; Hart, 1985) in these two sectors 41 and 42 are now more or less similar while their 43 peer now boasts even greater variety than before the crisis. This conflates well with the general density and expansion of specialist services noted recently in the UK construction industry by Gruneberg and Francis (2019), Hughes *et al.* (2015) and many others in the relevant policy-based literature. These differences in product variety across the sectors after the crisis can also be aligned with the degrees of product substitution in each of them. In particular, it does seem that the services offered by civil engineering firms[20] are less substitutable than they were before the crisis and this partly explains their lowered need for product differentiation.

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[20] There are indications across many government infrastructure publications including Infrastructure and Projects Authority (2017) and Department for Business, Innovation and Skills. (2013). that the UK government's procurement of civil engineering services is increasingly restricted to a narrower set of service providers meeting ever higher technical and quality-based specifications. This may indicate that substitutability is declining in the sector driven by one of the largest clients – the government – and its enhanced pre-tendering conditions.

Product differentiation strategies based on research and development and innovation often stressed by RBV (Peteraf, 1993), ISP (Porter, 1996) and VBM (Becerra, 2009) seem to have become vital to the specialist trades construction firms after the credit crisis. Perhaps this is an artefact of this difficult economic period which seems to have made trade in specialist services more quality-dependent than before. Some 43-firms have had to ensure that they deliver a higher range of quality services at value for money prices than ever before. This is why GMs have become so important since the crisis. By contrast, it could be argued that such product differentiation has become far less relevant to the UK 42-sector civil engineering firm. Perhaps through this period of severe economic decline, the sector has undergone a winnowing of firms that has reduced its competitive intensity.

GM associations with PAT show an intra-sector pattern that seems to have changed as a consequence of the credit crisis. Now it is the specialist trades firm that exhibits the highest GM profit effect followed by its building and civil engineering counterpart in that order.

8.2.10 OM

The pattern of associations also echoes the intra-sector findings of the previous chapter but with a slight twist. In the 41- and 43-sectors, the positive associations remain significant through the credit crisis but surprisingly after the crisis the civil engineering 42-sector also turns significant and positive. Additionally, while the 41- and 42-sectors show a four- to five-fold increase in the magnitude of the coefficient after the crisis, their 43 counterpart shows a steep 70% decline. These differences need explanation. Cost leadership as emphasised in the generic strategy literature by Porter (1996), Dess and Davis (1984) and Calori and Ardisson (1988) has become pivotal to firm performance since the crisis, especially in the civil engineering sector, while climbing in importance in its building counterpart but declining significantly in importance in its 43 specialist trades peer. This is intriguing since in the full sample it was the latter sector that showed the highest sensitivity to this determinant while its civil engineering counterpart was completely insensitive to it. Here are other tell-tale signs that the steep period of economic decline has completely transformed the industry. Now it is the 42-sector firm, the one that remained impervious to this variable in the full sample, that displays the greatest need for such cost-based efficiencies and leadership attributes with every unit increase contributing to a 12,391.6% increase in profits after tax.

Valuable rare and inimitable resources that generate cost reductions combined with quality improvements (Barney, 1991; Rumelt, 1984) are now the most important strategic factor driving sector 42-profits. A sea change now seems evident in the business model of this firm. This is in stark contrast to the complete insensitivity shown by this firm in the last chapter. A civil engineering firm after the crisis now needs to re-examine its strategic bundle of resources. The key question before it is whether this bundle is achieving the best possible disintermediation leading to the lowest possible transaction costs (Spulber, 2009). By contrast, for its specialist trades peer these resource-based considerations or transaction cost-lowering modalities are now a pale reflection of the pre-crisis period. Its business model seems to be distinctly less cost-driven than before.

Economies of scale, scope and learning (Besanko *et al.*, 2017; Penrose, 1995; Roberts, 2004) are now magnified in the civil engineering firm. After the enervating and draining period of the credit crisis, this firm now more than ever before needs all relevant economies to be extracted. Its profitability is now very strongly determined by these economies. Such a structural shift in 42-firm business models may also be seen to be a consequence of the regulatory pressures mounted by normative and policy prescriptive literature (I Infrastructure and Projects Authority, 2017; Cabinet Office, 2015) Many of these voices have been calling for greater quality and cost-effectiveness in infrastructure and public procurement in the UK. They have provided the impetus for the higher OM needs reflected in these 42-sector results.

At another level, the asymmetry among sectors in OM-PAT associations after the crisis in these results highlights a range of intra-sector implications. Sector 41 firms might share a supply chain relationship with 43 peers. That OM has become more important for the profits of the former firms while it has become less important for the latter naturally creates scope for conflict. Thus 41-firms might mount pressure for cost efficiencies on 43 supply chain partners which the latter may not be interested in achieving.

OM associations with PAT in these time-divided intra-sector results show deep structural changes in the cost efficiency structure of the UK construction industry after the credit crisis. The civil engineering and its specialist trades peer shows a radical change in sensitivities to this variable while only the building firm does not much alter its sensitivity.

8.2.11 SGATOTA

The true nature of the intra-sector associations in this variable stand revealed in these time-divided results. A radical shift during the crisis seems to have erased the negative effect of promotional and marketing expenditures on firm performance across the industry, irrespective of sector. It does appear that the SG&A of the construction firm whether in the buildings, civil engineering or specialist trades sector is simply now irrelevant to its profits.

These results add confusion to earlier theoretical musings of Chapter 7. SGATOTA now emerges as a completely neutral influence in the industry since the crisis. There is no reason to infer or attribute commodity or non-commodity characteristics to the products and services of any of the three key sectors in UK construction as was done in the full sample intra-sector results. Across the building, civil engineering and specialist trades sectors after the crisis, firms invariably display an insignificant association between this variable and profits. Marketing and promotion activities now can at best be considered a neutral influence on firm performance.

8.2.12 RG

As in the case of all variables above, the intra-sector time-divided result clarifies the true nature of associations of this variable with PAT across the UK construction industry. A negative RG profits relationship is only seen in the 43-sector specialist trades firm and only in the post-crisis period. Everywhere else in the industry in both the time divides, growth PAT associations remain insignificant. Building and civil engineering firms growing their revenues at a fast pace experience no profit drop unlike their specialist trades peers who suffer a higher-than-before 4.3% drop in profits after this severe period of economic decline.

Faster-growing 43-firms see higher costs in product development and MP to grab higher market share (Kotler and Keller, 2015; Lancaster, 1990) thus lowering their after tax profits. Their lower growing sector counterparts, by contrast, have already mastered their market position and so economise product development and MP costs. By contrast, 41-sector firms that before the crisis used to exhibit a similar pattern now seem immune to changes in RG along with their 42-sector peers. Thus, after the crisis the building and civil engineering firm business models have inexorably matured. Nascent growth-profitability negative associations no longer seem relevant (Scherer and Ross, 1990; Anderson and Zeithaml, 1984; Porter, 1996; Grant, 2019).

In Chapter 7, the TCE argument was advanced to explain that in the intra-sector full sample the 42-sector was the only one that showed insignificance in growth PAT associations. This was traced to the higher levels of sub-contracting in this civil engineering 42-sector. Such an explanation is hardly relevant now as the buildings 41-sector also seems to display a similar negative association and now there is no evidence that levels of sub-contracting in the buildings sector (41) are any different from the specialist trades sector (43). Yet perhaps one may be able to rely on the argument that the crisis has reduced volatilities in asset specificities and opportunism levels among building firms while enhancing these among their specialist trades peers (Williamson, 1991; Coase, 1937; Spulber, 2009). This may be what underlies this peculiar pattern of intra-sector associations after the crisis.

Overall, these time-divided intra-sector results confirm that the specialist trades 43-sector stands out. It is the only one where nascent and heavily contested business models of RG still predominate after the crisis. Other parts of the industry seem to have levelled out and RG is easier to obtain in them after this long and severe period of economic decline between 2009 and 2011.

8.3 Relationships between variables their time-divided ISFP effect

These time-divided intra-sector regression results are now organised as in Chapter 7 by descending order of size in the key sectors of the UK construction industry to enable a comparison of the interrelationships between the determinants and their joint effects on firm performance. However, to enable more cogent analysis, the discussions are broken down by sector.

Table 29: Positive associations in descending order of magnitude – Construction of buildings SIC (41)

Period 2000-2010		Period 2011-2019	
Independent Variables	exp(b)-1	Independent Variables	exp(b)-1
OM	2.056	OM	7.298
NCATOTA	1.239	GM	2.241
GM	1.21	CASHTOTA	1.303
CASHTOTA	1.052	NCATOTA	0.679
INCTECHCAPINVESTOREV		INCTECHCAPINVESTOREV	

Table 30: Negative associations in descending order of magnitude – Construction of buildings SIC (41)

Period 2000-2010		Period 2011-2019	
Independent Variables	exp(b)-1	Independent Variables	exp(b)-1
TCTOTA	-0.606	DBTOTA	-0.486
DBTOTA		TCTOTA	-0.388
TDTOTA	-0.28	LPFETOTA	
SGATOTA	-0.207	INVENTOTA	
INVENTOTA		TDTOTA	
LPFETOTA		SGATOTA	
RG	-0.041	RG	

Table 31: Positive associations in descending order of magnitude – Civil engineering SIC (42)

Period 2000-2010		Period 2011-2019	
Independent Variables	exp(b)-1	Independent Variables	exp(b)-1
OM	24.128	OM	123.961
GM	4.573	GM	2.838
NCATOTA	1.898	CASHTOTA	2.083
LPFETOTA	1.096	NCATOTA	
CASHTOTA		INCTECHCAPINVESTOREV	0.554
INCTECHCAPINVESTOREV	0.142	DBTOTA	
RG	0.018	SGATOTA	

Table 32: Negative associations in descending order of magnitude – Civil engineering SIC (42)

Period 2000-2010		Period 2011-2019	
Independent Variables	exp(b)-1	Independent Variables	exp(b)-1
TCTOTA	-0.599	TCTOTA	
INVENTOTA		LPFETOTA	
DBTOTA		INVENTOTA	
TDTOTA		RG	
SGATOTA	-0.151	TDTOTA	

Table 33: Positive associations in descending order of magnitude – Specialised construction activities SIC (43)

Period 2000-2010		Period 2011-2019	
Independent Variables	exp(b)-1	Independent Variables	exp(b)-1
OM	109.167	GM	103.063
GM	5.29	OM	32.149
NCATOTA	1.529	NCATOTA	1.316
CASHTOTA	1.252	CASHTOTA	1.077
INCTECHCAPINVESTOREV	0.449	INCTECHCAPINVESTOREV	0.239
LPFETOTA			

Table 34: Negative associations in descending order of magnitude – Specialised construction activities SIC (43)

Period 2000-2010		Period 2011-2019	
Independent Variables	exp(b)-1	Independent Variables	exp(b)-1
DBTOTA	-0.537	TCTOTA	-0.462
TCTOTA		DBTOTA	
INVENTOTA		INVENTOTA	
TDTOTA		TDTOTA	
SGATOTA	-0.19	SGATOTA	
RG	-0.032	RG	-0.043
		LPFETOTA	

8.3.1 Sector 41 construction of buildings firms (Tables 23 and 26)

Whether before or after the crisis, RM and MP remain the most important positive determinants of the performance of building firms in this UK construction sample. Yet invariably for this type of construction firm, OMs retain the highest positive influence. However, both margin-based determinants OM and GM rise in their performance effect after the crisis, the former by approx. 3.6 times and the latter by approximately twice. After the crisis, it is these cost efficiency and product differentiation-based determinants that seem to have become the most important positive influence on the building firm's profits. However, AAs in terms of cash and net current asset levels on the balance sheet of firms remain important but swap places through the crisis with the former gaining in importance. This is hardly surprising. Cash is now the third most important positive determinant of the building firm's profits. After the crisis, the business model of this firm has become highly cash-dependent.

Among the negative determinants, the only variable with a discernible effect after the crisis is TCTOTA. Before and after the crisis this variable remains firmly negative, suggesting how important faster payments to suppliers are to the building firm's profits.

By contrast, a host of other variables and their negative drag on firm performance pre-crisis have disappeared since the crisis. There is of course the sole exception of DBTOTA. Unsurprisingly, after the economic storm now taking long-term debt is a definite negative influence on firm performance among UK building firms.

8.3.2 Sector 42 civil engineering firms (Tables 24 and 27)

As usual, this sector of the UK construction industry stands out. The most startling set of intra-sector time-divided results are on display. For the first time, the first difference variable of technology and capital investment stays robustly positive as a determinant of firm performance through the crisis and none of the 12 collated variables in the model exerts any significant negative effect on the firm’s profits after the crisis. Thus, civil engineering firm PAT after 2011 is a monotonically positive function of determinants. This seems to suggest a radical change in the business model of this firm in the changed environment after the credit crisis. However, before the crisis, at least two variables – TCTOTA and SGATOTA – did have a significant negative effect on the profits of firms in the sector. Now it appears that managerial calibration of strategic firm policy in the civil engineering firm is simpler than in the other sectors. Now managers only need to pay attention to the four different invariably performance-enhancing determinants of OM, GM, CASHTOTA and INCTECHCAPINVESTOREV.

At another level, the pattern of associations even among the positive determinants in this sector exhibits three peculiarities. First, in the pre-crisis period, this is the only sector in UK construction that displays a positive significant association between RG and PAT. A firm’s ability to grow its revenues faster for the first and only time in this UK sample seems to increase its profitability. Before the crisis, it appears that revenue generation in sector 42 was easy and relatively cost-effective but the sector slipped back to the general industry pattern after this economic storm.

Second, non-current asset proportions in this civil engineering firm before the crisis had a positive effect on PAT and this is unprecedented in the sample. This suggests that the civil engineering business model at least in the early years was distinctly long-term asset driven, unlike its other peers in the industry. Once again there is a descent into the general industry pattern after the crisis.

Finally, this sector of UK construction is the only one that shows a positive significant effect of technology and capital investment on profits that multiplies through the credit crisis. INCTECHCAPINVESTOREV-PAT positive associations jump four-fold from 0.142 to 0.554 after the crisis. This further substantiates how different the business model of the civil engineering firm is when compared to its peers in other sectors of UK construction.

8.3.3 Sector 43 specialised construction activities firms (Tables 25 and 28)

This sector of the UK construction industry displays patterns in its positive and negative determinants that are stylised just like its buildings sector 41 counterpart above. It is the only sector that shows five robust positive determinants of firm performance that are scarcely altered by the crisis. OM, GM, NCATOTA, CASHTOTA and INCTECHCAPINVESTOREV remain in that descending order of magnitude the most influential positive drivers of performance both before and after the crisis. Of these, the only variable that increases its positive effect after the crisis is OM. Cost efficiencies have climbed in importance due to this extended period of economic decline and so OM has become the most important positive driver of the specialist trades firm performance.

By contrast, RG is the only negative coefficient that remains so through this economic period. This 43 grouping of firms is the only one in the industry to display a consistent lifecycle-based negative association both before and after the crisis. Growing revenues remain a costly proposition in this sector of the industry and the value versus growth divide remains distinct.

The suite of four additional sensitivity testing regressions confirms the results in the two-way fixed effects regressions presented in the previous section as seen in Table 34. The main findings of the time-divided samples remain largely unchanged. However, a few stylised nuances are worth noting. In the main, variable coefficient sign directions do not alter in the main panel-based random effects or MLE regressions but significances move up or down. Sector-by-sector, many coefficients become significant and that seems to corroborate the existence of the relationships already identified and discussed above. Endogeneity considerations remain prevalent as anticipated in the

Table 35: Robustness of the model – Sensitivity regressions. Pre and post-crisis periods. Sector 41

Independent Variables		Construction of buildings (41) Period 2000-2010					Construction of buildings (41) Period 2011-2019				
		Pooled OLS	Entity FE	Two-way FE	GLS RE	MLE RE	Pooled OLS	Entity FE	Two-way FE	GLS RE	MLE RE
NCATOTA	Significance	√	√	√	√	√	√	√	√	√	√
	Sign	+	+	+	+	+	+	+	+	+	+
LPFETOTA	Significance	X	X	X	X	X	√	√	X	X	X
	Sign	+	-	-	+	+	+	-	-	+	+
CASHTOTA	Significance	√	√	√	√	√	√	√	√	√	√
	Sign	+	+	+	+	+	+	+	+	+	+
DBTOTA	Significance	√	√	X	√	√	√	√	√	√	√
	Sign	-	-	-	-	-	-	-	-	-	-
INVENTOTA	Significance	√	X	X	X	X	√	X	X	√	√
	Sign	+	-	-	+	+	+	-	-	+	+
TDTOTA	Significance	√	√	√	√	√	X	X	X	√	√
	Sign	-	-	-	-	-	-	-	-	-	-
TCTOTA	Significance	√	√	√	√	√	√	√	√	√	√
	Sign	-	-	-	-	-	-	-	-	-	-
INCTECHCAPINVESTORE V	Significance	√	X	X	√	√	X	X	X	X	√
	Sign	+	+	+	+	+	+	+	+	+	+
GM	Significance	√	√	√	√	√	√	√	√	√	√
	Sign	+	+	+	+	+	+	+	+	+	+
OM	Significance	√	√	√	√	√	√	√	√	√	√
	Sign	+	+	+	+	+	+	+	+	+	+
SGATOTA	Significance	X	X	√	√	√	√	X	X	√	√
	Sign	-	-	-	-	-	-	-	-	-	-
RG	Significance	X	√	√	√	√	√	X	X	√	√
	Sign	-	-	-	-	-	-	-	-	-	-
Ln (TOTR)	Significance	√	√	√	√	√	√	√	√	√	√
	Sign	+	+	+	+	+	+	+	+	+	+

Table 36: Robustness of the model – Sensitivity regressions. Pre and post-crisis periods. Sector 42

Independent Variables		Civil engineering (42) Period 2000-2010					Civil engineering (42) Period 2011-2019				
		Pooled OLS	Entity FE	Two-way FE	GLS RE	MLE RE	Pooled OLS	Entity FE	Two-way FE	GLS RE	MLE RE
NCATOTA	Significance	√	√	√	√	√	√	√	X	√	√
	Sign	+	+	+	+	+	+	+	+	+	+
LPFETOTA	Significance	X	X	√	X	X	√	X	X	X	X
	Sign	+	+	+	+	+	+	-	-	+	+
CASHTOTA	Significance	X	X	X	X	X	X	√	√	√	√
	Sign	+	+	+	+	+	+	+	+	+	+
DBTOTA	Significance	√	X	X	√	√	√	X	X	√	√
	Sign	-	-	-	-	-	-	+	+	-	-
INVENTOTA	Significance	√	X	X	√	√	X	X	X	X	X
	Sign	-	-	-	-	-	-	-	-	-	-
TDTOTA	Significance	√	X	X	√	√	√	X	X	X	√
	Sign	-	-	-	-	-	-	-	-	-	-
TCTOTA	Significance	√	√	√	√	√	X	X	X	X	√
	Sign	-	-	-	-	-	-	-	-	-	-
INCTECHCAPINVESTOREV	Significance	X	√	√	X	√	√	√	√	√	√
	Sign	+	+	+	+	+	+	+	+	+	+
GM	Significance	√	X	√	√	√	√	√	√	√	√
	Sign	+	+	+	+	+	+	+	+	+	+
OM	Significance	X	X	X	X	√	√	√	√	√	√
	Sign	+	+	+	+	+	+	+	+	+	+
SGATOTA	Significance	X	X	X	X	√	X	X	X	X	X
	Sign	-	-	-	-	-	-	+	+	+	+
RG	Significance	X	X	X	X	X	√	X	X	√	√
	Sign	-	+	+	+	+	-	-	-	-	-
Ln (TOTR)	Significance	√	√	√	√	√	√	√	√	√	√
	Sign	+	+	+	+	+	+	+	+	+	+

Table 37: Robustness of the model – Sensitivity regressions. Pre and post-crisis periods. Sector 43

Independent Variables		Specialised construction activities (43) Period 2000-2010					Specialised construction activities (43) Period 2011-2019				
		Pooled OLS	Entity FE	Two-way FE	GLS RE	MLE RE	Pooled OLS	Entity FE	Two-way FE	GLS RE	MLE RE
NCATOTA	Significance	√	√	√	√	√	√	√	√	√	√
	Sign	+	+	+	+	+	+	+	+	+	+
LPFETOTA	Significance	X	X	X	X	X	√	X	X	X	√
	Sign	-	+	+	-	-	+	-	-	+	+
CASHTOTA	Significance	√	√	√	√	√	√	√	√	√	√
	Sign	+	+	+	+	+	+	+	+	+	+
DBTOTA	Significance	√	√	√	√	√	X	X	X	X	√
	Sign	-	-	-	-	-	-	-	-	-	-
INVENTOTA	Significance	X	X	X	X	X	√	X	X	√	√
	Sign	-	-	-	-	-	-	-	-	-	-
TDTOTA	Significance	√	√	X	√	√	√	X	X	√	√
	Sign	-	-	-	-	-	-	-	-	-	-
TCTOTA	Significance	√	X	X	√	√	X	√	√	√	√
	Sign	-	-	-	-	-	-	-	-	-	-
INCTECHCAPINVESTOREV	Significance	√	√	√	√	√	X	√	√	√	√
	Sign	+	+	+	+	+	+	+	+	+	+
GM	Significance	√	√	√	√	√	√	√	√	√	√
	Sign	+	+	+	+	+	+	+	+	+	+
OM	Significance	√	√	√	√	√	√	√	√	√	√
	Sign	+	+	+	+	+	+	+	+	+	+
SGATOTA	Significance	X	√	√	√	√	√	X	X	√	√
	Sign	-	-	-	-	-	-	-	-	-	-
RG	Significance	√	√	√	√	√	√	√	√	√	√
	Sign	-	-	-	-	-	-	-	-	-	-
Ln (TOTR)	Significance	√	√	√	√	√	√	√	√	√	√
	Sign	+	+	+	+	+	+	+	+	+	+

time-divided sub-samples. Instrumental two-stage least squares regression results displayed in Appendices 1 and 2 confirm this. The same set of arguments as advanced earlier in the intra-sector Chapter 7 also apply, and so these are merely noted for purposes of completeness.

8.4 Summary of discussions and findings

This chapter has analysed firm performance in the time-divided sub-samples of both the UK construction industry as a whole and its constituent three key sectors. Treating the credit crisis between 2009 and 2011 as an economic structural break, the full sample was divided into the two divides between 2000 and 2010 and 2011 and 2020 respectively. The same conceptually derived regression model was applied in both divides and the results were analysed. This summary has consequently to record the overall industry and intra-sector results and therefore this is done in the two separate parts that follow.

8.4.1 Overall industry

First, the profits of the average firm in the UK construction industry seems to be reduced in their positive sensitivity with respect to working capital after the credit crisis. Net current asset proportions are no longer as important for the profitability of this firm. This may arguably be traced to an improving environment of supply chain integration collaboration and partnership in the industry.

Second, whether before or after the credit crisis, non-current assets do not seem material to the profitability of the construction firm in this sample. Such a result seems to substantiate ubiquitous indications of under-capitalisation across the industry.

Third, cash sensitivities of profits in the industry have climbed since the crisis. That cash levels now have a much larger positive effect on the PAT of firms seems to be rooted in the lack of supply chain-based alternative financing mechanisms often stressed by industry policy analysts. Holding cash after the crisis is now a great deal more important and contributes directly to the bottom line of the UK firm.

Fourth, long-term debt after the economic storm of 2010 seems counter-intuitively to have a smaller negative effect on profits in the industry after 2011. This is a result that might goad firms to take higher leverage in the industry. Yet there is clear evidence that firm cash flows are volatile and higher leverage will lead to greater bankruptcy.

Therefore, policies and regulations in firm leverage seem now more than ever absolutely critical to the industry.

Fifth, the crisis seems to have increased fears of inventory shortage. Firms are hoarding. This has reduced the degree of the negative effect of inventory levels on profits in the industry post-2011, but this may encourage firms to continue hoarding inventory which can only add to the problem of cluttered construction project sites in the UK. Policy and regulation must not neglect this aspect.

Sixth, consumer credit after 2011 shows signs of a significantly reduced negative effect on profits in this industry. This might be construed as an indicator of the lower bargaining power of the industry incumbent firm, but this is a positive development for smaller and more fragile clients of the industry who can now demand and obtain more liberal terms of credit. There is thus some evidence of a salutary reduction in adversarial firm-consumer relationships in the industry after the crisis.

Seventh, trade credit levels remain as keen a negative influence on profits after the crisis as they were before. Thus, cash payments to suppliers remain an important prerequisite of profits in this UK industry. These time-divided results thus add further credence to normative industry-based narratives that stress firm-supplier collaboration and partnering predicated on quick payment terms for the latter.

Eighth, TCIs now seem to have a larger positive effect on after tax profits in the industry. In the changed industry scenario after the economic storm of 2010, a UK construction firm’s steady year-to-year investment in technology and capital assets now seems to exert a magnified positive effect on its profits. The average firm in this industry can no longer ignore a steady investment programme in a portfolio of relevant technology and capital assets. The results seem to underline how important such a programme now is to firm PAT.

Ninth, product differentiation strategies enabling higher GMs seem crucial to profits in the post-2011 sub-sample. The average construction firm now needs to pay much greater attention to effective segmentation and targeting of its potential customers while ensuring that its product features and attributes enable the extraction of a healthy GM. This is what will ultimately show up in higher PAT. The credit-based contraction has made a product differentiation emphasis a core necessity in construction firm strategy.

Tenth, cost leadership after the credit crisis seems to be another major driver of profitability in this UK sample. Higher product quality combined with lower costs has become an essential competitive prerequisite. The period of economic decline has raised customer expectations of higher product quality and lower costs. Economies of scale, scope and learning are therefore emphasised everywhere in the industry after the crisis.

Eleventh, the post-2011 sub-sample reveals a construction industry significantly changed in terms of marketing and promotion. Now the average firm in the industry is far less harmed by its expenditures on these counts. The crisis appears to have increased the need for discovering under-served customers through effective market research or pushing products and services through trials and promotions. Marketing expenditures in this changed industry are no longer as futile as they were before.

Twelfth, the industry seems to have slightly altered its growth versus profitability trade-off after the crisis. No longer is the average UK construction firm's RG as expensive in after tax profits as before. The business model of the average firm has matured and the market is no longer as nascent as before. Firms can grow revenues more easily than before.

8.4.2 Intra-sector

First, after tax profit sensitivities to working capital show a variegated pattern across the three key sectors of the UK construction industry after the crisis. The 41 buildings and 42-sector civil engineering firm sensitivities drop by large amounts while their 43 specialist trades peers do not. Such asymmetric patterns post-crisis corroborate narratives of intra-firm intra-sector supply chain collaboration and partnership rife in the policy literature. Post-2011 intra-sector working capital requirements have changed and this necessitates a joint and coordinated approach among firms especially those in supply-chain-based relationships in the industry.

Second, there is clear evidence that in none of the sectors after the crisis non-current assets generate any increase in after tax profits. This is surprising and rather worrying especially since, even the 42-sector civil engineering sector firm that displayed the only positive effect on PAT before the crisis, now post-2011 shows an insignificant association. Owning even specialist equipment in a generally technology-intensive sector such as this one does not give the firm any discernible learning or experiential benefits that translate to higher profits. Further theoretical and empirical investigations are warranted.

Third, profit sensitivity to cash levels jumps significantly post-crisis among civil engineering 42-sector firms, far outstripping firms in peer sectors in the industry. There has undoubtedly been a fundamental shift in the cash-based business needs of this firm. Holding cash now seems to be a prerequisite for healthy after tax profits. It does seem that the economic contraction has heightened the cash needs of the civil engineering firm far above those of its counterparts in the buildings and specialist trades sectors.

Fourth, intra-sector patterns of leverage in this UK construction sample show a curious pattern in the two periods. Only the 41-building sector firm exhibits a negative effect of debt on PAT after the crisis while its civil engineering and specialist trades counterparts display insignificant associations. The credit contraction has thus accentuated a direct negative effect of debt only in the case of the buildings firm. Rather counter-intuitively, large swathes of the industry including civil engineering and specialist trades firms now are hardly affected by the debt that they take, a fact that is rather worrying from both a regulatory and developmental perspective.

Fifth, none of the key sectors of the UK construction industry display any significant association between inventory levels and after tax profits whether pre- or post-2011. Managers across these key sectors would be impelled to disregard how much inventory they hold as inconsequential to their firm's profits, but this is dangerous in the context of an industry where project site-based inventory inefficiencies are ubiquitously recorded fact in the literature.

Sixth, all sectors of the industry post-2011 show a perplexing lack of significance in firm-level associations between PAT and trade debtor levels. The credit crisis seems to have only complicated the strategic CD of firms across the industry. The trade-offs between giving trade credit to customers and retaining custom or tightening terms and losing it has become all the more obtuse with a lack of clear direction evident in the results. Firm managers have no clear normative and they instead have to decide these levels based on individual firm situations and complexities.

Seventh, availing trade credit from suppliers has a negative effect on PAT after 2011 only in the specialist trades 43 and building 41 sectors. The credit crisis seems to have accentuated the need for UK construction firms in these sectors to hasten payments to their suppliers. By contrast, in the civil engineering 42-sector, TCTOTA associations with PAT are insignificant. Firms do not need to ensure that they pay suppliers earlier.

Eighth, the strong and positive effect of systematic TCIs on profits after the credit crisis is seen predominantly in the civil engineering 42 and partially in the specialist trades 43 sectors. Their building sector 41 peer exhibits an insignificant association both before and after the crisis. Thus, apart from the specialist trades firm, this result corroborates how TCIs have become very important drivers of profits for the civil engineering firm after the crisis. The technology-laced business template of this firm has been amplified by the dynamics of the credit crisis.

Ninth, post-2011 GM and its positive effect on profits of the construction firm in this sample seem to be highest in the specialist trades firm followed by the buildings and civil engineering peers. A re-calibration seems to have taken place intra-sector. Segmentation positioning and product differentiation strategies are most required in specialist trade firms because product substitutes and varieties have increased significantly in this market since the crisis. In the 41- and 42-sectors, the crisis seems to have created some pockets where the firms are more closely fastened to their clients and do not need as extensive a product differentiation.

Tenth, deep structural changes are evident in the cost efficiency dynamics across the industry. The heightened effect of OMs on after tax profits in the civil engineering sector and a striking decline in such effect in the specialist trades sector after the crisis have asymmetric implications for the supply chain of the industry. The steep period of economic decline seems to have drastically changed the business models of firms in at least these two sectors of the industry.

Eleventh, the seemingly negative effect of marketing and promotional expenditures on PAT seen in earlier results is completely erased across all sectors of this UK construction sample after 2011. It does seem as though the period of economic decline has now transformed the business models of all firms. Now marketing and promotional expenditures are not harmful to any firm in any sector but instead have but a neutral effect.

Twelfth, RG is costly in terms of after tax profits only in the specialist trades 43-sector after the credit crisis. Everywhere else in the UK construction industry, it seems that there is no longer a negative association between RG and PAT. Nascent and heavily contested business models have emerged as an important feature of the specialist trades 43-sector while, whether it be in the civil engineering or the buildings sectors, the average firm seems to have a more stable business template in which both revenues and profits can be grown without one affecting the other.

Before concluding this summary and moving to the final chapter of this thesis, the nature and peculiarities of interrelationships between the determinants and firm performances in each of the key sectors of the UK construction industry do need to be summarised. Sector 42, the civil engineering sector, stands out as one of the simplest business models in the industry after the credit crisis with an all-positive profit function making the task of the firm manager that much easier than peers in other sectors. Both the 41- and 43-sectors show a mix of positive and negative determinants in the profit functions, but it is only in the former that at least two remain significant after the crisis. Consequently, it does seem that the task before the buildings firm manager is by far the most complicated in terms of balancing between both positive and negative determinants of firm performance.

Chapter 9. Conclusions and Recommendations

Firm performance in the UK construction industry reveals itself in this thesis as a full and complex intra-sectoral and dynamic reality. This industry more than any other shows a complicated set of firm performance determinants that are interrelated and differentially graded across the many different types of firms. There are rich layers and levels of differentiation in the firms' performance pictures that completely justify the key critical rationale identified as the basis for this research in Chapter 1.

The thesis had set out to answer how and why firm performance varies in three key sectors of the UK construction industry and how a VBMA can help to improve ISFP within it. The results analysed in the thesis have provided a detailed and comprehensive answer to these research aims and objectives. At the very outset, for the very first time, a wide range of firm financial data are eclectically combined based on a conceptual template framed from the VBM of the firm. This template as applied and subsequently interpreted in the results shows robust signs of how useful it is fully justifying its importance, but more: the current determinants of firm performance in the industry, its key sectors and across time stand fully revealed in all their intricacies in these results.

This Chapter is the concluding one in this thesis and coalesces the main findings of this research from the analytical Chapters 6, 7 and 8 and weaves cogent and compelling answers to the three main research objectives identified in the Introduction. The conclusions that follow are organised into three sections. Section 9.1 answers research objective 1. It establishes the current determinants of firm performance in the UK construction industry. In section 9.2, research objective 2 is answered. The determinants of firm performance in the buildings 41-sector, the civil engineering 42-sector and the specialist trades 43-sector are compared and contrasted. Finally, Section 9.3 answers research objective 3. The time-based differences in performance dynamics both in the industry as a whole and in its three sectors are elucidated.

After presenting the answers to the three research objectives, the chapter next presents the main recommendations of the thesis. Section 9.4 lays out recommendations for firm managers across the industry and its three primary sectors. Key insights from the VBMA analyses and conclusions in the thesis are distilled into guidelines for improving a firm's performance. Section 9.5 details recommendations for policymakers and regulators in the UK construction industry. Corrective and developmental actions are laid out in this section that could help the industry grow more sustainably and contribute more effectively both to national output and gainful employment. The final set of recommendations in Section 9.6 establish fruitful directions for further academic research in this industry.

Section 9.7 identifies and enunciates the main theoretical and empirical contributions of the thesis to the body of knowledge in the domain of strategic performance studies in the construction industry. It shows the extent to which a VBM of quantitative analysis of firm performance in the key sectors of the UK construction industry has helped identify a road map to reform and improvement both in and outside it. Academic and professional insights from the thesis are combined to specify just how far our understanding of the theoretical underpinnings of firm performance has changed and deepened as a consequence. The section also outlines the gaps in these underpinnings that remain post this research thus providing yet other directions for academic endeavour.

Section 9.8 details the main limitations of this thesis. As with any research investigation, the many loopholes in this effort are identified but also rationalised. Future research in this area is alerted to ways in which these limitations may be overcome.

9.1 The current determinants of construction firm performance in the UK

This thesis has revealed a rich panoply of findings on the current nature of firm performance and its determination in the UK construction industry. A set of twelve eclectically identified separately measurable determinants in three conceptual aggregations of RM, CD and MP rooted in the VBM of the firm are seen to be the driving forces of firm performance in this industry. Important insights about these determinants organised by the three VBMA concepts add to extant theoretical understandings of the business model of the average firm.

9.1.1 RM in the construction firm

The results presented in Chapter 6 show that UK construction firms need to manage their resources in certain specific ways if they are to enhance profits. In general, a positive net working capital position needs to be combined with high cash levels at all times. Unlike industries such as manufacturing, a firm needs to pay greater attention to day-to-day operations and effective liquidity management. A precautionary motivation combined with an enhanced ability to successfully meet short-term liabilities must be read into this liquidity-performance imperative of the UK construction firm. At the same time, such a higher cash or liquidity dependence for profits echoes concerns that the industry lacks access to short-term credit. One has to conclude that cash or liquidity allows the UK firm to seize market opportunities, ensure smooth transactions and avoid risky situations and such a pattern is different from other peer industries where cash often has an associated opportunity loss. Such a finding also resonates with the lack of effective supply chain collaboration that is the bane of this industry. When firms cannot rely on partners in the supply chain for liquidity adjustment, they would rather build internal resilience.

At another level, non-current assets proportions do not seem to matter to firm performance in the industry. This seems to explain why many UK firms prefer to remain under-capitalised. It also aligns neatly with the finding that debt has a negative effect on profits in this industry. Perhaps this is why there is so much parallel evidence of difficult credit access and onerous credit terms in UK construction. Debt does not enable a firm to generate economies of scale, scope or learning, improve operational synergies, reduce transaction costs or extract vertical integration benefits

9.1.2 Competitive dynamics of the construction firm

The findings in the thesis about the CD in the UK construction industry show several divergent and confounding patterns. Rotating firm operating cash cycles as fast as they can seems to be a singularly important performance antecedent for the average firm in this industry. For instance, low inventory storage times have an important positive profit effect for a firm, flagging nebulously-defined property rights and the widespread prevalence of social embeddedness in this industry but this also underlines how important effective bargaining with raw materials suppliers is in this industry. Firms must negotiate with suppliers to supply inventory JIT. The marginal cost of inventory stock-out is not as important as that of holding inventory. Effective long-term supply chain partnerships with raw materials providers are thus essential for higher profits in this industry.

Similarly, the results show that consumer credit is not profit positive in this industry. The average UK construction firm is better off extending as little credit to its customers as possible as such credit has a negative drag on its profits. The top-performing firms in the industry have higher bargaining power vis-à-vis customers and are so able to insist on cash payment and yet retain custom. Such firms' products and services are to an extent rare, valuable and non-substitutable and so enable this. Yet these results also show how extending credit to customers even during difficult times does not improve profits. It is also apparent that, although construction has a product that exhibits information asymmetry, extending credit does not help but instead harms the selling firm. A sombre implication of these results is that regulatory advance action in this industry to restrain large successful firms from squeezing their smaller fragile customers by denying them credit is warranted.

Supplier credit, unlike in many other industries, also shows a clear negative effect on the profits of the UK construction firm. Firms in this industry are better off not availing themselves of trade credit from suppliers despite obvious cash flow advantages. This harkens back to how important a central theme of this thesis is that supply chain collaboration partnerships predicated on cash payments by UK construction firms to their suppliers are an essential performance prerequisite. These firms must build internal capacity to afford such a tight procurement payment cycle. Inevitably, this would ease their suppliers' cash cycles helping them maintain timely and effective supply lines and in turn reducing procurement inefficiencies across the chain. This clear performance incentive for the UK construction firm to pay its suppliers early is heartening. It suggests that there is now an empirical basis to challenge the adversarial tendencies rampant among some firms. The profit motivation in itself implies early supplier payments and so these firms must be educated.

Finally, the CD of steady incremental TCIs show a positive profit effect in this industry. The results underline how UK construction firms deepen their service and product offerings from a steadily implemented technology and capital investment programme. This naturally erects strategic barriers to other firms and shows up in higher after tax profits of incumbents in the industry. This systematic positive profit effect is proof both of experiential technology learning and its strategic value and of learning feedback loops and their importance. Technological leadership combined with pre-emption of scarce technological assets are important performance factors in this industry. The results also provide support to the normative exhortations of scholars in the literature that technology and capital co-investment is an important profit driver in the industry.

9.1.3 MP of the construction firm

The industry regression results in Chapter 6 flag both GM and OMs as important positive profit drivers in the UK construction industry. The powerful GM profit effect suggests important roles for effective market segmentation, product positioning and marketing in this industry. It is only by focusing on these that the average firm will be able to generate and sustain the high GMs so essential for high after tax profits. This is why differentiating its product offering through technological and R&D innovation is vital for these firms as without it they would not be able to achieve and maintain such high GMs. An expansion of both the width and depth of such product offerings would need simultaneous attention by this firm, a performance implication in this industry that parallels several peer industries.

In OMs, the results of the industry are even more emphatic. These margins evoke the strongest positive profit effect in the industry underlining at least two important theory-based implications. First, it is evident that for the UK construction firm cost leadership through locating and operationalising inimitable resources and capabilities to lower costs while maintaining or enhancing product quality is essential. Second, such a firm also needs to extract all possible economies of scale, scope and learning to enable it to lower costs while at the same time improving its product quality. Cost leadership and efficiencies are thus the most important driver of profits in UK construction, a fact not very different from many other industries. It explains the consistent narrative in the policy and regulatory literature focusing on cost benchmarking and management.

Marketing and promotional expenditures reduce UK construction profits. The results in Chapter 6 show that branding marketing or selling efforts are futile in this industry. This finding stands out in industry firm performance research with only one other study corroborating such a negative profit effect with four others contradicting it in peer industries. Yet given that the industry deals in a product that is tangible long-term and durable where the customer is less likely to be swayed by emotion and more likely to be driven by facts provides some contextual substantiation. This also explains why in all the copious regulatory, normative and prescriptive literature in UK construction there is never any link drawn between marketing expenditure and firm performance.

Experts in the industry do not seem to consider such expenditures to be important to profitability.

Finally, Chapter 6 results indicate a negative effect of RG on after tax profits in this industry. Inordinately volatile asset specificity and opportunism in the industry environment of UK construction must be read into this costly nature of RG. This industry faces formidable challenges to protect or grow profits from imitating competitors and thus firms that wish to grow revenues faster have to be prepared to tolerate lower profits.

The negative profit effect of growing revenues in this industry contradicts findings in other industries where scholars find that revenues and profits can be grown simultaneously. This contradiction can be explained. The UK construction industry and its complex fragmented supply chain are what make it highly likely that RG will be costly to achieve. This negative result may also be a reflection of the saturated nature of competition and outmoded tendering procedures in vogue in the industry, something already underlined by hosts of policy scholars.

9.2 Determinants of ISFP in UK construction

Intra-sector performance dynamics in the UK construction industry are richly variegated and the thesis reveals many of these topological differences in Chapter 7. The key findings emerging from these differences are clarified in terms of each of the three important concepts of the VBMA.

9.2.1 RM in the sectors of UK construction

The concept of RM is distinctly differentiated among the 41-, 42- and 43-sectors of UK construction. The 42-sector stands out in the industry with a monotonically positive RM function. This comprises three determinants including for the first time in the industry a positive profit effect for non-current assets and an insignificant one for leverage. By contrast, in both its peer sectors 41 buildings and 43 specialist trades, RM is a balanced function of three positive (net current assets, non-current assets and cash) and one negative (leverage) determinants. Drilling down into each of these determinant findings reveals other nuances.

For example, the 42- and 43-sectors are the only two in the UK construction industry that exhibit very high levels of profit sensitivities to net current asset proportions. Sector

41 building firms show very low-profit sensitivities to this determinant. These are the only firms in the industry that can afford to maintain lower working capital levels and adopt a long-term asset orientation. Perhaps that is why such building firms in industry empirical research (Ive and Murray, 2013) have been seen to maintain even negative working capital gaps. The findings in Chapter 7 suggest that coverage of short-term liabilities is an essential prerequisite to surmount economic adversities like the crisis. The contrast between the 41-sector and other sectors in this determinant clarifies and substantiates policy literature calls for intra-sector corroboration and partnerships in this industry.

Similarly, non-current asset proportions and leverage show distinctly different profit effects in the civil engineering 42-sector as compared to peers. The first determinant has a positive profit effect only among 42-firms suggesting a division of labour benefits and economies of scale, scope and learning in these technology-intensive firms. Add to this that leverage has an insignificant profit effect in this sector suggests that debt, if used to invest in productive non-current assets, might improve the profits of the firm, unlike its peers. Only for this civil engineering firm do the arguments of resource-based bargaining advantages or vertical integration benefits of leverage apply. Finally, higher cash levels are more important in this firm as they have the most important positive effect on its profits. It does seem that cash buffering is more important among civil engineers than peers potentially due to the long timeframe of projects, delayed payments by clients and quickly closing windows of materials procurement in the sector.

9.2.2 Competitive dynamics in the sectors of UK construction

Chapter 7 intra-sector results reveal that higher inventories are best avoided in the buildings (41) and specialist trades (43) sectors, a normative that tallies with the policy research. It does seem that negotiating down raw material lead times and holding slim inventories are essential elements of profitability in these sectors. This may explain the adversarial elements and higher degrees of social embeddedness in both these sectors. However, the results in the 42-sector show how for this technology-laced firm marginal costs of inventory holding and inventory stock-outs are perfectly balanced. Holding more or less inventory does not matter to the profits of this firm.

The results in this chapter also show that consumer credit drags down profitability the most in the 41 building sector. For the 43 specialist trades sector, it is less of a drag while it simply does not matter for the 42-sector civil engineering sector. One may therefore infer that the ability to bargain and reduce the extent of credit advanced to consumers is most useful to the buildings and the specialist trades firms in that descending order but given the client base of larger government firms with deeper pockets characteristic of civil engineer consumers giving or not giving credit does not matter in the 42-sector. Similarly, managers in 41- and 43-sectors may be rewarded for being strict with their customers, secure in the belief that these customers will put up with tighter payment conditions. There is no evidence of either information asymmetry reduction or repeat custom from financially constrained customers due to advancing credit in either of these sectors. Credit lines might have a neutral effect only in the civil engineering sector. This diversity in consumer credit profit effects across sectors of UK construction requires calibrated action from the regulators and policymakers.

By contrast, supplier credit is a negative profit driver across all three key sectors of the UK construction industry. For the first time, intra-sector results reveal CD that favour smaller 43-firms that are often suppliers to both their 41 and 43 counterparts. While this is welcome evidence in an industry that otherwise favours larger firms, it also belies standard working capital theory. Delaying payments to suppliers is a generally accepted trade practice in many industries. Perhaps this explains why cooperation and collaboration in the supply chain of the industry remain so important in policy and normative discourse in UK construction. All firms in the industry, whether 41, 42 or 43, benefit from paying their suppliers early. The evidence thus suggests a profits-based reason why such cooperation and voluntary faster payment to suppliers is in the interest of all sectors of the industry.

Among the three key sectors of UK construction, TCIs matter only for the 41 buildings and 43 specialist trades firms. A peculiar finding is that such investments simply do not matter to the civil engineering firm’s performance. It seems clear that technology upgrading is rare, inimitable and non-substitutable among buildings and specialist trades firms. For the civil engineering firm, it is ubiquitous and does not confer strategic advantages. Arguably two other arguments are inferable. First, 41- and 43-firms are the only ones that display evidence of performance catalysis out of single- and double loop and deuteron learning based on a systematic technology investment programme.

Second, these are the only two sectors where first and second mover advantages accrue to the firm out of a systematic asset investment programme.

Such an intra-sector finding is proof of the singular competitive aspects of these two sectors, as often observed by industry commentators. The 41- and 43-firms are less technology- and innovation-orientated and so those that implement a systematic programme of technology and innovation investment stand out among their peers. By contrast, the civil engineering firm business template is standardised around key technology and innovation templates already. So, in this sector, such a programme of investment does not confer discernible strategic benefits to the firm.

9.2.3 MP in the sectors of UK construction

GMs have a positive effect on profits everywhere in the UK construction industry. However, the magnitude of this effect is greatest in the specialist trades 43-sector with these smaller construction firms benefiting the most from intelligent segmentation of their market and effective positioning of their products and services. Product variety and substitutability are greatest in this sector when compared to the 41 buildings or 42-sector civil engineering sectors, something that fits the general intra-sector understanding of UK construction. The specialist trades construction firm in the UK necessarily has to be a product differentiator or lose its performance edge. The exaggerated profit sensitivity to GMs in this firm when read with the highest positive effects of technology and capital investment is a strong vote for product innovation. This small and rather fragile construction firm more than any other is in need of a growing and sustainable GM every year if it is to grow profits. Nevertheless, the margin dependence of all UK construction firms and especially this smaller firm is a matter of worry. There is a lowest price tendering dynamic across the industry and a high GM dependence makes this untenable. This explains why so many policy scholars worry about the slim GMs in this industry.

Unlike GMs in the sectors of the UK construction industry, OMs show a variegated pattern. Only the buildings 41 and specialist trades 43-sectors show a positive effect of this determinant on profits while for the civil engineering firm, OMs do not matter. These results thus suggest the importance of cost leadership strategies, particularly in the specialist trades and buildings sectors in this industry.

Whether it be the rare and valuable cost-reducing resources or the effective resource bundles that help disintermediation, thus enabling lower operating costs, both are relevant only in the 41- and 43-sectors of this industry. Similarly, economies of scale, scope and learning that often underlie cost leadership abilities of firms play important profit-enhancing roles only in these two sectors. For the civil engineer, such cost-reducing strategic initiatives do not enhance profits. Thus, these results echo policy debates in the industry about the need for cost optimisation and benchmarking strategies in the civil engineering sector. When firms have no profit incentive to reduce costs or improve OMs, this is a serious adverse consequence for their large infrastructure developing clients. That is why benchmarking these firms' costs is so important.

Marketing and promotional expenditures in these intra-sector results have a negative profit effect only in the case of the specialist trades 43 construction firms. In large swathes of the UK industry comprising sectors 41 and 42, these expenditures exhibit insignificant effects on profits. UK building and civil engineering firms are not negatively affected by spending on marketing. Discovering under-served customers through product trialling, branding and customer reach strategies is not entirely futile. This intra-sector difference shows why normative policy scholars underline the need to distinguish the degree of commoditisation among the three sectors of UK construction. Marketing has a negative profit effect only for the specialist trades firm with its various commodities trades such as plumbing, electrics and carpentry. The very nature of these professions is such that they are best served by word-of-mouth referrals rather than any overt marketing and promotion.

The civil engineering 42-sector stands out in RG profit associations as it does in these findings. Only this sector does not display the standard inverse lifecycle-based relationship between RG and after tax profits. In both its sector peers, the firm that wishes to grow its revenues faster has to spend on both positioning and differentiating its products in the market and thus tolerate lower profits. It does seem that only in the specialist trades and buildings sectors do nascent phases of product development persist and there is stiff competition among younger firms to establish business models making RG a costly proposition. This intra-sector variation may also be attributed to the higher levels of sub-contracting that is often the characteristic of sectors 41 and 43 of the industry, unlike the civil engineering 42-sector. In these sectors, volatilities in asset specificity and opportunism may be greater. Nevertheless, this intra-sector variation must be traced to likely difficulties in RG due to outmoded tendering processes and the obsession with lowest price tendering that is ubiquitous both in the buildings and specialist trades sectors of the UK (Ive and Murray, 2013; Gruneberg and Francis, 2019; Ancell, 2007).

Overall, these intra-sector results reveal strategic differences. What stands out, however, is the distinct profit determination of the 42-sector civil engineering firm. Seven of the 12 determinants of firm performance in the regression model do not affect the profits of this firm. Leverage, marketing expenses, inventories or consumer credit have none of the negative effects that they do in the industry. Cash levels and OMs do not have any of the positive effects seen elsewhere. RG profitability patterns are not negative in this sector. Consequently, the business profit function of this firm has only five determinants. This is a much simpler operating template than its peers in the other two sectors.

9.3 Time and the determinants of industry and ISFP

Cutting the overall sample of firm-year observations using the credit crisis as the watershed, an even richer analysis has been provided in Chapter 8. The key conclusions that emerge are marshalled as per the VBMA concepts.

9.3.1 RM in the industry and its sectors before and after the credit crisis

The working capital sensitivities of the construction profit function undergo a metamorphosis after the credit crisis. Maintaining a positive working capital gap drops in importance as a profit determinant in all sectors of the industry. The drop is greatest in the 41- and 42-sectors while it is the smallest in the specialist trades 43-sector. This changed liquidity profit dynamics in supply chain-linked firms in different sectors clarifies why efficiently integrated and partnered supply chain in this industry is so critical. Surprisingly, across the industry after the crisis non-current assets become unimportant to profits. Ostensibly, even specialised technological non-current assets in the 42-sector civil engineering sector after the stressful period are of no consequence. In this sector, this worrying lack of incentives for the performing firm to invest in non-current assets is detrimental to the overall knowledge improvement function. Further research is warranted.

Cash levels of construction firms have become highly important in the UK as profit drivers after the crisis. It is the credit uncertainties that firms in all sectors faced during the credit crisis that may be at work behind the scenes. At the same time experiencing the glue-like characteristics of cash in distressing times a positive reinforcing cycle seems to have set in everywhere and especially in the 42-sector. It is the interlinked production stages of the value chain in the civil engineer's business model that seem to now require higher cash buffers. Price-based uncertainties engendered by the crisis also seem to be at work everywhere across the industry, engendering agency-based conflicts. This is what has heightened both the precautionary motivation to hold cash and enhanced its profit effect.

Chapter 7 shows that leverage has a negative effect on profits only in the buildings 41-sector of the UK construction industry and that debt does not affect profits. The many likely positive and negative effects of taking debt including economies of scale and scope and vertical integration benefits and potential bankruptcy dangers do not affect profits in large swathes of the industry in 42- and 43-sectors.

9.3.2 Competitive dynamics in the industry and its sectors before and after the credit crisis

The credit crisis has transformed the competitive business models of all three key sectors of the UK construction industry. After this period, inventories do not affect profits in any of these sectors of UK construction. This is especially surprising in the buildings and civil engineering sectors, both of which are project site-based sectors where inventory scheduling and management ought to matter. It explains why industry policy discourse has been so concerned with benchmarking inventory management in the industry. If firms do not see any profit incentive to properly calibrate inventories, then the largely inefficient production-based inventory scheduling anecdotally documented in the industry will only be exacerbated in future. This is hardly a salutary industry- or sector-based eventuality and needs careful regulatory and developmental attention.

The results also suggest that after the crisis advancing credit to consumers simply does not matter in any sector of the industry. Firms in all three sectors may choose to extend credit or not and it would make no difference to their profits. There is no longer any trade-off between advancing credit retaining custom or insisting on faster payment and losing potential custom anywhere in the industry. Now the UK firm, whether it is in the building, civil engineering or specialist trades sectors, has to decide consumer credit levels based on its individual circumstances.

Supplier credit levels after this enervating period have negative profit effects only in the 43 specialist trades and 41 buildings sectors. In the smallest 43-firm, this negative effect is the greatest. Thus, 43- and 41-firms in that descending order of magnitude must ensure they are resilient enough to pay suppliers promptly. The civil engineering 42-sector firm is entirely unaffected by supplier credit. This intra-sector variegation, especially after the economic storm of 2010, suggests that credit-based partnership and collaboration are asymmetrically important across the sectors now. For 43- and 41-firms, trust and collaboration with suppliers by paying them early is also the profitable option while for their 42 peers there is no such profit incentive. This creates an intra-sector tension wherein one very important sector of the industry firm has no profit-based motive to collaborate with suppliers by paying them promptly.

Post the crisis, TCIs are a consistent positive driver of profits only in the 42- and 43 sectors. Interestingly, the downturn magnified the positive profit effect many times for 42-sector firms. By contrast, 41 building sector firms have always been and remain impervious to such technology and capital investment influences. Thus, these rather more intuitive results prove that idiosyncratic and innovative investments and strategic barriers arising out of them play a singular positive role primarily in the civil engineer's business model.

9.3.3 MP in the industry and its sectors

The 43-sector specialist trades firms display the highest GM profit effects pre- and post-crisis while the 41-sector building firms display the lowest. By contrast, 42-sector civil engineers show the steepest drop in such effects post 2011. Intelligent segmentation and positioning of products and services have now become critical requisites mainly for UK specialist trades construction firms. Ostensibly after the economic storm, this sector now exhibits a greater degree of product variety as firms compete to product differentiate and gain the extra trading margin that has become so important. This echoes narratives among policy and industry commentators about this growing product variety and range in sector 43. In contrast, the civil engineer's service and product portfolio have become less substitutable after the crisis. Clients, anxious about the quality guarantees associated with this engineering sector's product are reluctant to switch firms and this explains why 42-sector profits are relatively unaffected by GMs.

The effect of cost efficiencies and cost leadership on profits undergoes several changes intra-sector in the UK construction industry after the credit crisis. The civil engineering firm displays a drastic jump in profit sensitivities to OMs while its specialist trades peer shows a huge drop in such sensitivity through this period. Now generic strategies of cost leadership based on rare inimitable and valuable resources or effective disintermediation involving eclectically chosen resource bundles have climbed in importance among civil engineers, unlike their specialist trades peers where such strategies are no longer as instrumental after the economic storm. The former firms are now more than ever in need of economies of scale, scope and learning in the changed environment with large scale clients increasingly stressing an expanded product quality imperative combined with overall unit cost reductions. An asymmetric effect of these cost efficiency drivers across the sectors is thus clearly evident among the sectors of UK construction after the credit crisis.

After the credit crisis, in no sector of the UK construction industry is there any evidence that marketing and promotion expenditures have a negative effect on profits. Instead, the complete insignificance of this determinant clarifies that such expenditures do not directly inhibit profits.

Finally, RG profitability patterns in these time-divided intra-sector results flag the specialist trades 43-sector as the only one where nascent business models remain a large part of the MP of firms. Everywhere else in the industry after the crisis growing revenues do not necessarily come at the expense of after tax profits. Only the specialist trades sector retains an ongoing battle between different business models wherein growing revenues faster requires MP and product development costs that extract a significant toll on profits.

9.4 Recommendations to firm managers

Having detailed the main conclusions out of the three regressions in this research, the next sections of this concluding chapter distil important recommendations that emerge therefrom.

Firm managers in the UK construction industry have the challenging task of improving firm performance. Many performance insights emerge from the conclusions that they need to take into account. In what follows, recommendations to managers are divided into two different parts. Part one enunciates managerial performance protocols arising out of key differences evident in the overall business functions in each sector of the industry. Part two outlines what each sector's managers should or should not do in respect of each of the identified VBMA determinants based on the conclusions above. The two parts combine to present a blueprint for best intra-sector firm-managerial-practice.

9.4.1 Overall business-model-based recommendations

Table 38: Intra-sector performance functions

SECTOR	Performance Function (Pre/Post)
Construction of buildings SIC 41	Function of 8/6 variables
Civil engineering SIC 42	Function of 8/4 variables
Specialised construction activities SIC 43	Function of 8/7 variables

Table 38 summarises the significant variables in the profit functions of the three key sectors of the UK construction industry. Before the credit crisis, all sectors had eight significant variables in their profit functions but after the crisis, the 42-sector profit function is the simplest comprising just four significant variables while that of the 43-sector is the most complex with seven significant variables. Thus, improving the performance of the civil engineering firm after the crisis is the simplest managerial task in the industry while that of improving the performance of the 43 specialist trades firm is relatively complex.

Firm managers in each sector also need to pay attention to a different span of variables post-2010. This is summarised in Table 39. It is the significant variables shown against each sector in the table that must be focused on. The task of calibrating between positive and negative variables is largely similar in sectors 41 and 43. For 42-sector managers a focus on just four variables all of which have a positive effect on profits suffices. Their managerial task is thus the simplest.

Table 39: Relevant/important variables per sector

SIC 41	SIC 42	SIC 43
NCATOTA (+)	CASHTOTA (+)	NCATOTA (+)
CASHTOTA (+)	INCTECHCAPINVESTOREV (+)	CASHTOTA (+)

DBTOTA (-)	GM (+)	TCTOTA (-)
TCTOTA (-)	OM (+)	INCTECHCAPINVESTOREV (+)
GM (+)		GM (+)
OM (+)		OM (+)
		RG (-)

Managers in all sectors of the UK construction industry need to pay attention to cash levels, GM and OMs and try diligently to increase them. However, managers in sectors 42 and 43 must take additional steps to increase technology and capital investment while those in sectors 41 and 43 must ensure positive working capital gaps at all times. Finally, trade creditor levels must be reduced by both 41 and 43 managers while only the 41-sector managers should avoid leverage to finance themselves.

9.4.2 VBMA determinants-based recommendations

This section details recommendations for managers in each of the twelve variables constituting the VBMA determinants of ISFP in the UK construction industry.

9.4.2.1 NCATOTA (working capital coverage)

Sector 41 – Managers of this buildings sector can afford to give less importance to working capital coverage after the crisis as it appears that profits are less sensitive to this variable. Therefore, by logic, such managers can focus strategically on non-current assets.

Sector 42 – Managers of this civil engineering sector may overlook working capital coverage as this determinant is insignificant in its influence on profits.

Sector 43 – In contrast in this specialist trades sector, working capital remains as important after the crisis as it was before it. Managers must ensure as high a positive working capital gap as possible.

Managers in all three sectors need to keep in mind these differing working capital-based imperatives and coordinate and collaborate with their partners in other sectors accordingly.

9.4.2.2 LPFETOTA (plant equipment asset proportions)

Sector 41 – Non-current assets simply do not matter to the profits of the buildings firm after the crisis. Managers in this sector can afford to remain under- or over-capitalised and this would make no difference to profits.

Sector 42 – Counter-intuitively, this technology-intensive civil engineering firm whose profits before the crisis used to be positively affected by its non-current asset proportions are now unaffected by such proportions. A drastic change has therefore occurred in this sector due to the credit scarcity period. Therefore, even these managers like their 41 and 43 peers can now afford to neglect land, property, furniture, fittings and equipment.

Sector 43 – In the specialist trades sector, profits are unaffected by non-current asset proportions. Firm managers need not pay any special attention to their AAs in terms of LPFE.

From an intra-sector perspective, this complete lack of significance of LPFETOTA in all sectors after the credit crisis suggests that managers across the industry may treat the business template of every firm as working capital rather than long-term capital orientated. Small wonder, then, that industry investigators corroborate an under-capitalised business model in large parts of the industry. It is therefore a recommendation that managers in all sectors (including the 42-sector civil engineering sector) keep this operational template in mind.

9.4.2.3 CASHTOTA (cash levels)

Sector 41 – Cash levels after the crisis have increased in their positive effect on profits in this buildings sector. Firm managers are hence well-advised to maintain strong cash balances on their balance sheet to grow profits.

Sector 42 – This is the sector in which cash proportions have nearly doubled in their positive effect on firm after tax profits after the crisis. It is the highest effect in the entire industry since the crisis. Thus, civil engineering firm managers need to maintain as high cash balances as possible to enhance their profits.

Sector 43 – In contrast to other sectors, cash proportions show a reduced positive effect on profits after the crisis. Despite this reduction in profit effect, firm managers in the sector cannot afford to neglect cash levels given the large size of the coefficient in the findings.

Although cash levels remain a positive driver of profits across all sectors of the industry, the sensitivities of each sector remain very different from each other. Firm managers must keep these differential sensitivities in mind while dealing with intra-sector partners to ensure smooth coordination in the supply chain and the industry.

9.4.2.4 DBTOTA (debt levels)

Sector 41- Leverage turned distinctly negative reducing profits after the crisis in the buildings sector. Therefore, firm managers in this sector are well-advised to avoid financing through debt.

Sector 42 – Firm profits remain unaffected by debt whether before or after the credit crisis. There is thus no normative recommendation for civil engineering firm managers. They may choose to take or eschew debt depending on individual firm circumstances.

Sector 43 – Although an increase in debt levels in this specialist trades firm used to cause a strong decline in its profits before 2010, now such increases in debt levels have no significant influence after the crisis. Managers in this sector should note this sea change in their business models. Like their 42-firm peers, these managers too can decide the leverage question based entirely on individual firm circumstances.

Firm managers in all sectors must recognise how leverage is negative only in the buildings sector. Firms in the other two sectors and supply chain partners must be wary of buildings firms that do take debt due to this clear underperformance imperative.

9.4.2.5 INVENTOTA (inventory levels)

Sectors 41, 42 and 43 – Inventory levels continue to display insignificant effects on firm profits in all three key sectors of the industry after the crisis. There is no normative advice for firm managers in any of these sectors. This is a worrying result as anecdotal evidence abounds that in the buildings and civil engineering sectors firms often suffer large profit declines due to inventory pile-ups. Therefore, firm managers in these sectors must exercise discretion and judgement in respect of this finding. Individual firm circumstances must be the guide to deciding inventory levels.

9.4.2.6 TDTOTA (trade debt levels)

Sector 41 – A significant negative effect on profit before 2010 turns insignificant after the crisis. The buildings firm manager needs to recognise that their firm now need not insist that customers pay promptly or in cash. Instead, there can be greater accommodation of smaller and cash-poor clients by giving them more generous credit terms.

Sector 42 – Before and after the credit crisis the civil engineering firm’s profit is not affected by the levels of consumer credit extended by it. Managers in this sector can also accommodate customers and elongate credit terms although such cash-poor clients may be few as most are wealthy infrastructure clients.

Sector 43 – In this specialist trades sector, profit remains unaffected by the consumer credit levels chosen by the firm. These firms may give or withhold credit as they please. While this may be an obvious managerial recommendation to managers, the smaller size of this 43-firm should imply a cautious approach to giving liberal credit to customers. The best advice would be for sector firm managers to pay close heed to their internal situations and their customer’s financial situation before granting or rejecting credit.

9.4.2.7 TCTOTA (trade creditor levels)

Sector 41 – Taking trade credit from suppliers has halved in its negative effect on profits. Building firm managers are well-advised to take note of this. The change in credit environment in the sector post-crisis now allows partial scope to these managers to delay payments for supplies and face far less reduction in profits. Therefore, they are well-advised to avail themselves of such deferments, albeit discretionarily as and when appropriate.

Sector 42 – Supplier credit in this sector after the crisis has no significant effect on profits. Civil engineering managers need no longer fear the consequences of availing credit from suppliers. They may choose to either take such credit or avoid it.

Sector 43 – This is the only sector in the UK where the negative effect of supplier credit has climbed in importance after the crisis. Managers are advised not to avail trade credit from suppliers. This is ironic given that these smaller specialist trade firms are more in need of supplier credit to balance their cash flows.

9.4.2.8 INCTECHCAPINVESTOREV (technological and capital investment)

Sector 41 – Steady investment in TCI does not matter to building profits, whether before or after the crisis.

Sector 42 – A sharp increase is seen in the positive profits effect of technology and capital investment in the civil engineer's business model after the crisis. Therefore, firm managers in this sector are advised to establish a systematic schedule of investment in technology and capital assets.

Sector 43 – Although systematic investment in technology capital assets in this specialist trades firm still has a positive profit effect, it is much reduced after the crisis.

Thus, the intra-sector picture suggests that firm managers in only the civil engineering sector ought to pay focused attention to systematic TCIs. In other parts of the industry, such investments do not have any significant effect on profits.

9.4.2.9 GM

Sector 41 – A near doubling of sectoral GM effect on profits post-crisis suggests how important it is for the buildings sector managers to differentiate their market offerings. Product variety is the need of the hour in this sector of UK construction.

Sector 42 – GM effects on profits have halved in this sector after the crisis. The upheavals caused by the crisis seem to have enhanced the uniqueness of the civil engineering firm's product and service range. Managers in these firms can afford to pay less attention to product differentiation.

Sector 43 – The specialist trades firm is the only one in UK construction that exhibits a steep rise in GM profit associations. In this commodity sector, post-crisis product differentiation is an important profit influence.

The intra-sector variation in this variable underlines an important aspect of GM to profit association in this industry. The 41- and 43-firm managers need to increase their focus on product differentiation after the crisis period while civil engineers can afford to reduce such focus.

9.4.2.10 OM

Sector 41 – In this sector, OM increases its profits effect nearly four-fold after the crisis. Building firm managers are advised to reduce operating costs by using economies of scale, scope and learning in their business model. This will enable them to improve margins and thus profits.

Sector 42 – Civil engineering firms show a highly significant positive profits effect of OM after the crisis unlike earlier. The business model of this firm seems to have changed. Managers must now pay close attention to cost efficiencies if they are to improve the profits of this firm. The many initiatives taken by the government and public procurement specialists in the UK to benchmark operating costs in this sector are rightly directed and echo these findings.

Sector 43 – In stark contrast, OM profit effects among specialist trades firms drop by nearly two-thirds after the crisis. Operating cost overruns do not have as much of a dampening effect on firm profits in this sector after the credit crisis. Firm managers are well-advised to keep this in mind.

9.4.2.11 SGATOTA – sectors 41, 42 and 43

Selling general and administrative expenditures do not affect profits in any of the three main sectors of the UK construction industry firm managers across the industry are consequently well-advised to spend frugally and efficiently on this. The results should be construed to be an endorsement of the general futility of marketing and promotional expenditures everywhere in this industry.

9.4.2.12 RG

Sectors 41 and 42 – Both sector firms after the crisis display no trade-off between RG and profits. Buildings and civil engineering firms can therefore grow revenues faster without suffering the usual profitability declines. It is recommended that these firms strive to achieve greater market penetration and higher market shares.

Sector 43 – Post the crisis this is the only sector in UK construction where firms still have to trade off RG against profitability. Firm business models continue to be nascent and changing. Therefore, managers should take note of this trade-off that they face. An intelligent calibrated approach between growing revenues faster and profits is required.

9.5 Recommendations to regulators and policy framers

My conclusions flag important regulatory and policy-related aspects that have an intricate bearing on the firm's performance question in the UK construction industry. In what follows, six such different regulatory and policy-related aspects are presented and analysed. They are summarised in Table 40.

9.6 Novel contributions of this research to the body of knowledge

This thesis has contributed in five singular ways to the body of knowledge in strategic firm performance studies in the UK construction industry. In what follows, theory, policy practice and methodology are the four distinct categories under which these contributions are classified.

9.6.1 Theory-based contribution

First, the thesis has expanded existing theory on firm performance in the UK construction industry. It has added a versatile theoretical tool of performance assessment to analyse ISFP in the industry. It has also shown how the tool can be used at various levels to explicate the determinants of such performance. The nine eclectically identified determinants of firm performance in this tool encapsulate a holistic and complete assessment of firm performance in the industry and its sectors. Both the external and internal perspectives of firm performance have been combined in this tool and thus the theoretical repertoire of firm performance research solutions in the construction industry has been expanded.

Second, this VBMA tool of assessment has combined theoretical narratives from the TCEs, the RBV, the ISP, marketing and several related strategy-based paradigms. Through a careful sifting and prioritisation of the differing arguments from all these theories, the thesis has demonstrated how ISFP can be successfully reconstructed. This has refuted the criticism that the tool is too generic and diffuse by combining so many theories into one explanation.

Table 40: Policy recommendations

Policy-related / regulatory aspect	**Discussion**	**Recommendation**
Transactional short-term liquidity-orientated business model	There is a distinct lack of positive profit effect from long term AAs especially in the 42- and 43-sectors.	Tax incentives especially to sector 42-sector civil engineering firms to invest in non-current assets. Other positive incentives for firms in 42- and 43-sectors to invest in long-term assets.
Leverage	In sectors 42 and 43 there is a worrying lack of significance in the effect of leverage on profits. This may incite firms to take excessive debt.	Leverage best practice policy guidelines should be framed for 42/43-sectors to encourage firms to stick to healthy leverage levels. Special institutional mechanisms for efficient and effective leverage access may need to be set up in these two sectors. Need to share and disseminate best practice guidelines from across the globe on effective leverage use in the construction industry.
Inventory Management	In the findings, inventory levels show ambiguous effects on after tax profits of firms in all three sectors of the UK construction industry. This is worrying because anecdotal and other evidence abounds in this project site-based industry that inventory pile-ups are an endemic problem. Lack of a profit incentive to manage inventory will only add to this problem.	Policy framers and regulators must design effective inventory management protocols to encourage project site de-clutter in all sectors of the industry. An inventory regulatory mechanism must be set up in the industry to impose penalties on firms that continue to violate inventory norms. Seminars and educational forums on effective inventory management in the industry should be regularly organised to share best practices in this regard from around the globe.
Consumer Credit	After the credit crisis, trade debtors have no significant effect on profits in any sector of UK construction in the findings. This could result in unfair customer-buyer relationships in the industry. These could only add to already growing adverse relationships between firms in the industry.	Trade credit guidelines for all sectors and supply chain partners in the industry need to be developed to enable balanced consumer credit decisions. Government procurement contracts must insist on looser credit terms for supply chain participants especially smaller firms at the lowest rung of the contract chain.
Supply chain partnerships and collaboration	The findings in many determinants of profits in UK construction sectors show that there is an overweening need for supply chain-based collaborations and partnerships across them.	Policy framers should take active steps to encourage holistic partnerships among firms across all three sectors of the UK industry. Trade financing bodies in the industry must insist that firms accessing their credit channels develop healthy collaborative relations with trade partners.

Technology and capital investment	Post the crisis the findings reveal an important positive effect of technology and capital investment on firm PAT in the 42-sector civil engineering sector. anecdotal and policy-based discussions also underline the need for such investment in this sector that is sorely lacking.	Technology-based knowledge-generating and disseminating institutions are much needed in the civil engineering sector of UK construction. The government needs to facilitate the development of such an institution. This will ensure that technology adoption not only in the civil engineering sector but also in the industry is accelerated. There is also a need to set up active bilateral exchanges of technology best practices in all sectors of the UK industry. Advanced construction technology practices from other European nations need embedding through such interchanges between the UK and these countries. Once again the government must play the role of coordinator and catalyst in such an initiative.

9.6.2 Contribution to policy

The research based on the new tool of performance assessment has enabled a set of six recommendations to policy framers and regulators in the UK construction industry. In business models, leverage, inventory management, consumer credit, supply chain collaboration and partnerships, and TCIs, the thesis has identified recommendations that help improve firm performance in the industry, its key sectors and across time. Many of these recommendations are directed at the government as the prime facilitator of the industry. Others give specific advice to other stakeholders in the industry such as expert panels, discussion forums and seminar groups. A novel recommendation is to set up a technology learning and facilitating institution in the civil engineering sector of the industry.

Apart from these specific recommendations, the thesis also adds in different ways to policy debate and commentary in the industry. For example, in intra-sector comparisons across the determinants of firm performance, many notable differences are highlighted that add to extant understandings of how buildings, civil engineering and specialist trade firms in the industry work. Key widely-accepted understandings are amended with the quantitative evidence emerging from the thesis. Similarly in time-divided findings, the research reveals some key differences in the way in which different sectoral firms respond to conditions of economic stress. Such differences raise several questions about earlier understandings of the business models of firms in these sectors.

9.6.3 Contribution to firm practice

The research has identified how each sector of the UK construction industry has a unique and differentiated profit function. In particular after the crisis, by showing that the civil engineering firm has the simplest set of four positive determinants while sector peers have more complex functions, the thesis has discovered a key intra-sector difference. Firm managers in each sector can now manage their performance as they negotiate efficiently with sector peers. In addition, the set of different determinants unveiled in each sector has made the task of firm managers in each of these sectors that much more cogent.

Twelve normative recommendations emerge from the findings for each sector's managers. Whether it be in current or non-current AAs, leverage, inventory management or the six other determinants of ISFP, these managers are given specific guidelines as to the best firm practice. Thus, a ready blueprint for performance improvement in each sector of UK construction is uniquely placed before them.

Finally, in various intra-sector and time-divided discussions, the thesis makes clear recommendations to firm managers in each sector on how they must deal and negotiate with counterparts in other sectors and those among supply chain partners. This is unprecedented as a firm-to-firm practice manual and contributes to the growing field of firm practice manuals in UK construction.

9.6.4 Contribution to research methods

This thesis has applied the same set of eclectically collated determinants in three regressions: industry, intra-sector and time-divided. Each of these regressions is panel-based comprising a large number of firm-year observations. The implementation of three such regressions across the UK construction industry is a first for this industry and expands the repertoire of solutions. Baseline results are now available to future researchers to benchmark their findings.

9.7 Future research directions

The thesis is best viewed as an inflection point in the trajectory of firm performance studies in the UK construction industry. There are inevitably other important research directions that future scholars of firm performance in UK construction may fruitfully engage with.

First, the use of nine determinants and twelve variables is eclectic and wide-spanning but is by no means the only or best way of assessing the concepts of the VBM. Undoubtedly it is an efficient use of the firm financial data that are easily available in industry databases. Yet, surely, there could be many other ways to select, combine or even transform variables to better operationalise the theory itself. For example, in CD, the levels of concentration of the industry or its sectors could be used as an indicator or determinant. Similarly, in MP scholars could use demand-based elasticity measures to fortify understandings of how exactly a construction firm's efforts to differentiate are impeded or aided by the substitutability of its product or service portfolio. Future generations of scholars must take up this task and use these findings as a base to calibrate research efforts in expanding the vocabulary of variables in UK construction performance research.

Second, there is a need to extend the VBMA identified in the thesis in various ways. RM, CD and MP represent three cornerstones of value creation and appropriation and hence firm performance in UK construction. The thesis has proven this both at the industry and the intra-sector levels. Yet important managerial aspects underlie these concepts that may account for firm performance differences in a more detailed way. For example, Becerra (2009) identifies how managerial processes, methods and routines could be a singular differentiating factor in each of these concepts. Good firms could be implementing such methods and routines and thus stealing a march over their peers. Insofar as my thesis has only focused on the concepts treating them as performance differentiators in themselves, the instrumentalities of underlying managerial efforts and initiatives are hidden behind the numbers. Future generations of scholars would do well to find new ways to conceptualise and operationalise these managerial processes and protocols to better understand how resources management, CD and MP truly affect ISFP in the UK construction industry

Finally, the thesis is a quantitative firm performance investigation using a wide-spanning theoretical tool of assessment. The few earlier quantitative studies that exist lack this width of span or theory-based grounding. It has already been shown how most firm performance studies in UK construction are qualitative and opinion-based. Future generations of scholars need to adopt a wide variety of research trajectories to expand the body of knowledge. Mixed-method research combining both qualitative and quantitative aspects is an important need in the industry and scholarly effort in this direction would be vital and is strongly suggested.

9.8 Research limitations

Significant limitations exist in this research effort. The main ones can be categorised as theoretical, conceptual and data-based.

9.8.1 Theoretical limitations

Firm strategy is complex and multidimensional and cannot be completely captured even by a VBMA that combines several strategic theories of firm performance. Although this framework is wide and covers a large part of the manager’s strategic landscape, some strategic aspects of the firm's performance have likely slipped through. It is to be hoped that these theoretical blind spots will be located and filled by future research in this field.

9.8.2 Conceptual limitations

From a conceptual perspective, the nine determinants identified are not necessarily the only ones that have performance effects nor are they the best ones that ought to be modelled. Yet, a start has been made by the thesis. A wide-span set of nine variegated determinants has been tested and analysed. This should now be taken forward with bolder attempts to identify newer determinants of ISFP and better ways to model them.

9.8.3 Methodological limitations

From a technical standpoint, two limitations can be identified. First, the use of an advanced panel-based OLS regression analysis model is not the only way to assess firm performance. Many quantitative approaches could be used to determine ISFP. For example, data envelopment analyses or structured regressions should be trialled. If selected, they could yield even more meaningful results. Second, the choice of variables to proxy determinants of firm performance is based on data availability and sufficiency considerations in this sample. However, there are better variable measures that more closely mimic chosen determinants and thus provide more effective explanations for firm performance differences. This is where future academic research would best be concentrated.

9.8.4 Data-based limitations

Although this data sample encompasses two decades of firm-year observations between 2000 and 2019 for 3,096 UK construction firms, this still represents just a fraction of the number of such firms in the country. More data can be collected from other sources and this would help more robust research in the industry.

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Appendices

Appendix 1: Instrumental variable regression with 2-way fixed effects – Overall Industry

Variables	2 way FE	IV reg with 2way FE
	b	b
NCATOTA	0.732***	199.137*
LPFETOTA	0.179	236.028**
CASHTOTA	0.866***	248.051*
DEBTOTA	-0.711***	186.971***
INVENTOTA	-0.373***	245.494**
TDTOTA	-0.299***	82.029***
TCTOTA	-0.647***	37.303***
INCTECHCAPINVESTOREV	0.054***	-1.335***
GM	1.285***	-40.633***
OM	1.951***	-136.415***
SGATOTA	-0.197***	-195.496
RG	-0.033***	7.061***

Appendix 2: Instrumental variable regressions with 2-way fixed effects – Sectors SIC 41, SIC 42 and SIC 43

	Construction of buildings sector SIC code 41		Civil engineering sector SIC code 42		Specialised construction activities sector SIC code 43	
	2 way FE	IV reg with 2way FE	2 way FE	IV reg with 2way FE	2 way FE	IV reg with 2way FE
	b	b	b	b	b	b
NCATOTA	0.569***	153.836	0.943***	-4366.23	0.859***	5919.302
LPFETOTA	-0.108	-559.713	0.567*	84.16	0.205	129.398
CASHTOTA	0.774***	289.359	0.994***	533.103	0.747***	143.726
DEBTOTA	-0.642***	104.414	-0.435	67.194	-0.667*	-927.165
INVENTOTA	-0.339**	86.548	-0.421	-678.312	-0.350*	-234.184
TDTOTA	-0.450***	87.801**	-0.21	69.236	-0.183*	200.632
TCTOTA	-0.641***	40.586***	-0.567*	23.891***	-0.356**	56.650***
INCTECHCAPINVESTOREV	0.028**	-1.146***	0.123	-2.122	0.267*	-1.474*
GM	1.078***	-41.060**	1.639**	-64.733	2.858***	-32.754**
OM	1.628***	-93.118	2.696	-364.125	4.138***	-44.581*
SGATOTA	-0.121	-503.157	-0.067	-60.788	-0.198**	-115.12
RG	-0.019*	6.356***	-0.022	4.250***	-0.041***	12.760*

Overall industry, 2000-2010

Variable	Mean	Median	SD	CV	Min	Max	N
Ln (PAT)	6.440	6.290	1.791	0.278	1.946	11.937	15835
NCATOTA	0.197	0.175	0.280	1.423	-1.014	0.990	22438
LPFETOTA	0.064	0.005	0.148	2.299	0.000	0.898	22438
CASHTOTA	0.148	0.080	0.179	1.210	0.000	0.869	22438
DEBTOTA	0.072	0.000	0.174	2.424	0.000	1.000	22438
INVENTOTA	0.171	0.049	0.255	1.495	0.000	0.986	22438
TDTOTA	0.194	0.114	0.220	1.132	0.000	0.853	22438
TCTOTA	0.189	0.130	0.198	1.049	0.000	0.772	22438
INCTECHCAPINVESTOREV	0.894	0.056	3.747	4.192	0.000	32.577	14405
GM	0.186	0.151	0.184	0.989	-0.233	1.000	15450
OM	0.043	0.032	0.288	6.754	2.281	1.436	15450
SGATOTA	0.314	0.186	0.471	1.502	0.000	2.817	22438
RG	1.663	1.606	1.245	0.748	-0.951	8.351	9765
Ln (TOTR)	10.034	9.948	1.519	0.151	4.796	14.572	15449

Overall industry, 2011-2019

Variable	Mean	Median	SD	CV	Min	Max	N
Ln (PAT)	7.018	6.937	1.759	0.251	1.946	11.937	17746
NCATOTA	0.243	0.223	0.292	1.201	-1.014	0.990	22656
LPFETOTA	0.089	0.019	0.154	1.732	0.000	0.898	22656
CASHTOTA	0.168	0.111	0.177	1.053	0.000	0.869	22656
DEBTOTA	0.079	0.000	0.183	2.319	0.000	1.000	22656
INVENTOTA	0.150	0.023	0.255	1.695	0.000	0.986	22656
TDTOTA	0.282	0.253	0.250	0.888	0.000	0.853	22656
TCTOTA	0.210	0.164	0.195	0.930	0.000	0.772	22656
INCTECHCAPINVESTOREV	0.867	0.045	3.777	4.358	0.000	32.577	20400
GM	0.182	0.147	0.176	0.971	-0.233	1.000	20407
OM	0.073	0.037	0.257	3.492	2.281	1.436	20407
SGATOTA	0.270	0.167	0.402	1.488	0.000	2.817	22656
RG	1.811	1.691	1.224	0.676	-4.104	9.557	14202
Ln (TOTR)	10.385	10.207	1.216	0.117	4.796	14.572	20405

Appendix 3: Summary statistics – Overall industry tables

Overall industry, 2000-2019

Variable	Mean	Median	SD	CV	Min	Max	N
Ln (PAT)	6.745	6.655	1.798	0.267	1.946	11.937	33581
NCATOTA	0.220	0.198	0.287	1.304	-1.014	0.990	45094
LPFETOTA	0.077	0.011	0.151	1.975	0.000	0.898	45094
CASHTOTA	0.158	0.096	0.178	1.128	0.000	0.869	45094
DEBTOTA	0.075	0.000	0.179	2.370	0.000	1.000	45094
INVENTOTA	0.161	0.034	0.255	1.590	0.000	0.986	45094
TDTOTA	0.238	0.181	0.240	1.006	0.000	0.853	45094
TCTOTA	0.199	0.148	0.197	0.987	0.000	0.772	45094
INCTECHCAPINVESTOREV	0.878	0.050	3.765	4.288	0.000	32.577	34805
GM	0.183	0.148	0.180	0.979	-0.233	1.000	35857
OM	0.060	0.035	0.271	4.503	-2.281	1.436	35857
SGATOTA	0.292	0.175	0.438	1.502	0.000	2.817	45094
RG	1.751	1.655	1.235	0.705	-4.104	9.557	23967
Ln (TOTR)	10.233	10.112	1.366	0.133	4.796	14.572	35854

Overall industry, 2000-2010

Variable	Mean	Median	SD	CV	Min	Max	N
Ln (PAT)	6.440	6.290	1.791	0.278	1.946	11.937	15835
NCATOTA	0.197	0.175	0.280	1.423	-1.014	0.990	22438
LPFETOTA	0.064	0.005	0.148	2.299	0.000	0.898	22438
CASHTOTA	0.148	0.080	0.179	1.210	0.000	0.869	22438
DEBTOTA	0.072	0.000	0.174	2.424	0.000	1.000	22438
INVENTOTA	0.171	0.049	0.255	1.495	0.000	0.986	22438
TDTOTA	0.194	0.114	0.220	1.132	0.000	0.853	22438
TCTOTA	0.189	0.130	0.198	1.049	0.000	0.772	22438
INCTECHCAPINVESTOREV	0.894	0.056	3.747	4.192	0.000	32.577	14405
GM	0.186	0.151	0.184	0.989	-0.233	1.000	15450
OM	0.043	0.032	0.288	6.754	2.281	1.436	15450
SGATOTA	0.314	0.186	0.471	1.502	0.000	2.817	22438
RG	1.663	1.606	1.245	0.748	-0.951	8.351	9765
Ln (TOTR)	10.034	9.948	1.519	0.151	4.796	14.572	15449

Overall industry, 2011-2019

Variable	Mean	Median	SD	CV	Min	Max	N
Ln (PAT)	7.018	6.937	1.759	0.251	1.946	11.937	17746
NCATOTA	0.243	0.223	0.292	1.201	-1.014	0.990	22656
LPFETOTA	0.089	0.019	0.154	1.732	0.000	0.898	22656
CASHTOTA	0.168	0.111	0.177	1.053	0.000	0.869	22656
DEBTOTA	0.079	0.000	0.183	2.319	0.000	1.000	22656
INVENTOTA	0.150	0.023	0.255	1.695	0.000	0.986	22656
TDTOTA	0.282	0.253	0.250	0.888	0.000	0.853	22656
TCTOTA	0.210	0.164	0.195	0.930	0.000	0.772	22656
INCTECHCAPINVESTOREV	0.867	0.045	3.777	4.358	0.000	32.577	20400
GM	0.182	0.147	0.176	0.971	-0.233	1.000	20407
OM	0.073	0.037	0.257	3.492	2.281	1.436	20407
SGATOTA	0.270	0.167	0.402	1.488	0.000	2.817	22656
RG	1.811	1.691	1.224	0.676	-4.104	9.557	14202
Ln (TOTR)	10.385	10.207	1.216	0.117	4.796	14.572	20405

Appendix 4: Summary statistics by sector and period tables

Sector: 41. 2000-2019

Variable	Mean	Median	SD	CV	Min	Max	N
Ln (PAT)	7.027	6.908	1.991	0.283	1.946	11.937	15537
NCATOTA	0.240	0.205	0.320	1.332	-1.014	0.990	20556
LPFETOTA	0.065	0.005	0.152	2.334	0.000	0.898	20556
CASHTOTA	0.150	0.081	0.181	1.205	0.000	0.869	20556
DEBTOTA	0.092	0.000	0.206	2.241	0.000	1.000	20556
INVENTOTA	0.247	0.057	0.324	1.313	0.000	0.986	20556
TDTOTA	0.171	0.057	0.215	1.257	0.000	0.853	20556
TCTOTA	0.184	0.105	0.206	1.119	0.000	0.772	20556
INCTECHCAPINVESTOREV	1.424	0.040	4.996	3.509	0.000	32.577	16639
GM	0.181	0.124	0.214	1.185	-0.233	1.000	17149
OM	0.078	0.035	0.350	4.468	-2.281	1.436	17149
SGATOTA	0.218	0.106	0.412	1.890	0.000	2.817	20556
RG	1.676	1.573	1.243	0.741	-4.104	9.425	11288
Ln (TOTR)	10.339	10.243	1.504	0.145	4.796	14.572	17146

Sector: 42. 2000-2019

Variable	Mean	Median	SD	CV	Min	Max	N
Ln (PAT)	6.615	6.632	1.513	0.229	1.946	11.937	3943
NCATOTA	0.194	0.175	0.250	1.291	-1.014	0.990	5253
LPFETOTA	0.099	0.024	0.162	1.632	0.000	0.898	5253
CASHTOTA	0.173	0.123	0.176	1.017	0.000	0.869	5253
DEBTOTA	0.075	0.002	0.180	2.385	0.000	1.000	5253
INVENTOTA	0.065	0.010	0.120	1.830	0.000	0.986	5253
TDTOTA	0.286	0.269	0.242	0.849	0.000	0.853	5253
TCTOTA	0.220	0.188	0.194	0.881	0.000	0.772	5253
INCTECHCAPINVESTOREV	0.601	0.071	2.662	4.426	0.000	32.577	4096
GM	0.148	0.129	0.139	0.940	-0.233	1.000	4216
OM	0.045	0.032	0.208	4.607	-2.281	0.855	4216
SGATOTA	0.308	0.199	0.462	1.498	0.000	2.817	5253
RG	1.820	1.696	1.230	0.676	0.000	7.766	2869
Ln (TOTR)	10.252	10.138	1.274	0.124	4.796	14.572	4216

Sector: 43. 2000-2019

Variable	Mean	Median	SD	CV	Min	Max	N
Ln (PAT)	6.333	6.330	1.487	0.235	1.946	11.937	11830
NCATOTA	0.208	0.204	0.250	1.202	-1.014	0.990	16194
LPFETOTA	0.075	0.018	0.133	1.758	0.000	0.898	16194
CASHTOTA	0.167	0.112	0.176	1.056	0.000	0.869	16194
DEBTOTA	0.047	0.000	0.120	2.551	0.000	1.000	16194
INVENTOTA	0.089	0.029	0.139	1.562	0.000	0.986	16194
TDTOTA	0.311	0.299	0.250	0.803	0.000	0.853	16194
TCTOTA	0.221	0.196	0.189	0.854	0.000	0.772	16194
INCTECHCAPINVESTOREV	0.193	0.048	1.286	6.661	0.000	32.577	11647
GM	0.194	0.181	0.126	0.647	-0.233	1.000	11996
OM	0.038	0.035	0.138	3.577	-2.281	1.436	11996
SGATOTA	0.365	0.283	0.436	1.194	0.000	2.817	16194
RG	1.789	1.706	1.204	0.673	0.000	9.557	8169
Ln (TOTR)	10.015	9.942	1.122	0.112	4.796	14.572	11996

Sector: 41. 2000-2010

Variable	Mean	Median	SD	CV	Min	Max	N
Ln (PAT)	6.768	6.633	1.963	0.290	1.946	11.937	7258
NCATOTA	0.216	0.179	0.309	1.433	-1.014	0.990	9882
LPFETOTA	0.072	0.004	0.174	2.411	0.000	0.898	9882
CASHTOTA	0.142	0.066	0.182	1.281	0.000	0.869	9882
DEBTOTA	0.083	0.000	0.193	2.319	0.000	1.000	9882
INVENTOTA	0.258	0.081	0.324	1.253	0.000	0.986	9882
TDTOTA	0.138	0.031	0.187	1.358	0.000	0.853	9882
TCTOTA	0.185	0.099	0.210	1.135	0.000	0.772	9882
INCTECHCAPINVESTOREV	1.372	0.046	4.834	3.525	0.000	32.577	6996
GM	0.181	0.127	0.213	1.173	-0.233	1.000	7500
OM	0.047	0.032	0.365	7.799	-2.281	1.436	7500
SGATOTA	0.251	0.119	0.456	1.816	0.000	2.817	9882
RG	1.626	1.557	1.245	0.766	-0.951	8.351	4634
Ln (TOTR)	10.191	10.110	1.643	0.161	4.796	14.572	7499

Sector: 41. 2011-2019

Variable	Mean	Median	SD	CV	Min	Max	N
Ln (PAT)	7.255	7.122	1.987	0.274	1.946	11.937	8279
NCATOTA	0.262	0.232	0.327	1.247	-1.014	0.990	10674
LPFETOTA	0.059	0.006	0.128	2.182	0.000	0.898	10674
CASHTOTA	0.158	0.093	0.180	1.139	0.000	0.869	10674
DEBTOTA	0.100	0.000	0.217	2.172	0.000	1.000	10674
INVENTOTA	0.237	0.036	0.325	1.372	0.000	0.986	10674
TDTOTA	0.202	0.090	0.234	1.158	0.000	0.853	10674
TCTOTA	0.184	0.111	0.203	1.103	0.000	0.772	10674
INCTECHCAPINVESTOREV	1.462	0.037	5.110	3.496	0.000	32.577	9643
GM	0.181	0.122	0.216	1.194	-0.233	1.000	9649
OM	0.103	0.038	0.335	3.264	-2.281	1.436	9649
SGATOTA	0.187	0.095	0.363	1.944	0.000	2.817	10674
RG	1.711	1.581	1.240	0.725	-4.104	9.425	6654
Ln (TOTR)	10.454	10.316	1.376	0.132	4.796	14.572	9647

Sector: 42. 2000-2010

Variable	Mean	Median	SD	CV	Min	Max	N
Ln (PAT)	6.218	6.190	1.499	0.241	1.946	11.270	1815
NCATOTA	0.172	0.161	0.242	1.407	-1.014	0.990	2623
LPFETOTA	0.064	0.007	0.143	2.249	0.000	0.898	2623
CASHTOTA	0.152	0.095	0.171	1.126	0.000	0.869	2623
DEBTOTA	0.076	0.000	0.191	2.523	0.000	1.000	2623
INVENTOTA	0.081	0.016	0.134	1.655	0.000	0.986	2623
TDTOTA	0.225	0.179	0.228	1.016	0.000	0.853	2623
TCTOTA	0.202	0.156	0.194	0.961	0.000	0.772	2623
INCTECHCAPINVESTOREV	0.739	0.080	3.023	4.090	0.000	32.577	1653
GM	0.145	0.127	0.143	0.986	-0.233	1.000	1773
OM	0.043	0.026	0.225	5.229	-2.281	0.855	1773
SGATOTA	0.324	0.208	0.491	1.515	0.000	2.817	2623
RG	1.706	1.595	1.278	0.749	0.000	7.399	1145
Ln (TOTR)	9.959	9.927	1.421	0.143	4.796	13.809	1773

Sector: 42. 2011-2019

Variable	Mean	Median	SD	CV	Min	Max	N
Ln (PAT)	6.953	7.016	1.442	0.207	1.946	11.937	2128
NCATOTA	0.216	0.195	0.257	1.189	-1.014	0.990	2630
LPFETOTA	0.135	0.070	0.171	1.273	0.000	0.898	2630
CASHTOTA	0.195	0.153	0.179	0.918	0.000	0.869	2630
DEBTOTA	0.075	0.005	0.168	2.236	0.000	1.000	2630
INVENTOTA	0.050	0.007	0.101	2.028	0.000	0.962	2630
TDTOTA	0.346	0.354	0.241	0.696	0.000	0.853	2630
TCTOTA	0.238	0.208	0.192	0.806	0.000	0.772	2630
INCTECHCAPINVESTOREV	0.508	0.066	2.382	4.689	0.000	32.577	2443
GM	0.151	0.132	0.137	0.907	-0.233	1.000	2443
OM	0.047	0.037	0.195	4.171	-2.281	0.819	2443
SGATOTA	0.293	0.193	0.431	1.471	0.000	2.817	2630
RG	1.896	1.770	1.191	0.628	0.000	7.766	1724
Ln (TOTR)	10.465	10.276	1.109	0.106	4.796	14.572	2443

Sector: 43. 2000-2010

Variable	Mean	Median	SD	CV	Min	Max	N
Ln (PAT)	5.995	5.951	1.489	0.248	1.946	11.375	5631
NCATOTA	0.185	0.181	0.251	1.360	-1.014	0.990	8350
LPFETOTA	0.048	0.006	0.096	1.993	0.000	0.898	8350
CASHTOTA	0.159	0.097	0.180	1.132	0.000	0.869	8350
DEBTOTA	0.048	0.000	0.125	2.594	0.000	1.000	8350
INVENTOTA	0.103	0.041	0.150	1.460	0.000	0.986	8350
TDTOTA	0.251	0.210	0.241	0.961	0.000	0.853	8350
TCTOTA	0.198	0.163	0.190	0.960	0.000	0.772	8350
INCTECHCAPINVESTOREV	0.221	0.054	1.480	6.701	0.000	32.577	4699
GM	0.201	0.187	0.138	0.687	-0.233	1.000	5047
OM	0.033	0.034	0.164	5.015	-2.281	1.000	5047
SGATOTA	0.371	0.285	0.467	1.260	0.000	2.817	8350
RG	1.669	1.628	1.215	0.728	0.000	8.240	3270
Ln (TOTR)	9.749	9.667	1.289	0.132	4.796	14.572	5047

Sector: 43.2011-2019

Variable	Mean	Median	SD	CV	Min	Max	N
Ln (PAT)	6.641	6.671	1.416	0.213	1.946	11.937	6199
NCATOTA	0.232	0.231	0.246	1.059	-1.014	0.990	7844
LPFETOTA	0.104	0.038	0.157	1.511	0.000	0.898	7844
CASHTOTA	0.176	0.128	0.172	0.979	0.000	0.869	7844
DEBTOTA	0.046	0.000	0.115	2.499	0.000	1.000	7844
INVENTOTA	0.074	0.018	0.125	1.676	0.000	0.986	7844
TDTOTA	0.375	0.379	0.243	0.647	0.000	0.853	7844
TCTOTA	0.246	0.226	0.185	0.749	0.000	0.772	7844
INCTECHCAPINVESTOREV	0.174	0.043	1.135	6.518	0.000	32.577	6948
GM	0.190	0.178	0.116	0.612	-0.233	1.000	6949
OM	0.043	0.036	0.114	2.681	-2.281	1.436	6949
SGATOTA	0.360	0.282	0.401	1.114	0.000	2.817	7844
RG	1.869	1.767	1.190	0.637	0.000	9.557	4899
Ln (TOTR)	10.207	10.053	0.937	0.092	4.796	14.572	6949

Appendix 5: Pearson correlation tables – by overall industry and key sectors

Overall industry, 2000-2019

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
(1) Ln (PAT)	1													
(2) NCATOTA	0.144**	1												
(3) LPFETOTA	0.033**	-0.206**	1											
(4) CASHTOTA		0.178**	-0.139**	1										
(5) DBTOTA	0.144**	0.099**	0.203**	-0.192**	1									
(6) INVENTOTA	0.122**	0.235**	-0.146**	-0.232**	0.062**	1								
(7) TDTOTA	-0.284**	-0.035**		-0.026**	-0.187**	-0.329**	1							
(8) TCTOTA	-0.307**	-0.149**	-0.051**	0.111**	-0.218**	-0.192**	0.536**	1						
(9) INCTECHCAPINVESTTOREV	0.24**	-0.199**	0.12**	-0.154**	0.26**	-0.092**	-0.236**	-0.241**	1					
(10) GM	0.224**	0.013*	0.153**	-0.097**	0.191**	0.025**	-0.169**	-0.264**	0.344**	1				
(11) OM	0.378**	0.045**	0.061**	-0.032**	0.112**	-0.01*	-0.117**	-0.135**	0.172**	0.335**	1			
(12) SGATOTA	-0.186**	-0.072**	0.018**	0.057**	-0.101**	-0.143**	0.24**	0.232**	-0.135**	-0.093**	-0.115**	1		
(13) RG	0.13**	0.042**	0.094**	-0.022**		-0.076**		-0.019**	0.081**	0.061**	0.088**	0.027**	1	
(14) Ln (TOTR)	0.652**	0.016**	-0.03**		-0.017**		-0.025**	0.022**	-0.105**	-0.137**	0.155**	-0.058**	0.213**	1

**p<.01, *p<.05

Overall industry, 2000-2010

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
(1) Ln (PAT)	1													
(2) NCATOTA	0.151**	1												
(3) LPFETOTA	0.063**	-0.189**	1											
(4) CASHTOTA		0.184**	-0.134**	1										
(5) DBTOTA	0.151**	0.07**	0.252**	-0.178**	1									
(6) INVENTOTA	0.134**	0.223**	-0.121**	-0.227**	0.004	1								
(7) TDTOTA	-0.28**	-0.036**	-0.04**	-0.06**	-0.149**	-0.249**	1							
(8) TCTOTA	-0.265**	-0.139**	-0.075**	0.098**	-0.193**	-0.15**	0.497**	1						
(9) INCTECHCAPINVESTTOREV	0.18**	-0.191**	0.265**	-0.139**	0.286**	-0.107**	-0.216**	-0.24**	1					
(10) GM	0.159**	0.03**	0.209**	-0.081**	0.184**		-0.107**	-0.258**	0.299**	1				
(11) OM	0.295**	0.094**	0.114**		0.068**		-0.046**	-0.073**	-0.08**	0.285**	1			
(12) SGATOTA	-0.167**	-0.055**		0.06**	-0.098**	-0.128**	0.288**	0.268**	-0.136**	-0.132**	-0.086**	1		
(13) RG	0.161**	0.05**	0.073**	-0.029**		-0.037**	-0.023*		0.044**	0.03**	0.095**	0.022*	1	
(14) Ln (TOTR)	0.691**	0.026**	-0.03**			0.039**	-0.066**	0.048**	-0.147**	-0.141**	0.173**	-0.057**	0.24**	1

**p<.01, *p<.05

Overall industry, 2011-2019

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
(1) Ln (PAT)	1													
(2) NCATOTA	0.114**	1												
(3) LPFETOTA	-0.015*	-0.237**	1											
(4) CASHTOTA	-0.032**	0.164**	-0.155**	1										
(5) DBTOTA	0.138**	0.122**	0.156**	-0.209**	1									
(6) INVENTOTA	0.131**	0.255**	-0.165**	-0.233**	0.118**	1								
(7) TDTOTA	-0.344**	-0.064**		-0.017*	-0.232**	-0.398**	1							
(8) TCTOTA	-0.351**	-0.168**	-0.037**	0.12**	-0.244**	-0.23**	0.572**	1						
(9) INCTECHCAPINVESTTOREV	0.281**	-0.206**	0.018**	-0.164**	0.242**	-0.082**	-0.253**	-0.242**	1					
(10) GM	0.284**		0.11**	-0.108**	0.196**	0.035**	-0.214**	-0.269**	0.377**	1				
(11) OM	0.434**			-0.062**	0.152**	-0.015*	-0.192**	-0.19**	0.376**	0.381**	1			
(12) SGATOTA	-0.18**	-0.083**	0.043**	0.06**	-0.105**	-0.167**	0.224**	0.198**	-0.137**	-0.059**	-0.137**	1		
(13) RG	0.098**	0.028**	0.103**	-0.024**	0.017*	-0.101**	0.017*	-0.029**	0.108**	0.085**	0.078**	0.044**	1	
(14) Ln (TOTR)	0.61**		-0.047**		-0.037**	-0.038**	-0.032**		-0.07**	-0.133**	0.125**	-0.035**	0.181**	1

**p<.01, *p<.05

Sector: 41. 2000-2019

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
(1) Ln (PAT)	1													
(2) NCATOTA	0.122**	1												
(3) LPFETOTA		-0.215**	1											
(4) CASHTOTA	-0.083**	0.102**	-0.106**	1										
(5) DBTOTA	0.147**	0.206**	0.146**	-0.198**	1									
(6) INVENTOTA	0.16**	0.309**	-0.182**	-0.306**	0.074**	1								
(7) TDTOTA	-0.306**	-0.092**		0.1**	-0.205**	-0.372**	1							
(8) TCTOTA	-0.338**	-0.173**	-0.043**	0.181**	-0.253**	-0.276**	0.547**	1						
(9) INCTECHCAPINVESTTOREV	0.291**	-0.258**	0.161**	-0.19**	0.247**	-0.159**	-0.229**	-0.257**	1					
(10) GM	0.311**	-0.024**	0.153**	-0.142**	0.222**	0.033**	-0.249**	-0.303**	0.429**	1				
(11) OM	0.418**		0.055**	-0.078**	0.112**	-0.035**	-0.123**	-0.147**	0.228**	0.374**	1			
(12) SGATOTA	-0.224**	-0.092**		0.098**	-0.123**	-0.167**	0.178**	0.225**	-0.131**	-0.144**	-0.125**	1		
(13) RG	0.153**	0.028**	0.09**			-0.087**	0.022*		0.119**	0.074**	0.122**	0.019*	1	
(14) Ln (TOTR)	0.628**	0.042**	-0.025**	0.025**	-0.034**	-0.022**	0.028**	0.064**	-0.11**	-0.109**	0.176**	-0.078**	0.247**	1

**p<.01, *p<.05

Sector: 42. 2000-2019

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
(1) Ln (PAT)	1													
(2) NCATOTA	0.14**	1												
(3) LPFETOTA	0.096**	-0.165**	1											
(4) CASHTOTA	0.135**	0.281**	-0.161**	1										
(5) DBTOTA	0.157**	-0.055**	0.338**	-0.185**	1									
(6) INVENTOTA	-0.06**	0.064**	-0.063**	-0.107**	-0.078**	1								
(7) TDTOTA	-0.161**	0.047**	-0.048**	-0.115**	-0.217**	-0.145**	1							
(8) TCTOTA	-0.174**	-0.088**	-0.08**	0.054**	-0.226**	0.04**	0.521**	1						
(9) INCTECHCAPINVESTTOREV	0.086**	-0.108**	0.129**	-0.134**	0.418**	-0.092**	-0.269**	-0.256**	1					
(10) GM	0.069**	0.053**	0.164**		0.239**		-0.142**	-0.172**	0.113**	1				
(11) OM	0.203**	0.067**	0.155**	0.032*	0.294**	-0.033*	-0.074**	-0.092**	-0.143**	0.356**	1			
(12) SGATOTA	-0.061**	-0.037**		0.052**	-0.102**		0.141**	0.156**	-0.12**	-0.157**	-0.076**	1		
(13) RG	0.141**		0.117**	-0.044*	0.126**	-0.059**		-0.053**	0.066**	0.054**	0.139**		1	
(14) Ln (TOTR)	0.626**	-0.059**	-0.034*	0.032*			0.071**	0.097**	-0.233**	-0.206**	0.118**	0.036*	0.173**	1

**p<.01, *p<.05

Sector: 43. 2000-2019

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
(1) Ln (PAT)	1													
(2) NCATOTA	0.18**	1												
(3) LPFETOTA	0.084**	-0.176**	1											
(4) CASHTOTA	0.116**	0.261**	-0.169**	1										
(5) DBTOTA	0.069**	-0.036**	0.254**	-0.179**	1									
(6) INVENTOTA	-0.084**	0.031**	-0.049**	-0.14**	-0.027**	1								
(7) TDTOTA	-0.179**	0.046**		-0.176**	-0.068**	-0.195**	1							
(8) TCTOTA	-0.242**	-0.12**	-0.035**	0.02*	-0.114**		0.541**	1						
(9) INCTECHCAPINVESTTOREV		-0.107**	0.108**	-0.061**	0.082**	-0.04**	-0.135**	-0.133**	1					
(10) GM	0.098**	0.103**	0.195**	-0.049**	0.152**		-0.098**	-0.238**	0.124**	1				
(11) OM	0.267**	0.156**	0.09**	0.095**			-0.05**	-0.075**	-0.38**	0.158**	1			
(12) SGATOTA	-0.132**	-0.047**	0.035**				0.271**	0.27**	-0.058**	0.033**	-0.084**	1		
(13) RG	0.094**	0.095**	0.055**					-0.061**	0.023*	0.033**		0.025*	1	
(14) Ln (TOTR)	0.656**		-0.024**		-0.028**	-0.056**	-0.026**	-0.028**	-0.186**	-0.207**	0.087**	-0.043**	0.182**	1

**p<.01, *p<.05

Sector: 41. 2000-2010

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
(1) Ln (PAT)	1													
(2) NCATOTA	0.155**	1												
(3) LPFETOTA	0.072**	-0.232**	1											
(4) CASHTOTA	-0.047**	0.1**	-0.126**	1										
(5) DBTOTA	0.162**	0.158**	0.217**	-0.173**	1									
(6) INVENTOTA	0.169**	0.3**	-0.188**	-0.313**		1								
(7) TDTOTA	-0.281**	-0.095**	-0.075**	0.068**	-0.186**	-0.298**	1							
(8) TCTOTA	-0.286**	-0.172**	-0.108**	0.159**	-0.235**	-0.257**	0.503**	1						
(9) INCTECHCAPINVESTTOREV	0.206**	-0.24**	0.307**	-0.164**	0.286**	-0.171**	-0.207**	-0.253**	1					
(10) GM	0.257**		0.269**	-0.135**	0.228**	0.024*	-0.205**	-0.297**	0.387**	1				
(11) OM	0.326**	0.09**	0.117**	-0.042**	0.06**		-0.048**	-0.07**	-0.052**	0.328**	1			
(12) SGATOTA	-0.205**	-0.092**	-0.04**	0.101**	-0.128**	-0.157**	0.209**	0.248**	-0.131**	-0.18**	-0.095**	1		
(13) RG	0.187**	0.064**	0.064**		-0.034*	-0.031*		0.035*	0.049**	0.037*	0.126**		1	
(14) Ln (TOTR)	0.675**	0.07**	-0.037**	0.032**				0.092**	-0.17**	-0.095**	0.208**	-0.084**	0.281**	1

**p<.01, *p<.05

Sector: 41. 2011-2019

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
(1) Ln (PAT)	1													
(2) NCATOTA	0.079**	1												
(3) LPFETOTA	-0.042**	-0.195**	1											
(4) CASHTOTA	-0.126**	0.099**	-0.079**	1										
(5) DBTOTA	0.129**	0.24**	0.078**	-0.223**	1									
(6) INVENTOTA	0.163**	0.324**	-0.184**	-0.298**	0.129**	1								
(7) TDTOTA	-0.363**	-0.111**	0.065**	0.114**	-0.231**	-0.429**	1							
(8) TCTOTA	-0.379**	-0.174**	0.041**	0.203**	-0.269**	-0.295**	0.6**	1						
(9) INCTECHCAPINVESTTOREV	0.34**	-0.272**	0.031**	-0.208**	0.222**	-0.15**	-0.248**	-0.26**	1					
(10) GM	0.353**	-0.038**	0.035**	-0.147**	0.218**	0.041**	-0.283**	-0.309**	0.458**	1				
(11) OM	0.472**	-0.056**		-0.115**	0.15**	-0.061**	-0.2**	-0.214**	0.442**	0.415**	1			
(12) SGATOTA	-0.229**	-0.082**	0.06**	0.105**	-0.116**	-0.187**	0.186**	0.202**	-0.135**	-0.113**	-0.146**	1		
(13) RG	0.127**		0.121**			-0.125**	0.039**		0.165**	0.101**	0.115**	0.026*	1	
(14) Ln (TOTR)	0.585**				-0.067**	-0.057**	0.031**	0.041**	-0.064**	-0.124**	0.133**	-0.055**	0.217**	1

**p<.01, *p<.05

Sector: 42. 2000-2010

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
(1) Ln (PAT)	1													
(2) NCATOTA	0.123**	1												
(3) LPFETOTA	0.101**	-0.102**	1											
(4) CASHTOTA	0.08**	0.295**	-0.147**	1										
(5) DBTOTA	0.217**	-0.065**	0.44**	-0.173**	1									
(6) INVENTOTA		0.073**	-0.064**	-0.112**	-0.099**	1								
(7) TDTOTA	-0.159**		-0.067**	-0.087**	-0.184**	-0.052**	1							
(8) TCTOTA	-0.141**	-0.061**	-0.1**	0.073**	-0.21**	0.095**	0.517**	1						
(9) INCTECHCAPINVESTTOREV	0.12**	-0.127**	0.224**	-0.15**	0.464**	-0.12**	-0.256**	-0.284**	1					
(10) GM		0.068**	0.153**		0.246**		-0.062**	-0.154**		1				
(11) OM	0.168**	0.063**	0.274**		0.334**		-0.072**	-0.113**	-0.076**	0.306**	1			
(12) SGATOTA			0.062**	0.045*	-0.101**		0.229**	0.229**	-0.143**	-0.184**	-0.085**	1	1	
(13) RG	0.173**		0.149**	-0.097**	0.162**				0.078**		0.158**			
(14) Ln (TOTR)	0.645**	-0.06*				0.069**	0.071**	0.178**	-0.223**	-0.192**	0.115**	0.067**	0.192**	1

**p<.01, *p<.05

Sector: 42. 2011-2019

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
(1) Ln (PAT)	1													
(2) NCATOTA	0.122**	1												
(3) LPFETOTA		-0.259**	1											
(4) CASHTOTA	0.133**	0.254**	-0.232**	1										
(5) DBTOTA	0.116**	-0.045*	0.267**	-0.202**	1									
(6) INVENTOTA		0.084**		-0.072**	-0.049*	1								
(7) TDTOTA	-0.273**		-0.141**	-0.21**	-0.268**	-0.201**	1							
(8) TCTOTA	-0.219**	-0.132**	-0.107**		-0.246**		0.516**	1						
(9) INCTECHCAPINVESTTOREV	0.08**	-0.09**	0.075**	-0.117**	0.367**	-0.072**	-0.279**	-0.236**	1					
(10) GM	0.122**	0.041*	0.17**		0.237**		-0.213**	-0.186**	0.195**	1				
(11) OM	0.246**	0.07**	0.065**	0.051*	0.254**		-0.082**	-0.074**	-0.21**	0.401**	1			
(12) SGATOTA	-0.059**	-0.047*		0.07**	-0.104**		0.076**	0.082**	-0.106**	-0.129**	-0.066**	1		
(13) RG	0.095**	0.048*	0.075**		0.102**	-0.049*	-0.059*	-0.091**	0.068**	0.074**	0.123**		1	
(14) Ln (TOTR)	0.583**	-0.099**	-0.118**						-0.235**	-0.238**	0.124**	0.047*	0.137**	1

**p<.01, *p<.05

Sector: 43. 2000-2010

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
(1) Ln (PAT)	1													
(2) NCATOTA	0.143**	1												
(3) LPFETOTA		-0.119**	1											
(4) CASHTOTA	0.11**	0.263**	-0.128**	1										
(5) DBTOTA	0.068**		0.187**	-0.176**	1									
(6) INVENTOTA	-0.076**	0.038**	-0.029**	-0.128**	-0.042**	1								
(7) TDTOTA	-0.198**	0.032**	0.099**	-0.204**	-0.028*	-0.126**	1							
(8) TCTOTA	-0.218**	-0.111**	0.04**		-0.094**		0.531**	1						
(9) INCTECHCAPINVESTTOREV		-0.098**	0.049**	-0.066**	0.063**	-0.049**	-0.126**	-0.136**	1					
(10) GM		0.122**	0.112**	-0.031*	0.131**			-0.214**	0.153**	1				
(11) OM	0.187**	0.137**		0.105**				-0.038**	-0.583**	0.101**	1			
(12) SGATOTA	-0.101**		0.107**				0.347**	0.333**	-0.055**		-0.06**	1		
(13) RG	0.119**	0.06**	0.034*				-0.037*	-0.064**	0.054**				1	
(14) Ln (TOTR)	0.685**					-0.042**	-0.073**		-0.187**	-0.251**	0.102**		0.203**	1

**p<.01, *p<.05

Sector: 43. 2011-2019

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
(1) Ln (PAT)	1													
(2) NCATOTA	0.177**	1												
(3) LPFETOTA	0.067**	-0.266**	1											
(4) CASHTOTA	0.104**	0.253**	-0.232**	1										
(5) DBTOTA	0.085**	-0.072**	0.332**	-0.184**	1									
(6) INVENTOTA	-0.051**	0.047**	-0.03**	-0.147**		1								
(7) TDTOTA	-0.256**		-0.133**	-0.183**	-0.114**	-0.241**	1							
(8) TCTOTA	-0.293**	-0.159**	-0.137**		-0.137**		0.529**	1						
(9) INCTECHCAPINVESTTOREV		-0.114**	0.159**	-0.055**	0.1**	-0.035**	-0.144**	-0.13**	1					
(10) GM	0.19**	0.096**	0.272**	-0.062**	0.17**		-0.156**	-0.258**	0.093**	1				
(11) OM	0.351**	0.176**	0.139**	0.083**	0.044**		-0.112**	-0.118**	-0.121**	0.234**	1			
(12) SGATOTA	-0.119**	-0.086**		-0.028*			0.205**	0.2**	-0.066**	0.091**	-0.109**	1		
(13) RG	0.055**	0.107**	0.043**			0.029*		-0.063**		0.066**		0.058**	1	
(14) Ln (TOTR)	0.609**		-0.095**		-0.033**	-0.044**	-0.058**	-0.056**	-0.186**	-0.148**	0.051**		0.142**	1

**p<.01, *p<.05

Appendix 6: Various inflation factor (VIF) tables

Variable	VIF	1/VIF
NCATOTA	1.46	0.68686
LPFETOTA	1.3	0.769788
CASHTOTA	1.36	0.735513
DEBTOTA	1.3	0.772124
INVENTOTA	1.67	0.597029
TDTOTA	1.78	0.560436
TCTOTA	1.54	0.649826
INCTECHCAPINVESTOREV	1.73	0.577542
GM	1.45	0.688987
OM	1.78	0.562877
SGATOTA	1.1	0.911368
RG	1.09	0.917339
Ln (TOTR)	1.14	0.876471
Year		
2002	1.94	0.514486
2003	1.96	0.511148
2004	1.97	0.506501
2005	2.02	0.495814
2006	2.08	0.480644
2007	2.19	0.456992
2008	2.07	0.483478
2009	1.92	0.522089
2010	2.09	0.47915
2011	2.38	0.419818
2012	2.45	0.408628
2013	2.55	0.392333
2014	2.91	0.343517
2015	3.01	0.332159
2016	3.05	0.328019
2017	3.1	0.322573
2018	3.03	0.329861
2019	1.32	0.759749
Mean VIF	1.96	

Appendix 7: Measures of firm performance

Tobin's Q = Market share per share/book value per share

ROA = operating profit / total assets

ROCE = Earnings before interest & tax / (Total Assets – Current Liabilities)

EVA = Economic Value Added

Holding Period Return = (Share price (t) – Share price (t-1) + dividends (t-1)) / Share price (t-1)

Appendix 8: Mean increases and decreases – Overall industry

	Pre-credit crisis mean	Post-credit crisis mean	Change%
NCATOTA	0.197	0.243	23.35%
LPFETOTA	0.064	0.089	39.06%
CASHTOTA	0.148	0.168	13.51%
DBTOTA	0.072	0.079	9.72%
INVENTOTA	0.171	0.15	-12.28%
TDTOTA	0.194	0.282	45.36%
TCTOTA	0.189	0.21	11.11%
INCTECHCAPINVESTTOREV	0.894	0.867	-3.02%
GM	0.186	0.182	-2.15%
OM	0.043	0.073	69.77%
SGATOTA	0.314	0.27	-14.01%
RG	1.663	1.811	8.90%

Appendix 9: Fisher type unit root test. Based on Augmented Dickey-Fuller tests

Variable		Statistic	p-value	N Panels	Panels excluded
Ln (PAT)	Inverse chi-squared(5834) P	9241.2907	0	3096	179
	Inverse normal Z	-14.0887	0		
	Inverse logit t(13724) L*	-28.202	0		
	Modified inv. chi-squared Pm	43.1867	0		
NCATOTA	Inverse chi-squared(5834) P	1.11E+04	0	3096	179
	Inverse normal Z	-20.5125	0		
	Inverse logit t(13724) L*	-31.9652	0		
	Modified inv. chi-squared Pm	48.6526	0		
LPFETOTA	Inverse chi-squared(5834) P	9997.253	0	3096	179
	Inverse normal Z	-17.523	0		
	Inverse logit t(13724) L*	-31.6815	0		
	Modified inv. chi-squared Pm	38.542	0		
CASHTOTA	Inverse chi-squared(5834) P	1.29E+04	0	3096	179
	Inverse normal Z	-34.3669	0		
	Inverse logit t(13724) L*	-46.8339	0		
	Modified inv. chi-squared Pm	65.5917	0		
DBTOTA	Inverse chi-squared(5834) P	1.50E+04	0	3096	179
	Inverse normal Z	-45.1613	0		
	Inverse logit t(13724) L*	-72.6702	0		
	Modified inv. chi-squared Pm	84.8266	0		
INVENTOTA	Inverse chi-squared(5834) P	1.39E+04	0	3096	179
	Inverse normal Z	-37.7078	0		
	Inverse logit t(13724) L*	-60.0346	0		
	Modified inv. chi-squared Pm	74.9983	0		
TDTOTA	Inverse chi-squared(5834) P	1.14E+04	0	3096	427
	Inverse normal Z	-23.2326	0		
	Inverse logit t(13724) L*	-35.8152	0		
	Modified inv. chi-squared Pm	51.1449	0		
TCTOTA	Inverse chi-squared(5834) P	1.31E+04	0	3096	425
	Inverse normal Z	-31.3828	0		
	Inverse logit t(13724) L*	-46.6542	0		
	Modified inv. chi-squared Pm	67.4593	0		
INCTECHCAPINVESTORE	Inverse chi-squared(5834) P	1.26E+04	0	3096	425
	Inverse normal Z	-26.0997	0		
	Inverse logit t(13724) L*	-48.5839	0		
	Modified inv. chi-squared Pm	70.4203	0		
GM	Inverse chi-squared(5834) P	1.12E+04	0	3096	179
	Inverse normal Z	-28.4648	0		
	Inverse logit t(13724) L*	-42.4392	0		
	Modified inv. chi-squared Pm	56.4924	0		

OM	Inverse chi-squared(5834) P	1.26E+04	0	3096	1336
	Inverse normal Z	-33.1991	0		
	Inverse logit t(13724) L*	-50.253	0		
	Modified inv. chi-squared Pm	70.4773	0		
SGATOTA	Inverse chi-squared(5834) P	1.44E+04	0	3096	425
	Inverse normal Z	-33.9531	0		
	Inverse logit t(13724) L*	-53.5117	0		
	Modified inv. chi-squared Pm	79.448	0		
RG	Inverse chi-squared(5834) P	7357.4402	0	3096	179
	Inverse normal Z	-24.1196	0		
	Inverse logit t(13724) L*	-49.0764	0		
	Modified inv. chi-squared Pm	45.7725	0		
Ln (TOTR)	Inverse chi-squared(5834) P	8230.4382	0	3096	567
	Inverse normal Z	0.9583	0.831 1		
	Inverse logit t(13724) L*	-10.1658	0		
	Modified inv. chi-squared Pm	27.9445	0		

Ho: All panels contain unit roots

Ha: At least one panel is stationary

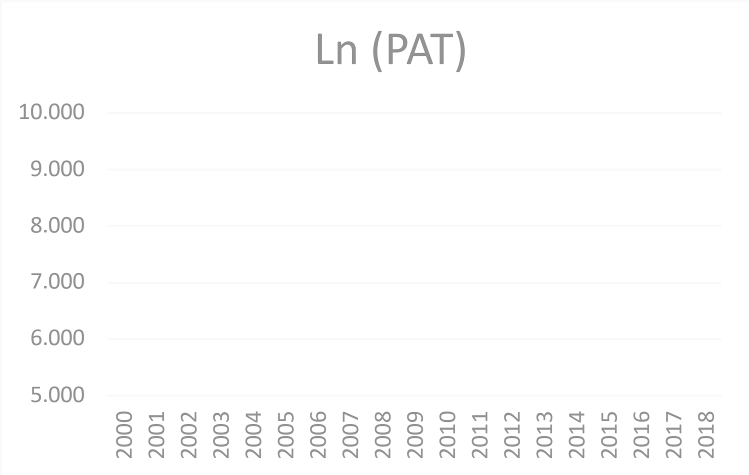
Appendix 10: Chow tests for structural breaks – Overall industry and sectors 41, 42 and 43. (tables and graphs)

Overall industry summary

Variable	Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Ln (PAT)	Mean	6.102	6.114	6.192	6.302	6.446	6.596	6.706	6.793	6.556	6.368	6.439	6.485	6.524	6.635	6.889	7.115	7.267	7.381	7.413	7.498
	SD	1.787	1.821	1.758	1.776	1.811	1.796	1.772	1.761	1.694	1.701	1.887	1.829	1.802	1.802	1.743	1.673	1.687	1.656	1.677	1.544
	Min	1.946	1.946	1.946	1.946	1.946	1.946	1.946	1.946	1.946	1.946	1.946	1.946	1.946	1.946	1.946	1.946	1.946	1.946	1.946	3.332
	Max	11.937	11.817	11.937	11.937	11.937	11.937	11.937	11.937	11.937	11.937	11.937	11.937	11.937	11.937	11.937	11.937	11.937	11.937	11.937	11.937
	N	1,085	1,241	1,329	1,370	1,401	1,444	1,528	1,626	1,580	1,553	1,678	1,767	1,840	1,950	2,155	2,307	2,424	2,498	2,445	360
NCATOTA	Mean	0.167	0.171	0.179	0.189	0.192	0.198	0.211	0.201	0.195	0.219	0.220	0.221	0.228	0.236	0.241	0.247	0.243	0.252	0.267	0.270
	SD	0.256	0.251	0.252	0.268	0.271	0.275	0.286	0.283	0.297	0.304	0.300	0.306	0.304	0.295	0.289	0.282	0.287	0.288	0.287	0.274
	Min	-1.014	-1.014	-1.014	-1.014	-1.014	-1.014	-1.014	-1.014	-1.014	-1.014	-1.014	-1.014	-1.014	-1.014	-1.014	-1.014	-1.014	-1.014	-1.014	-1.014
	Max	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990
	N	1,543	1,697	1,779	1,861	1,949	2,048	2,126	2,231	2,319	2,404	2,481	2,563	2,626	2,706	2,782	2,845	2,932	2,972	2,823	407
DBTOTA	Mean	0.062	0.066	0.067	0.067	0.068	0.069	0.072	0.074	0.077	0.082	0.081	0.081	0.081	0.081	0.080	0.081	0.076	0.078	0.070	0.096
	SD	0.150	0.159	0.164	0.162	0.168	0.171	0.175	0.180	0.183	0.191	0.190	0.191	0.187	0.186	0.183	0.182	0.178	0.183	0.171	0.203
	Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Max	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	N	1,543	1,697	1,779	1,861	1,949	2,048	2,126	2,231	2,319	2,404	2,481	2,563	2,626	2,706	2,782	2,845	2,932	2,972	2,823	407
OM	Mean	0.062	0.044	0.064	0.053	0.053	0.069	0.068	0.051	-0.003	-0.006	0.046	0.046	0.058	0.060	0.075	0.081	0.080	0.085	0.086	0.107
	SD	0.208	0.297	0.212	0.252	0.276	0.268	0.258	0.296	0.356	0.350	0.287	0.290	0.250	0.271	0.263	0.265	0.276	0.236	0.209	0.215
	Min	-2.281	-2.281	-2.281	-2.281	-2.281	-2.281	-2.281	-2.281	-2.281	-2.281	-2.281	-2.281	-2.281	-2.281	-2.281	-2.281	-2.281	-2.281	-2.281	-0.639
	Max	1.000	1.000	0.995	0.988	1.000	1.436	1.436	1.436	1.064	1.238	1.436	1.436	1.436	1.436	1.436	1.436	1.436	1.436	1.436	1.410
	N	1,042	1,140	1,194	1,258	1,269	1,310	1,356	1,462	1,549	1,843	2,027	2,114	2,195	2,301	2,425	2,564	2,728	2,863	2,810	407
GM	Mean	0.183	0.186	0.190	0.191	0.192	0.195	0.191	0.191	0.170	0.177	0.184	0.177	0.175	0.178	0.184	0.187	0.187	0.185	0.179	0.166
	SD	0.181	0.181	0.181	0.181	0.173	0.184	0.180	0.188	0.195	0.190	0.182	0.175	0.174	0.176	0.183	0.183	0.181	0.174	0.166	0.173
	Min	-0.233	-0.233	-0.233	-0.233	-0.233	-0.233	-0.233	-0.233	-0.233	-0.233	-0.233	-0.233	-0.233	-0.233	-0.233	-0.233	-0.233	-0.233	-0.233	-0.233
	Max	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	N	1,042	1,140	1,194	1,258	1,269	1,310	1,356	1,462	1,549	1,843	2,027	2,114	2,195	2,301	2,425	2,564	2,728	2,863	2,810	407

INCTECHCAPINVESTOREV	Mean		0.881	0.801	0.779	0.850	0.861	0.834	0.882	1.015	0.976	0.959	0.925	1.012	0.958	0.855	0.834	0.858	0.771	0.743	1.122
	SD		3.741	3.379	3.323	3.721	3.622	3.441	3.762	4.225	3.944	3.916	3.747	4.148	4.019	3.726	3.652	3.876	3.559	3.467	4.313
	Min		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Max		32.577	32.577	32.577	32.577	32.577	32.577	32.577	32.577	32.577	32.577	32.577	32.577	32.577	32.577	32.577	32.577	32.577	32.577	32.577
	N	0	1,140	1,194	1,258	1,269	1,310	1,355	1,462	1,549	1,842	2,026	2,114	2,194	2,301	2,423	2,563	2,727	2,862	2,810	406
LPFETOTA	Mean	0.074	0.067	0.066	0.066	0.063	0.060	0.056	0.054	0.055	0.058	0.090	0.090	0.091	0.089	0.089	0.091	0.089	0.087	0.087	0.077
	SD	0.161	0.152	0.150	0.150	0.150	0.150	0.139	0.136	0.138	0.137	0.162	0.159	0.159	0.155	0.153	0.155	0.152	0.151	0.150	0.152
	Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Max	0.898	0.898	0.898	0.898	0.898	0.898	0.898	0.898	0.898	0.898	0.898	0.898	0.898	0.898	0.898	0.898	0.898	0.898	0.898	0.898
	N	1,543	1,697	1,779	1,861	1,949	2,048	2,126	2,231	2,319	2,404	2,481	2,563	2,626	2,706	2,782	2,845	2,932	2,972	2,823	407
CASHTOTA	Mean	0.133	0.137	0.145	0.148	0.137	0.142	0.147	0.145	0.151	0.167	0.162	0.158	0.158	0.161	0.163	0.169	0.175	0.177	0.176	0.191
	SD	0.178	0.174	0.181	0.179	0.167	0.173	0.182	0.175	0.180	0.189	0.183	0.181	0.181	0.177	0.172	0.174	0.174	0.175	0.174	0.204
	Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Max	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869
	N	1,543	1,697	1,779	1,861	1,949	2,048	2,126	2,231	2,319	2,404	2,481	2,563	2,626	2,706	2,782	2,845	2,932	2,972	2,823	407
INVENTOTA	Mean	0.188	0.187	0.182	0.178	0.183	0.179	0.167	0.164	0.162	0.155	0.152	0.153	0.154	0.150	0.151	0.154	0.152	0.149	0.141	0.149
	SD	0.247	0.248	0.248	0.247	0.257	0.263	0.257	0.262	0.264	0.258	0.249	0.251	0.251	0.248	0.252	0.261	0.264	0.260	0.249	0.263
	Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Max	0.986	0.986	0.986	0.986	0.986	0.986	0.986	0.986	0.986	0.986	0.986	0.986	0.986	0.986	0.986	0.986	0.986	0.986	0.986	0.986
	N	1,543	1,697	1,779	1,861	1,949	2,048	2,126	2,231	2,319	2,404	2,481	2,563	2,626	2,706	2,782	2,845	2,932	2,972	2,823	407
TCTOTA	Mean	0.201	0.196	0.200	0.195	0.189	0.180	0.182	0.188	0.188	0.179	0.186	0.197	0.201	0.204	0.208	0.216	0.216	0.220	0.217	0.211
	SD	0.206	0.205	0.201	0.198	0.199	0.194	0.197	0.197	0.200	0.190	0.193	0.199	0.201	0.199	0.198	0.198	0.192	0.190	0.186	0.194
	Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Max	0.772	0.772	0.772	0.772	0.772	0.772	0.772	0.772	0.772	0.772	0.772	0.772	0.772	0.772	0.772	0.772	0.772	0.772	0.772	0.772
	N	1,543	1,697	1,779	1,861	1,949	2,048	2,126	2,231	2,319	2,404	2,481	2,563	2,626	2,706	2,782	2,845	2,932	2,972	2,823	407
TOTOTA	Mean	0.198	0.198	0.202	0.197	0.185	0.180	0.184	0.187	0.187	0.182	0.238	0.263	0.267	0.279	0.284	0.289	0.288	0.293	0.290	0.261
	SD	0.226	0.223	0.221	0.220	0.215	0.213	0.218	0.217	0.214	0.209	0.240	0.254	0.256	0.258	0.256	0.251	0.247	0.242	0.237	0.253
	Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Max	0.853	0.853	0.853	0.853	0.853	0.853	0.853	0.853	0.853	0.853	0.853	0.853	0.853	0.853	0.853	0.853	0.853	0.853	0.853	0.853
	N	1,543	1,697	1,779	1,861	1,949	2,048	2,126	2,231	2,319	2,404	2,481	2,563	2,626	2,706	2,782	2,845	2,932	2,972	2,823	407

SGATOTA	Mean	0.339	0.342	0.345	0.347	0.320	0.298	0.295	0.292	0.303	0.313	0.285	0.279	0.273	0.273	0.275	0.265	0.262	0.265	0.272	0.264
	SD	0.523	0.526	0.505	0.499	0.475	0.461	0.446	0.447	0.457	0.456	0.418	0.426	0.410	0.414	0.421	0.390	0.382	0.382	0.390	0.408
	Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Max	2.817	2.817	2.817	2.817	2.817	2.817	2.817	2.817	2.817	2.817	2.817	2.817	2.817	2.817	2.817	2.817	2.817	2.817	2.817	2.817
	N	1,543	1,697	1,779	1,861	1,949	2,048	2,126	2,231	2,319	2,404	2,481	2,563	2,626	2,706	2,782	2,845	2,932	2,972	2,823	407
RG	Mean		1.603	1.664	1.762	1.794	1.801	1.746	1.707	1.609	1.318	1.626	1.851	1.847	1.889	1.726	1.727	1.767	1.808	1.902	1.843
	SD		1.203	1.167	1.190	1.179	1.234	1.149	1.246	1.204	1.410	1.356	1.240	1.242	1.245	1.171	1.207	1.195	1.235	1.258	1.195
	Min		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.951	0.000	0.000	0.000	-4.104	-0.029	0.000	0.000	-0.573	0.000	0.000
	Max		7.960	8.321	7.870	7.832	8.240	6.301	7.548	8.351	7.955	8.328	9.228	9.425	7.635	9.557	9.174	8.313	8.864	8.573	8.315
	N	0	865	875	912	915	956	1,017	1,125	1,072	936	1,092	1,385	1,433	1,515	1,832	1,883	1,942	2,011	1,929	272
Ln (TOTR)	Mean	9.630	9.694	9.824	9.883	9.975	10.099	10.220	10.280	10.303	10.122	10.054	10.092	10.156	10.192	10.292	10.398	10.467	10.572	10.680	10.779
	SD	1.621	1.609	1.527	1.567	1.581	1.539	1.480	1.522	1.504	1.399	1.353	1.334	1.284	1.283	1.266	1.205	1.197	1.101	1.005	0.963
	Min	4.796	4.796	4.796	4.796	4.796	4.796	4.796	4.796	4.796	4.796	4.796	4.796	4.796	4.796	4.796	4.796	4.796	4.796	4.796	9.638
	Max	14.572	14.572	14.572	14.572	14.572	14.572	14.572	14.572	14.572	14.572	14.572	14.572	14.572	14.572	14.572	14.572	14.572	14.572	14.572	14.572
	N	1,042	1,140	1,194	1,258	1,269	1,310	1,356	1,462	1,548	1,843	2,027	2,114	2,195	2,300	2,425	2,564	2,727	2,863	2,810	407



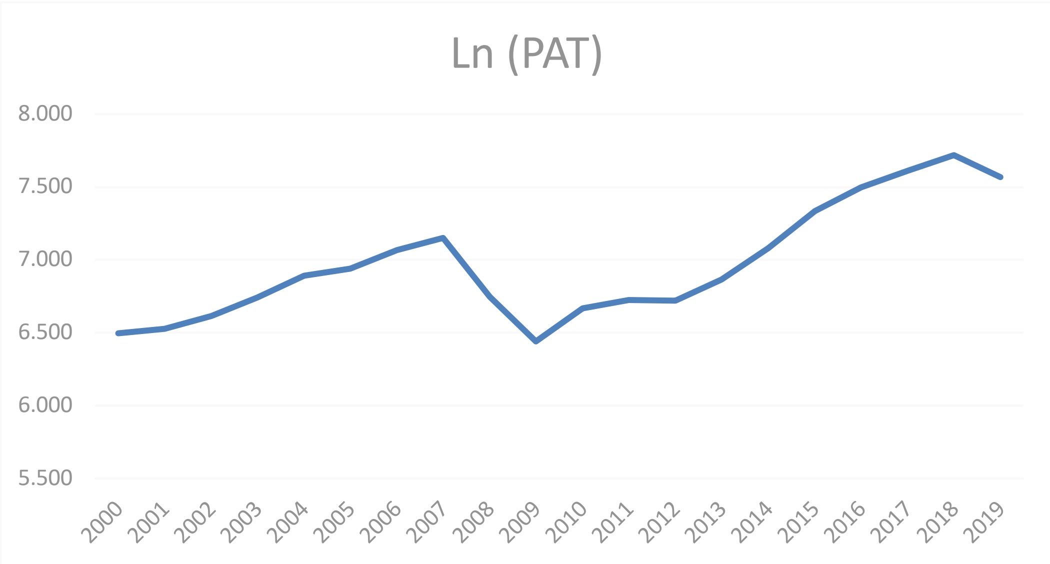
Sector 41 summary

Variable	Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
	N	668	721	766	801	848	900	936	987	1,043	1,082	1,130	1,163	1,215	1,256	1,291	1,343	1,399	1,421	1,367	219
Ln (PAT)	Mean	6.495	6.529	6.614	6.742	6.891	6.941	7.069	7.149	6.747	6.441	6.669	6.727	6.722	6.864	7.081	7.335	7.496	7.614	7.719	7.567
	SD	1.951	2.028	1.929	1.930	1.938	1.930	1.964	1.950	1.817	1.893	2.104	2.054	2.012	2.056	1.985	1.949	1.922	1.872	1.880	1.746
	Min	1.946	1.946	1.946	1.946	1.946	1.946	1.946	1.946	1.946	1.946	1.946	1.946	1.946	1.946	1.946	1.946	1.946	1.946	1.946	3.332
	Max	11.937	11.817	11.937	11.937	11.937	11.937	11.937	11.937	11.937	11.937	11.937	11.937	11.937	11.937	11.937	11.937	11.937	11.937	11.937	11.937
	N	528	558	602	626	657	687	711	749	680	677	783	803	840	897	987	1,049	1,142	1,192	1,176	193
NCATOTA	Mean	0.194	0.190	0.192	0.205	0.211	0.214	0.232	0.228	0.211	0.237	0.234	0.236	0.245	0.256	0.260	0.269	0.261	0.274	0.285	0.291
	SD	0.283	0.279	0.286	0.295	0.292	0.298	0.310	0.307	0.331	0.335	0.340	0.344	0.341	0.334	0.334	0.316	0.318	0.317	0.320	0.291
	Min	-1.014	-1.014	-1.014	-1.014	-1.014	-1.014	-1.014	-1.014	-1.014	-1.014	-1.014	-1.014	-1.014	-1.014	-1.014	-1.014	-1.014	-1.014	-1.014	-0.888
	Max	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990
	N	668	721	766	801	848	900	936	987	1,043	1,082	1,130	1,163	1,215	1,256	1,291	1,343	1,399	1,421	1,367	219
DBTOTA	Mean	0.060	0.068	0.071	0.075	0.079	0.082	0.086	0.087	0.089	0.098	0.100	0.102	0.101	0.102	0.104	0.105	0.095	0.098	0.090	0.123

	SD	0.146	0.158	0.171	0.176	0.184	0.193	0.197	0.199	0.205	0.217	0.222	0.226	0.221	0.220	0.220	0.219	0.208	0.215	0.204	0.236
	Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Max	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	N	668	721	766	801	848	900	936	987	1,043	1,082	1,130	1,163	1,215	1,256	1,291	1,343	1,399	1,421	1,367	219
OM	Mean	0.083	0.047	0.087	0.067	0.078	0.097	0.088	0.059	-0.042	-0.053	0.061	0.061	0.078	0.088	0.105	0.109	0.111	0.122	0.123	0.146
	SD	0.247	0.360	0.223	0.308	0.294	0.319	0.326	0.375	0.463	0.475	0.380	0.381	0.321	0.345	0.350	0.366	0.354	0.301	0.276	0.273
	Min	-2.281	-2.281	-2.281	-2.281	-2.281	-2.281	-2.281	-2.281	-2.281	-2.281	-2.281	-2.281	-2.281	-2.281	-2.281	-2.281	-2.281	-2.281	-2.281	-0.108
	Max	1.000	1.000	0.995	0.988	0.987	1.436	1.436	1.436	1.064	1.238	1.436	1.436	1.436	1.436	1.436	1.436	1.436	1.436	1.436	1.410
	N	502	544	567	608	622	648	674	721	771	876	967	992	1,032	1,079	1,125	1,198	1,285	1,361	1,358	219
GM	Mean	0.180	0.186	0.187	0.190	0.193	0.201	0.187	0.197	0.157	0.158	0.176	0.168	0.171	0.177	0.188	0.190	0.188	0.187	0.176	0.155
	SD	0.199	0.207	0.207	0.204	0.195	0.213	0.199	0.219	0.232	0.226	0.217	0.208	0.212	0.217	0.230	0.230	0.219	0.210	0.200	0.210
	Min	-0.233	-0.233	-0.233	-0.233	-0.233	-0.233	-0.233	-0.233	-0.233	-0.233	-0.233	-0.233	-0.233	-0.233	-0.233	-0.233	-0.233	-0.233	-0.233	-0.105
	Max	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	N	502	544	567	608	622	648	674	721	771	876	967	992	1,032	1,079	1,125	1,198	1,285	1,361	1,358	219
INCTECHCAPINVESTOREV	Mean		1.220	1.116	1.164	1.158	1.276	1.297	1.383	1.613	1.641	1.546	1.512	1.697	1.574	1.452	1.452	1.442	1.303	1.283	1.881
	SD		4.415	4.070	4.293	4.360	4.607	4.505	5.012	5.573	5.362	5.164	5.014	5.538	5.290	4.992	5.030	5.244	4.900	4.827	5.726
	Min		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Max		32.577	32.577	32.577	32.577	32.577	32.577	32.577	32.577	32.577	32.577	32.577	32.577	32.577	32.577	32.577	32.577	32.577	32.577	32.577
	N	0	544	567	608	622	648	673	721	771	875	967	992	1,031	1,079	1,124	1,197	1,284	1,360	1,358	218
LPFETOTA	Mean	0.086	0.082	0.080	0.081	0.076	0.076	0.069	0.061	0.064	0.064	0.069	0.065	0.063	0.063	0.060	0.058	0.054	0.054	0.054	0.045
	SD	0.193	0.186	0.186	0.186	0.186	0.185	0.172	0.161	0.167	0.164	0.146	0.139	0.137	0.136	0.128	0.125	0.117	0.119	0.122	0.125
	Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Max	0.898	0.898	0.898	0.898	0.898	0.898	0.898	0.898	0.898	0.898	0.898	0.898	0.898	0.898	0.898	0.898	0.898	0.898	0.898	0.878
	N	668	721	766	801	848	900	936	987	1,043	1,082	1,130	1,163	1,215	1,256	1,291	1,343	1,399	1,421	1,367	219
CASHTOTA	Mean	0.129	0.130	0.140	0.140	0.131	0.133	0.147	0.144	0.143	0.155	0.156	0.153	0.150	0.155	0.154	0.152	0.162	0.168	0.166	0.176
	SD	0.184	0.173	0.182	0.177	0.172	0.176	0.192	0.181	0.180	0.188	0.188	0.189	0.187	0.180	0.177	0.174	0.176	0.179	0.177	0.199
	Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Max	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869

	N	668	721	766	801	848	900	936	987	1,043	1,082	1,130	1,163	1,215	1,256	1,291	1,343	1,399	1,421	1,367	219
INVENTOTA	Mean	0.273	0.267	0.263	0.263	0.272	0.270	0.255	0.259	0.257	0.245	0.235	0.239	0.242	0.232	0.237	0.245	0.243	0.236	0.221	0.230
	SD	0.308	0.309	0.312	0.312	0.325	0.332	0.326	0.333	0.337	0.332	0.318	0.322	0.321	0.316	0.321	0.331	0.336	0.330	0.318	0.325
	Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Max	0.986	0.986	0.986	0.986	0.986	0.986	0.986	0.986	0.986	0.986	0.986	0.986	0.986	0.986	0.986	0.986	0.986	0.986	0.986	0.986
	N	668	721	766	801	848	900	936	987	1,043	1,082	1,130	1,163	1,215	1,256	1,291	1,343	1,399	1,421	1,367	219
TCTOTA	Mean	0.208	0.196	0.205	0.200	0.193	0.177	0.177	0.179	0.180	0.168	0.172	0.182	0.179	0.179	0.181	0.190	0.185	0.188	0.185	0.182
	SD	0.222	0.218	0.220	0.212	0.210	0.204	0.209	0.205	0.213	0.200	0.201	0.209	0.208	0.205	0.205	0.207	0.199	0.197	0.194	0.204
	Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Max	0.772	0.772	0.772	0.772	0.772	0.772	0.772	0.772	0.772	0.772	0.772	0.772	0.772	0.772	0.772	0.772	0.772	0.772	0.772	0.772
	N	668	721	766	801	848	900	936	987	1,043	1,082	1,130	1,163	1,215	1,256	1,291	1,343	1,399	1,421	1,367	219
TOTOTA	Mean	0.144	0.143	0.143	0.139	0.132	0.125	0.130	0.127	0.127	0.128	0.175	0.196	0.195	0.200	0.203	0.206	0.201	0.204	0.208	0.186
	SD	0.194	0.191	0.190	0.186	0.182	0.176	0.182	0.179	0.176	0.178	0.215	0.236	0.236	0.236	0.239	0.239	0.232	0.227	0.225	0.236
	Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Max	0.853	0.853	0.853	0.853	0.853	0.804	0.853	0.853	0.853	0.853	0.853	0.853	0.853	0.853	0.853	0.853	0.853	0.853	0.853	0.853
	N	668	721	766	801	848	900	936	987	1,043	1,082	1,130	1,163	1,215	1,256	1,291	1,343	1,399	1,421	1,367	219
SGATOTA	Mean	0.280	0.276	0.280	0.290	0.252	0.240	0.237	0.226	0.248	0.244	0.222	0.209	0.194	0.198	0.193	0.182	0.173	0.172	0.181	0.185
	SD	0.503	0.495	0.495	0.510	0.436	0.438	0.430	0.416	0.464	0.439	0.419	0.407	0.369	0.391	0.386	0.355	0.328	0.318	0.348	0.415
	Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Max	2.817	2.817	2.817	2.817	2.817	2.817	2.817	2.817	2.817	2.817	2.817	2.817	2.817	2.817	2.817	2.817	2.817	2.817	2.817	2.817
	N	668	721	766	801	848	900	936	987	1,043	1,082	1,130	1,163	1,215	1,256	1,291	1,343	1,399	1,421	1,367	219
RG	Mean		1.655	1.693	1.707	1.732	1.734	1.649	1.714	1.508	1.377	1.488	1.825	1.783	1.774	1.658	1.673	1.635	1.672	1.763	1.573
	SD		1.257	1.203	1.132	1.166	1.240	1.120	1.307	1.272	1.369	1.306	1.293	1.309	1.252	1.172	1.265	1.178	1.194	1.291	1.174
	Min		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.951	0.000	0.000	0.000	-4.104	-0.029	0.000	0.000	-0.573	0.000	0.000
	Max		7.960	8.321	6.704	7.832	7.217	5.829	7.548	8.351	7.779	8.328	9.228	9.425	7.399	7.070	9.174	8.313	6.739	8.573	8.315
	N	0	404	420	427	447	468	498	542	498	415	515	614	646	680	848	917	927	949	933	140
Ln (TOTR)	Mean	9.937	9.946	10.078	10.087	10.177	10.258	10.378	10.409	10.392	10.197	10.095	10.136	10.196	10.226	10.304	10.454	10.547	10.664	10.820	10.893
	SD	1.675	1.720	1.625	1.679	1.672	1.663	1.594	1.684	1.661	1.564	1.542	1.503	1.434	1.434	1.468	1.391	1.372	1.245	1.101	1.022
	Min	4.796	4.796	4.796	4.796	4.796	4.796	4.796	4.796	4.796	4.796	4.796	4.796	4.796	4.796	4.796	4.796	4.796	4.796	4.796	9.657

Max	14.572	14.572	14.572	14.572	14.572	14.572	14.572	14.572	14.572	14.572	14.572	14.572	14.572	14.572	14.572	14.572	14.572	14.572	14.572	14.572
N	502	544	567	608	622	648	674	721	770	876	967	992	1,032	1,078	1,125	1,198	1,284	1,361	1,358	219

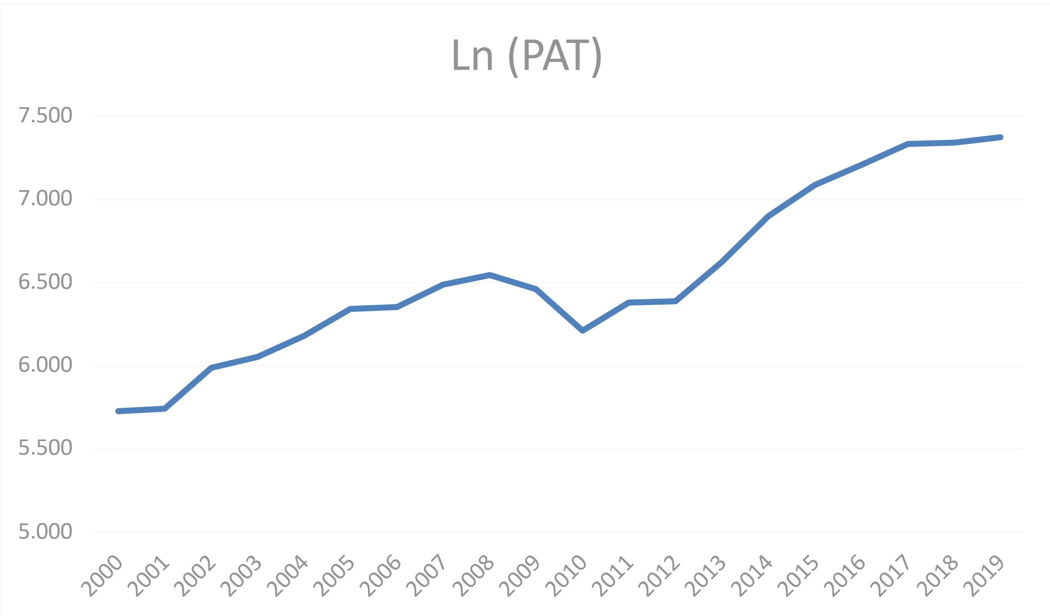


Sector 42 summary

Variable	Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Ln (PAT)	Mean	5.727	5.740	5.986	6.055	6.180	6.341	6.351	6.488	6.544	6.459	6.212	6.380	6.387	6.621	6.899	7.088	7.206	7.331	7.342	7.373
	SD	1.435	1.496	1.376	1.380	1.505	1.620	1.416	1.396	1.518	1.507	1.571	1.575	1.500	1.512	1.381	1.266	1.390	1.371	1.271	1.022
	Min	2.079	1.946	1.946	1.946	1.946	1.946	1.946	2.398	1.946	2.197	1.946	1.946	1.946	1.946	1.946	1.946	2.485	2.079	1.946	4.615
	Max	10.052	10.437	9.551	9.562	10.162	11.270	10.480	10.899	10.579	10.521	10.063	10.478	10.697	11.570	10.658	10.065	11.163	11.937	11.717	8.732
	N	118	145	153	160	158	163	169	183	183	182	201	214	231	241	259	279	289	293	284	38
NCATOTA	Mean	0.137	0.144	0.162	0.162	0.155	0.182	0.193	0.159	0.170	0.201	0.204	0.215	0.196	0.201	0.216	0.222	0.216	0.224	0.237	0.185
	SD	0.213	0.187	0.206	0.240	0.242	0.243	0.269	0.242	0.256	0.279	0.240	0.228	0.276	0.251	0.232	0.258	0.264	0.273	0.260	0.285
	Min	-0.523	-0.505	-0.596	-1.014	-1.014	-1.014	-1.014	-1.014	-1.014	-1.014	-0.554	-0.405	-1.014	-1.014	-1.014	-1.014	-1.014	-1.014	-1.014	-1.014
	Max	0.990	0.990	0.984	0.932	0.862	0.990	0.990	0.990	0.990	0.990	0.973	0.990	0.956	0.930	0.990	0.960	0.990	0.958	0.959	0.940
	N	187	204	212	222	233	236	247	260	265	277	280	294	300	315	328	334	345	344	325	45
DBTOTA	Mean	0.072	0.074	0.076	0.072	0.079	0.075	0.070	0.082	0.078	0.083	0.072	0.069	0.076	0.080	0.076	0.086	0.077	0.072	0.062	0.094
	SD	0.181	0.188	0.196	0.191	0.206	0.195	0.185	0.203	0.184	0.196	0.179	0.176	0.173	0.174	0.168	0.181	0.166	0.160	0.142	0.175
	Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Max	1.000	1.000	1.000	0.942	1.000	0.986	1.000	0.999	0.992	0.992	1.000	1.000	0.983	1.000	1.000	1.000	1.000	1.000	0.884	1.000
	N	187	204	212	222	233	236	247	260	265	277	280	294	300	315	328	334	345	344	325	45
OM	Mean	0.047	0.032	0.049	0.059	0.034	0.049	0.044	0.042	0.035	0.038	0.047	0.050	0.051	0.022	0.044	0.053	0.046	0.050	0.057	0.051
	SD	0.185	0.273	0.269	0.178	0.317	0.242	0.228	0.190	0.249	0.208	0.137	0.137	0.126	0.276	0.216	0.180	0.234	0.200	0.130	0.148
	Min	-1.040	-2.281	-2.281	-0.866	-2.281	-2.281	-1.996	-1.230	-2.281	-2.281	-0.632	-0.518	-0.766	-2.281	-2.281	-2.281	-2.281	-2.281	-1.493	-0.639
	Max	0.852	0.855	0.844	0.817	0.805	0.791	0.763	0.743	0.739	0.724	0.794	0.819	0.778	0.721	0.737	0.749	0.746	0.707	0.676	0.434
	N	120	134	137	147	149	149	156	162	167	215	237	246	264	291	299	317	326	331	324	45
GM	Mean	0.129	0.127	0.149	0.149	0.155	0.145	0.146	0.136	0.139	0.151	0.157	0.148	0.150	0.147	0.148	0.154	0.157	0.151	0.150	0.149
	SD	0.150	0.147	0.139	0.145	0.154	0.129	0.133	0.126	0.136	0.147	0.156	0.133	0.141	0.130	0.133	0.141	0.148	0.144	0.126	0.126
	Min	-0.233	-0.233	-0.021	-0.233	-0.233	-0.073	-0.233	-0.233	-0.152	-0.177	-0.213	-0.106	-0.225	-0.233	-0.042	-0.233	-0.233	-0.223	-0.077	-0.233
	Max	0.901	0.771	0.782	0.933	1.000	0.747	0.734	0.756	0.945	1.000	1.000	0.926	0.911	0.857	1.000	1.000	1.000	1.000	1.000	0.474
	N	120	134	137	147	149	149	156	162	167	215	237	246	264	291	299	317	326	331	324	45
INCTECHCAPINVESTOREV	Mean		1.358	1.050	0.740	0.936	0.707	0.573	0.504	0.511	0.488	0.764	0.590	0.484	0.685	0.599	0.480	0.509	0.479	0.305	0.316
	SD		5.192	3.965	2.643	3.706	3.073	1.809	1.577	1.542	1.776	3.470	2.198	1.976	3.245	3.097	2.394	2.336	2.244	1.155	0.809
	Min		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

	Max		32.577	32.208	24.157	32.577	32.577	10.751	9.948	10.359	15.725	32.577	18.842	20.036	32.577	32.577	32.577	32.577	32.577	14.998	3.311
	N	0	134	137	147	149	149	156	162	167	215	237	246	264	291	299	317	326	331	324	45
LPFETOTA	Mean	0.083	0.069	0.056	0.055	0.052	0.054	0.039	0.056	0.051	0.056	0.127	0.130	0.142	0.131	0.130	0.136	0.137	0.138	0.134	0.124
	SD	0.173	0.158	0.135	0.124	0.125	0.134	0.093	0.145	0.140	0.134	0.180	0.179	0.188	0.166	0.167	0.168	0.171	0.172	0.162	0.177
	Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Max	0.898	0.898	0.862	0.846	0.857	0.851	0.809	0.893	0.898	0.898	0.898	0.898	0.898	0.898	0.898	0.879	0.816	0.838	0.817	0.727
	N	187	204	212	222	233	236	247	260	265	277	280	294	300	315	328	334	345	344	325	45
CASHTOTA	Mean	0.123	0.144	0.145	0.164	0.141	0.143	0.148	0.144	0.156	0.173	0.176	0.170	0.180	0.176	0.190	0.206	0.211	0.207	0.210	0.226
	SD	0.155	0.166	0.166	0.178	0.162	0.163	0.170	0.172	0.173	0.188	0.175	0.173	0.182	0.175	0.170	0.174	0.184	0.183	0.177	0.218
	Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Max	0.703	0.817	0.869	0.869	0.813	0.751	0.869	0.869	0.766	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869
	N	187	204	212	222	233	236	247	260	265	277	280	294	300	315	328	334	345	344	325	45
INVENTOTA	Mean	0.104	0.102	0.105	0.094	0.097	0.081	0.071	0.067	0.063	0.061	0.067	0.058	0.053	0.056	0.051	0.047	0.046	0.044	0.048	0.043
	SD	0.139	0.141	0.146	0.137	0.137	0.134	0.131	0.129	0.130	0.122	0.125	0.113	0.096	0.111	0.099	0.097	0.097	0.097	0.102	0.069
	Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Max	0.902	0.817	0.732	0.667	0.719	0.672	0.893	0.915	0.916	0.986	0.818	0.680	0.614	0.962	0.675	0.850	0.667	0.755	0.790	0.314
	N	187	204	212	222	233	236	247	260	265	277	280	294	300	315	328	334	345	344	325	45
TCTOTA	Mean	0.210	0.199	0.210	0.211	0.194	0.197	0.202	0.201	0.199	0.192	0.208	0.212	0.239	0.244	0.240	0.242	0.244	0.245	0.236	0.246
	SD	0.204	0.197	0.197	0.198	0.193	0.190	0.199	0.196	0.194	0.186	0.189	0.190	0.200	0.202	0.201	0.193	0.192	0.188	0.172	0.184
	Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Max	0.772	0.772	0.772	0.765	0.772	0.711	0.702	0.734	0.772	0.772	0.759	0.772	0.772	0.772	0.772	0.772	0.772	0.772	0.772	0.772
	N	187	204	212	222	233	236	247	260	265	277	280	294	300	315	328	334	345	344	325	45
TOTOTA	Mean	0.216	0.213	0.223	0.216	0.210	0.218	0.211	0.223	0.216	0.213	0.299	0.334	0.347	0.369	0.356	0.347	0.343	0.343	0.335	0.317
	SD	0.224	0.226	0.223	0.222	0.219	0.223	0.224	0.238	0.233	0.220	0.244	0.259	0.260	0.260	0.245	0.232	0.230	0.227	0.219	0.232
	Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Max	0.853	0.853	0.853	0.853	0.853	0.853	0.853	0.853	0.853	0.853	0.853	0.853	0.853	0.853	0.853	0.853	0.853	0.853	0.853	0.853
	N	187	204	212	222	233	236	247	260	265	277	280	294	300	315	328	334	345	344	325	45
SGATOTA	Mean	0.336	0.345	0.332	0.338	0.341	0.320	0.300	0.312	0.315	0.325	0.311	0.291	0.308	0.308	0.306	0.291	0.270	0.276	0.296	0.286
	SD	0.543	0.553	0.502	0.501	0.505	0.506	0.465	0.486	0.470	0.460	0.444	0.443	0.474	0.454	0.457	0.423	0.382	0.398	0.438	0.273
	Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.010
	Max	2.817	2.817	2.817	2.817	2.817	2.817	2.817	2.817	2.817	2.817	2.817	2.817	2.817	2.817	2.817	2.817	2.817	2.817	2.817	1.497

	N	187	204	212	222	233	236	247	260	265	277	280	294	300	315	328	334	345	344	325	45
RG	Mean		1.599	1.586	1.761	2.040	1.966	1.782	1.825	1.819	1.156	1.587	1.969	1.750	1.854	1.706	1.814	2.003	1.947	2.067	2.362
	SD		1.224	1.110	1.254	1.399	1.398	1.129	1.202	1.207	1.402	1.280	1.334	1.056	1.273	1.095	1.152	1.096	1.226	1.253	1.224
	Min		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Max		4.989	4.383	6.121	6.563	5.303	4.752	5.425	5.681	5.753	7.399	7.575	5.399	6.569	6.351	7.178	6.139	7.766	7.455	4.617
	N	0	110	105	112	105	99	120	121	118	113	142	160	190	212	227	225	214	242	226	28
Ln (TOTR)	Mean	9.404	9.461	9.664	9.805	9.842	10.035	10.136	10.234	10.317	10.106	10.122	10.203	10.231	10.221	10.432	10.519	10.548	10.659	10.726	10.759
	SD	1.559	1.601	1.453	1.361	1.480	1.351	1.426	1.406	1.408	1.325	1.170	1.181	1.153	1.248	1.127	1.062	1.066	1.037	0.932	0.791
	Min	4.796	4.796	4.796	5.384	4.796	5.434	4.796	4.796	4.796	4.796	5.976	5.852	5.394	5.017	4.956	4.905	4.796	4.852	9.545	9.658
	Max	12.851	13.033	13.165	13.343	13.420	13.670	13.526	13.659	13.713	13.809	13.737	13.675	13.651	13.694	13.885	14.192	14.504	14.572	14.196	13.263
	N	120	134	137	147	149	149	156	162	167	215	237	246	264	291	299	317	326	331	324	45

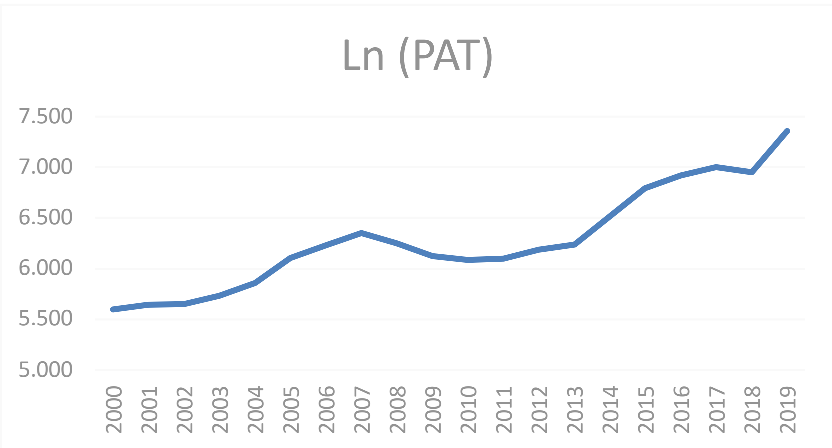


Sector 43 summary

Variable	Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Ln (PAT)	Mean	5.598	5.643	5.648	5.734	5.856	6.102	6.229	6.350	6.250	6.122	6.083	6.100	6.186	6.240	6.514	6.791	6.917	7.000	6.949	7.358
	SD	1.473	1.491	1.491	1.465	1.473	1.438	1.425	1.425	1.493	1.423	1.550	1.518	1.520	1.426	1.399	1.271	1.288	1.290	1.334	1.328
	Min	1.946	1.946	1.946	1.946	1.946	1.946	1.946	1.946	1.946	1.946	1.946	1.946	1.946	1.946	1.946	1.946	1.946	1.946	1.946	4.111
	Max	10.403	10.464	10.364	10.455	10.696	10.971	11.182	11.375	11.315	11.184	11.223	11.461	11.653	11.142	10.449	11.317	11.937	11.833	11.636	11.593
	N	368	442	476	490	488	498	540	572	598	586	573	631	642	680	764	824	841	860	844	113
NCATOTA	Mean	0.150	0.163	0.173	0.185	0.184	0.186	0.192	0.183	0.182	0.204	0.210	0.208	0.218	0.224	0.227	0.236	0.237	0.242	0.257	0.282
	SD	0.226	0.231	0.221	0.238	0.248	0.254	0.259	0.263	0.266	0.268	0.261	0.270	0.255	0.250	0.238	0.233	0.239	0.240	0.240	0.221
	Min	-0.949	-1.000	-1.014	-1.014	-1.014	-1.014	-1.014	-1.014	-1.014	-1.014	-1.014	-1.014	-1.014	-1.014	-1.014	-1.014	-1.014	-1.014	-1.014	-0.818
	Max	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.857
	N	586	647	672	704	731	768	797	829	848	875	893	925	930	948	971	974	994	1,014	963	125
DBTOTA	Mean	0.049	0.050	0.050	0.049	0.049	0.044	0.046	0.048	0.052	0.048	0.045	0.049	0.048	0.048	0.047	0.045	0.046	0.047	0.040	0.046
	SD	0.119	0.130	0.127	0.124	0.127	0.119	0.123	0.127	0.135	0.124	0.114	0.121	0.120	0.115	0.113	0.103	0.115	0.121	0.109	0.130
	Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Max	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.928
	N	586	647	672	704	731	768	797	829	848	875	893	925	930	948	971	974	994	1,014	963	125
OM	Mean	0.033	0.033	0.036	0.028	0.024	0.034	0.038	0.038	0.033	0.034	0.029	0.026	0.032	0.036	0.046	0.054	0.051	0.046	0.043	0.058
	SD	0.157	0.219	0.182	0.193	0.221	0.154	0.135	0.168	0.142	0.129	0.120	0.167	0.133	0.119	0.081	0.064	0.134	0.114	0.085	0.067
	Min	-2.281	-2.281	-2.281	-2.281	-2.281	-2.281	-2.281	-2.281	-2.281	-2.281	-2.281	-2.281	-2.281	-2.281	-1.409	-0.288	-1.931	-2.281	-1.187	-0.152
	Max	0.636	0.500	0.531	0.900	1.000	0.889	0.508	0.804	0.851	1.000	0.802	1.436	0.968	0.965	0.542	0.568	1.436	0.569	0.537	0.329
	N	347	378	399	416	408	416	427	469	496	617	674	724	743	774	832	875	933	983	960	125
GM	Mean	0.202	0.200	0.202	0.204	0.202	0.199	0.204	0.195	0.192	0.203	0.203	0.192	0.186	0.189	0.189	0.193	0.193	0.189	0.189	0.193
	SD	0.156	0.135	0.143	0.149	0.135	0.139	0.147	0.142	0.131	0.128	0.124	0.125	0.116	0.116	0.113	0.113	0.117	0.118	0.115	0.105
	Min	-0.212	-0.233	-0.233	-0.181	-0.193	-0.227	-0.233	-0.233	-0.233	-0.074	-0.233	-0.233	-0.233	-0.233	-0.068	-0.131	-0.233	-0.233	-0.131	-0.017
	Max	1.000	1.000	1.000	1.000	0.955	0.980	1.000	1.000	0.938	0.961	0.974	0.975	0.976	0.974	0.980	0.977	0.962	1.000	1.000	0.596
	N	347	378	399	416	408	416	427	469	496	617	674	724	743	774	832	875	933	983	960	125

INCTECHCAPINVESTOREV	Mean		0.225	0.235	0.163	0.230	0.257	0.217	0.237	0.228	0.206	0.217	0.201	0.240	0.230	0.169	0.129	0.197	0.137	0.128	0.109
	SD		1.695	1.647	0.374	1.646	1.737	1.605	1.604	1.543	1.337	1.300	1.243	1.717	1.684	1.159	0.319	1.459	0.348	0.362	0.217
	Min		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Max		32.577	32.577	4.133	32.577	32.577	32.577	32.577	32.577	32.577	32.577	32.577	32.577	32.577	32.577	6.136	32.577	5.617	6.383	1.310
	N	0	378	399	416	408	416	427	469	496	617	673	724	743	774	831	875	933	983	960	125
LPFETOTA	Mean	0.052	0.045	0.047	0.046	0.044	0.040	0.039	0.036	0.038	0.047	0.094	0.100	0.101	0.100	0.106	0.111	0.108	0.105	0.104	0.085
	SD	0.097	0.083	0.088	0.086	0.087	0.085	0.082	0.069	0.077	0.093	0.157	0.160	0.160	0.156	0.158	0.162	0.158	0.157	0.152	0.121
	Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Max	0.898	0.745	0.697	0.752	0.750	0.728	0.657	0.635	0.898	0.651	0.866	0.898	0.898	0.898	0.863	0.898	0.854	0.883	0.874	0.718
	N	586	647	672	704	731	768	797	829	848	875	893	925	930	948	971	974	994	1,014	963	125
CASHTOTA	Mean	0.147	0.147	0.158	0.158	0.148	0.158	0.153	0.155	0.164	0.181	0.170	0.162	0.164	0.166	0.168	0.182	0.185	0.186	0.185	0.211
	SD	0.178	0.176	0.188	0.184	0.168	0.175	0.177	0.175	0.185	0.189	0.180	0.174	0.173	0.173	0.166	0.172	0.170	0.169	0.172	0.211
	Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Max	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.853	0.869	0.869	0.791
	N	586	647	672	704	731	768	797	829	848	875	893	925	930	948	971	974	994	1,014	963	125
INVENTOTA	Mean	0.130	0.130	0.120	0.117	0.115	0.110	0.100	0.089	0.084	0.081	0.081	0.080	0.078	0.081	0.077	0.074	0.072	0.070	0.066	0.059
	SD	0.166	0.168	0.159	0.160	0.158	0.157	0.146	0.142	0.138	0.133	0.129	0.124	0.125	0.131	0.127	0.127	0.124	0.123	0.116	0.118
	Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Max	0.933	0.955	0.926	0.986	0.839	0.823	0.853	0.929	0.986	0.986	0.986	0.986	0.790	0.986	0.986	0.896	0.921	0.844	0.851	0.683
	N	586	647	672	704	731	768	797	829	848	875	893	925	930	948	971	974	994	1,014	963	125
TCTOTA	Mean	0.203	0.206	0.199	0.196	0.193	0.188	0.191	0.201	0.201	0.197	0.204	0.219	0.224	0.233	0.244	0.255	0.258	0.266	0.266	0.255
	SD	0.195	0.199	0.186	0.187	0.196	0.190	0.189	0.192	0.190	0.182	0.187	0.193	0.191	0.191	0.188	0.186	0.177	0.175	0.172	0.174
	Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Max	0.772	0.772	0.772	0.772	0.772	0.772	0.772	0.772	0.772	0.772	0.772	0.772	0.772	0.772	0.772	0.772	0.772	0.772	0.772	0.713
	N	586	647	672	704	731	768	797	829	848	875	893	925	930	948	971	974	994	1,014	963	125
TOTOTA	Mean	0.255	0.257	0.259	0.256	0.237	0.233	0.235	0.242	0.247	0.237	0.304	0.331	0.341	0.360	0.374	0.392	0.396	0.403	0.398	0.378
	SD	0.250	0.246	0.242	0.242	0.238	0.238	0.243	0.236	0.234	0.227	0.254	0.258	0.259	0.259	0.251	0.238	0.228	0.221	0.214	0.250
	Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Max	0.853	0.853	0.853	0.853	0.853	0.853	0.853	0.853	0.853	0.853	0.853	0.853	0.853	0.853	0.853	0.853	0.853	0.853	0.853	0.853
	N	586	647	672	704	731	768	797	829	848	875	893	925	930	948	971	974	994	1,014	963	125

SGATOTA	Mean	0.380	0.396	0.406	0.403	0.376	0.352	0.353	0.353	0.357	0.377	0.347	0.350	0.347	0.346	0.361	0.357	0.368	0.372	0.376	0.348
	SD	0.495	0.529	0.506	0.475	0.493	0.470	0.453	0.457	0.441	0.446	0.400	0.422	0.407	0.401	0.420	0.391	0.399	0.400	0.379	0.281
	Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Max	2.817	2.817	2.817	2.817	2.817	2.817	2.817	2.817	2.817	2.817	2.817	2.817	2.817	2.817	2.817	2.817	2.817	2.817	2.817	1.826
	N	586	647	672	704	731	768	797	829	848	875	893	925	930	948	971	974	994	1,014	963	125
RG	Mean		1.510	1.665	1.780	1.760	1.816	1.805	1.626	1.661	1.293	1.790	1.808	1.918	2.010	1.779	1.710	1.850	1.892	1.983	2.009
	SD		1.090	1.157	1.225	1.063	1.180	1.178	1.109	1.134	1.395	1.433	1.146	1.194	1.214	1.184	1.106	1.209	1.252	1.188	1.099
	Min		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Max		5.702	6.896	7.870	5.478	8.240	5.857	5.901	6.411	7.215	7.552	7.163	8.520	7.635	9.557	7.623	8.229	8.864	7.314	6.140
	N	0	289	279	311	300	318	325	373	373	344	358	508	501	522	633	630	668	689	655	93
Ln (TOTR)	Mean	9.204	9.344	9.445	9.506	9.630	9.799	9.926	10.020	10.085	9.947	9.901	9.926	10.015	10.057	10.158	10.229	10.277	10.369	10.432	10.569
	SD	1.442	1.372	1.311	1.387	1.402	1.324	1.249	1.248	1.229	1.086	1.022	1.070	1.019	1.008	0.952	0.891	0.906	0.812	0.772	0.842
	Min	4.796	4.796	4.796	4.796	4.796	4.796	4.796	4.796	4.796	4.796	4.796	4.796	4.796	4.796	4.796	7.466	4.796	7.682	8.858	9.638
	Max	13.745	13.852	13.960	14.053	14.151	14.310	14.436	14.572	14.572	14.572	14.572	14.572	14.572	14.572	14.572	14.572	14.572	14.572	14.572	13.819
	N	347	378	399	416	408	416	427	469	496	617	674	724	743	774	832	875	933	983	960	125



Appendix 11: Wooldridge autocorrelation test

	Sector 41	Sector 42	Sector 43
Corr	-0.248	-0.306	-0.275
F	54.569	39.286	76.762
p	0	0	0