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Cash holding dynamics and competition intensity: Evidence from UK firms

Gbenga Adamolekun[1] | Edward Jones[2] | Hao Li[3]

[1]The Business School, Edinburgh Napier University, Edinburgh, UK
[2]Edinburgh Business School, Heriot-Watt University, Edinburgh, UK
[3]Cardiff Business School, Cardiff University, Cardiff, UK

Correspondence
Gbenga Adamolekun, The Business School, Edinburgh Napier University, EH14 1DJ Edinburgh, UK.
Email: b.adamolekun@napier.ac.uk

Abstract

Using a quasi-natural experiment and various measures of competition intensity, we examine whether an increase in product market competition is a key driver of firm cash holdings. We find that firms increase cash holdings when competition is intense. The results suggest that the degree of increase in cash holdings is magnified among firms exposed to high predatory threat and financing friction. In addition, we examine if increasing cash holdings offers a competitive advantage in the product market. Our results indicate that firms with large cash reserves make gains in market share at the expense of their rivals. Gains in the product market are more pronounced among firms with low exposure to predatory risk and financing frictions.

JEL CLASSIFICATION
G30, G32, G39

1 | INTRODUCTION

According to the literature on financial flexibility, competitive pressure increases cash flow risk (Bolton & Scharfstein, 1990; MacKay & Phillips, 2005). In turn, cash flow risk heightens default risk and ultimately the bank lending rate (Minton & Schrand, 1999; Valta, 2012). Building on this premise, we investigate whether, during increased competitive pressure, changes in firms' cash holdings vary with the degree of product differentiation and financing frictions.[1] In addition, using a quasi natural experiment we confirm that firms increase their cash holdings in response to increased competition. Furthermore, we evaluate if changes in cash holdings amidst intense competition, financing friction and predatory threat result in gains in the product market.

We argue that since increased competition results in an increased cost of debt, firms will favour financing their activities with internal rather than external funds during periods of intense competition. Increasing the cash in a firm's treasury becomes a priority in such periods since cash mitigates the adverse impact of the resulting cash flow risk (Bates et al., 2009; Valta, 2012). Correspondingly, the share performance of a firm is negatively affected by cash flow risk (Minton & Schrand, 1999). Therefore, internal finance would be vital for firms in intensely competitive industries. Firms can increase cash holdings by cutting dividends, selling redundant assets, disposing of unproductive product lines, and reducing investments (Opler et al., 1999; Subramaniam et al., 2011).

The motivation for the trend to higher cash holdings has been the subject of much discussion by industry practitioners and researchers alike. For instance, Harford (1999) demonstrates how firms that pursue a high cash holdings policy engage in investments that are perceived to be value-destroying. Alternatively, Yu et al. (2015), using Taiwanese data, find that high cash holdings may indicate an alignment of interest between shareholders and managers. In a recent study, Faulkender et al. (2019) demonstrate that the accumulation of foreign cash by US multinationals is motivated by the declining corporate tax rates overseas. Other studies such as Opler et al. (1999), Opler et al. (2001), Bates et al. (2009) and Bolton et al. (2011) contend that as a result of high growth opportunities, financial constraints, volatile cash flow and the high transaction costs associated with raising external finance, firms increase their cash holdings. In a press release on 22 January 2014, Deloitte (2014) argue that there is a polarisation in the cash holdings of FTSE non-financial firms. They posit that most

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of the cash is held by a small number of firms. Another article in the Financial Times (FT, 15 September 2013) reveals that the growth in net cash (cash minus short-term debt) is accelerating.[2] Such trends beg the question, Why are firms increasing their cash reserves?

An emerging strand of the literature focuses on an alternative motivation for cash holdings: the strategic motive. Recent evidence in the literature has brought to light the strategic advantages of holding cash. The cash-holding policy adopted by a firm is dictated by the anticipated degree of competition among its rivals (Lyandres & Palazzo, 2016). To this effect, Fresard (2010) highlights the strategic dimension of cash holdings and argues that due to large cash reserves, corporations can make gains in competitive industries at the expense of industry rivals. Cash holdings offer a competitive advantage in several ways. For example, due to an increase in competition in a high growth environment, firms exposed to high predatory risk respond by increasing their corporate investment to deter entrants (Aguerrevere, 2009; Akdoğu & MacKay, 2008; Jiang et al., 2015). When the speed of adjustment to the competitive environment is key, cash may offer a pre-emptive advantage and reinforce other corporate strategies. Cash-rich firms may resort to further enhancing their capability to discourage rivals (Álvarez & Hernando, 2007). The resulting corporate capabilities create competitive organisational assets in form of speed, efficiency, flexibility, incremental improvements and innovations (Baldwin & Clark, 1992; Bowman & Ambrosini, 2000; Stalk et al., 1992; Watts et al., 1995). Despite the obvious theoretical and empirical link between increased competition and cash holdings level, the question of whether firms increase their cash holdings in response to increased competition intensity remains unanswered. Our study fills this gap in the literature using companies listed on the London Stock Exchange (LSE).

Using the United Kingdom as the setting for our study offers some advantages. Firstly, our study provides some empirical insight regarding the implications and motivations for increasing levels of cash holdings in the United Kingdom. Furthermore, as identified by La Porta et al. (1997), La Porta et al. (2000) and Gaud et al. (2007), corporate finance practice is not uniform worldwide; country factors such as the legal system, culture, developmental status and institutional structure could shape corporate practices in specific jurisdictions. The legal competitive structure of the United Kingdom is uniquely appropriate for our study. Being a member state of the European Union (EU) during the period of the study, the United Kingdom is compelled to adhere to externally determined rules and regulations on competition.[3] The EU competitive environment operates as a unified financial market and as such allows for 'near-perfect capital mobility' (Mendoza & Tesar, 2005, p. 163). Similarly, using a sample of firms listed on the London Stock Exchange (LSE) offers the opportunity for testing the relationship between product competition and cash holdings in one of the most liquid non-US market and one of the most attractive markets internationally (Galariotis & Giouvris, 2007; FT, 24 March 2006).

Our findings are as follows. Firstly, using various measures of competition (industry concentration, HHI, Theil's Entropy Index and Gini Coefficient), we find that firms increase cash holdings as the intensity of competition increases. The results suggest that firms with a low degree of product/service differentiation (i.e. firms exposed to predatory threats) increase their cash holdings at higher levels of competition intensity.[4] Furthermore, the results indicate that firms exposed to higher financing frictions increase their cash holdings more than their counterparts.[5] In addition, we find that firms with high cash reserves make gains in market share at the expense of their rivals in the product market. Gains in the product market arising from increased cash holdings are amplified if a firm has low exposure to predatory threats (i.e. high degree of product differentiation) and low exposure to financing frictions. The central message of our paper to managers of firms exposed to financing frictions and predatory threat is that cash can and should be preserved to survive intensely competitive periods.

We contribute to the existing literature in a number of ways. Firstly, we demonstrate how changes in cash holdings, motivated by the degree of competition, differ with firms' exposure to predatory risk and financing friction. To the best of our knowledge, we are the first study to empirically demonstrate how gains in market share attributable to cash holdings during intense competition differ with firm exposure to predatory threat and financing friction. We build on the work of Valta (2012) and empirically demonstrate using a quasi natural experiment that in response to the high cost of borrowing and predatory threat in intensely competitive industries, firms build up their cash reserves. We also extend the growing strand of the literature that identifies the strategic benefit of financial flexibility and specifically cash reserves in the product market (see, for instance, Fresard, 2010; Lyandres & Palazzo, 2016). We offer novel evidence on the benefit of cash holdings to firms exposed to adverse selection bias and predatory threat. Our study enhances the strand of literature that explores the dynamics between cash holdings and competition (see, for instance, Haushalter et al., 2007; Hoberg et al., 2014; Lyandres & Palazzo, 2016; Sabherwal & Thai, 2019) in three ways. Firstly, we evaluate firm cash holding choices under an intense competitive state from the lenses of firm exposure to financing friction and predatory threat. Similarly, we examine varying gains in the product markets attributable to cash holdings based on the degree of product differentiation and financing difficulties. Lastly, we use a quasi experiment to confirm the conjecture that firms increase their cash holdings in response to increased competition.

The remainder of this paper is structured as follows: Section 2 presents the literature on cash holdings and competitiveness. The data and methodology used in this study are outlined in Section 3. Section 4 presents the findings of the study and the robustness checks, and Section 5 concludes the study.

2 | LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

2.1 | Cash holdings and product market competition

The role of firm financial policy in the product market is well documented in the finance literature (see, e.g. Alimov, 2014;

Fresard, 2010; Valta, 2012). Although the link between financial policy and firms' competitiveness in the product market is well documented, most studies focus on the role of debt in the product market. Prior studies rely on the argument that cash and debt are substitutes. However, Acharya et al. (2007) and Fresard (2010) argue that cash and debt play distinct roles in satisfying a firm's financing needs.

There are several ways in which cash can be used as a strategic tool. Firstly, when the speed of adjustment to the competitive environment is key, cash may offer some pre-emptive advantages. Firms can deter entry into their competitive space or maintain competitiveness by means of corporate investment. During periods of increased competitive pressure, firms exposed to high predatory risk respond by increasing their corporate investment (Aguerrevere, 2009; Akdoğu & MacKay, 2008; Jiang et al., 2015). As a result of the first-mover advantage and the exercise of existing growth options, cash-rich firms are able to shield themselves from the adverse effects of increased competition.

Similarly, Valta (2012) asserts that the cost of debt is higher for firms in competitive product markets. Increased competition can have adverse effects on a firm's default risk and asset liquidation value which in turn raises the bank lending rate. Further increases in competition will result in increases in the already expensive cost of debt, hence rendering debt less attractive to managers. Moreover, a firm's share performance is also adversely affected by the resulting cash flow risk (Minton & Schrand, 1999), making equity issue an unlikely alternative. In such industries, cash becomes an attractive means of responding to competitive threats. Therefore, cash-rich firms can strategically position themselves during periods of increased competition at the expense of other competitors. As documented in the literature, failure to respond to insurgence into competitive space quickly and adequately will result in losses in the product market (Froot et al., 1993; Haushalter et al., 2007; Jiang et al., 2015). Accordingly, the lack of internal finance may expose the firm to predatory risk. By implication, one firm's failure to react quickly results in another firm's gain.

In the strategic management framework of Akdoğu and MacKay (2012), cash can be used to exercise good investment opportunities. Cash-rich firms can respond faster than rivals during periods of increased competition or uncertainty. The presence of cash also indicates cash-rich firms are less likely to fall behind rivals since they can quickly exercise their investment options when competition becomes intense or their current share of the market is threatened. Firms can also use aggressive pricing as a means of deterring new entrants. By means of a strong financial position, firms may challenge a new entrant or rival by attacking their profitability. Methods adopted may include reducing prices such that entrance to the industry becomes less attractive (Bolton & Scharfstein, 1990).

Cash-rich firms may seek to further enhance their ability to discourage rivals and new entrants when their market share is threatened. Firms can boost their capacity by creating organisational assets in form of speed, efficiency, flexibility, incremental product or service improvements and innovations, combined with human skills, organisational procedures, physical assets as well as a collection of information systems that enhance performance (Baldwin & Clark, 1992). These might include investment in form of relocation of stores, plants, upgrading distribution networks, funding advertisement campaigns targeted at rivals, or recruiting more efficient and productive personnel (Campello, 2006; Cepeda-Carrion et al., 2012). Such actions require a rapid response to increased competition and may be delayed by financing frictions. Hence, they are better suited to cash financing.

Lastly, high cash holdings can be used as a tool for signalling aggressive behaviour to rivals, therefore distorting the activities of rivals in the product market. By building up superior cash positions, deep-pocketed firms indicate they can increase the business risk of rivals by distorting their cash flow and ultimately forcing them to exit an industry (Benoit, 1984; Bolton & Scharfstein, 1990; Campello, 2006).

2.2 | Cash holdings and increased competition intensity

The role of cash as a strategic tool is well documented in the literature. For instance, Haushalter et al. (2007), Duchin (2010), Fresard (2010), Kim and Bettis (2014), Lyandres and Palazzo (2016) and Upadhyay and Zeng (2017) discuss the role of cash as a strategic tool. However, few studies have provided empirical evidence on exactly how cash provides a strategic advantage to firms. An emerging strand of the literature focuses on the relationship between cash holdings and product market competition. The evidence suggests that cash holdings policies could be dictated by the firm's competitive environment (Fresard, 2010; Lyandres & Palazzo, 2016).

The question of whether firms increase their cash in response to increased competition remains unanswered. Why should firms increase their cash in response to increases in competition? Chief among the reasons is the rise in the cost of debt orchestrated by the heightened level of competition (Valta, 2012). Financing both new and existing projects internally becomes a more attractive alternative for firms during periods of intense competition especially when time is of the essence, since in such periods, debt is costly and equity is undervalued (Minton & Schrand, 1999; Valta, 2012). Furthermore, cash is a primary tool for deterring entrance and expanding market share (Akdoğu & MacKay, 2012; Fresard, 2010; Lyandres & Palazzo, 2016). In this framework, firms will increase their cash reserves in order to maintain and enhance their competitive position. Hence, our first hypothesis is

> **Hypothesis 1.** Firms increase their cash holdings as competition increase.

2.3 | Cash holdings, increased competition intensity and predatory risk

The ability of a firm to effectively compete in the product market is a function of the level of internal liquidity the firm controls (Bolton & Scharfstein, 1990; Telser, 1966). The main merit of financial slack is

that it affords a firm the ability to be flexible in the product market (Bolton & Scharfstein, 1990). As a result of this flexibility, firms can react promptly and aggressively to predatory actions of rivals in the product market. In addition, they can create barriers in their competitive space, hence restricting the entrance of new or potential rivals. Through cash, firms in such competitive space can fund various competitive strategies to deter entry or maintain competitive advantage. Competitive strategies can be in form of aggressive pricing, investment in capabilities or simply an increase in cash to convey competitive signals (Bolton & Scharfstein, 1990; Campello, 2006).

The competitive merit of cash holdings is largely dependent on the nature of competitive interaction in a firm's product market. Froot et al. (1993) argue that increased cash holdings are more valuable in product markets where firms compete with closely related products/services. Accordingly, in such a competitive space, there is a high degree of interdependence of growth opportunities. As discussed previously, Valta (2012) argues that the cost of debt increases as competition increases. Minton and Schrand (1999) demonstrate that cash flow risk not only adversely affects a firm's cost of debt but also her share performance. Taken together, external financing is thus rendered less attractive during periods of increased competition. By implication, the impact of increased competition will be amplified in industries where firms compete with strategic substitutes. If a firm wants to retain its competitive advantage in such an industry, it must internally fund growth opportunities. Failure to promptly fund investment opportunities will result in the loss of market share to rivals during periods of increased competition.

These arguments imply that cash should be more valuable to firms in industries where there is high predatory risk (Alimov, 2014; Chi & Su, 2016). Therefore, such firms must seek to increase cash holdings as competition increases since the barriers to entry in such industries are typically low. For instance, barriers to entry would be expected to be higher in the Airline industry than in the restaurant and bar industry. Following the predatory threat-based theories, our second set of hypotheses is

> **Hypothesis 2a.** Increases in cash holdings during increased competition are positively associated with the degree of exposure to predatory threat.

Furthermore, since rivals cannot easily replicate investment opportunities if a firm's product/service significantly differs, we posit that

> **Hypothesis 2b.** Gains in market share associated with increased cash holdings are negatively associated with the degree of exposure to predatory risk.

2.4 | Cash holdings, increased competition and financing frictions

Cash differs fundamentally from negative debt. Cash confers a different advantage to a firm in the competitive market. Cutting back on indebtedness today does not guarantee access to more debt in the future. Therefore, future financing needs are not met merely by reducing debts today (Acharya et al., 2007). Due to financing frictions, firms with excess cash reserves build up their reserve to combat exposure to financing shortfalls (Hennessy et al., 2007). Previous evidence by Kaplan and Zingales (1997) suggests that in the presence of financing frictions, the optimal level of investment is a function of the extent of exposure to financing frictions and the internal finances available to the firm.

Cash is of more value to financially constrained firms (Faulkender & Wang, 2006; Pinkowitz et al., 2006). Due to the presence of market imperfections and financing frictions, constrained firms often rely on internal finance to fund operating and investment needs (Brick & Liao, 2017; Denis & Sibilkov, 2009; Faulkender & Wang, 2006; Pinkowitz et al., 2006). Cash, therefore, is of utmost importance for the survival of firms exposed to financing frictions. Accordingly, our third set of hypotheses is as follows:

> **Hypothesis 3a.** During periods of increased competition, increases in cash holdings are positively associated with the degree of exposure to financing frictions.

> **Hypothesis 3b.** Gains in market share associated with increased cash holdings are negatively associated with the degree of exposure to financing frictions.

3 | DATA AND METHODOLOGY

3.1 | Data

Firm-level data for all UK listed non-financial firms are collected from DataStream for the period 1980–2017. To ensure firms engaged in similar activities are categorised into appropriate groups, we employ a narrow classification of industries. We rely on the Thomson Reuters Industry level 5 classifications. This ensures firms within the same economic markets are grouped together. Similar to Fresard (2010), this procedure results in the allocation of our data into 105 industry groups. Details of the industry groups are reported in Appendix A. After excluding financial industries, 92 industry groups remain. From 78,404 firm-year observations identified from the Thomson Reuters Industry level 5 classification, 76,128 firm-year observations are included in the final sample.

3.2 | Measuring competition

To measure competition, we adopt competition measures established in Ghatak (2003), Fresard (2010), Morellec et al. (2014) and Jiang et al. (2015). We estimate competition using four metrics: Industry Concentration Index (change in the number of firms in an industry), Gini coefficient, Theil's entropy index (TEI) and Herfindahl–Hirschman index (HHI). The selected proxies for competition ensure our results are

robust to symmetric and nonsymmetric industries.[6] For instance, the HHI effectively captures competition when firms in an industry are nonsymmetric, whilst the industry concentration index is a robust measure of competition when firms in an industry are symmetric (Huang & Lee, 2013).

3.2.1 | Industry concentration index

We follow a similar approach proposed by Huang and Lee (2013), Morellec et al. (2014) and Jiang et al. (2015) to estimate the Industry Concentration Index (ICI). By counting the changes to the number of firms in an industry, the ICI measures the degree of competition in an industry. The population of an industry can significantly affect the ability of a firm to influence prices (Huang & Lee, 2013). An increase in the number of firms within an industry indicates an increase in competition whilst a decrease in the number of firms suggests a decrease in competition. We identify periods of increased competition as periods where

$$\Delta i_t > = 1$$

where i is the number of firms in an industry and t indexes the year.

3.2.2 | Gini coefficient

The Gini coefficient measures the degree of statistical dispersion of wealth or income of residents of a nation (Gini, 1912). In the context of a firm, it can be adjusted to capture the dispersion of market share among the firms in an industry. In this context, the Gini coefficient can be defined as

$$G = 1 + \left(\frac{1}{n}\right) - \left(\frac{2}{n}\right)\left(\sum_{i=1}^{n} iS_t\right) \tag{1}$$

where $S_1 \geq S_2 \geq \ldots \geq S_n$, $\sum_{t=1}^{n} S_t = 1$. S_t therein refers to the share of sales accounted by the ith ranked firm and n denotes the number of firms in an industry at time t. Nissan and Caveny (1993) and Ghatak (2003) rewrite the equation such that it effectively takes account of differences between pairs of companies within an industry. The equation can be rewritten as

$$G = 1/2n \sum_{i=1}^{j} \sum_{j=2}^{n} |S_i - S_j| \tag{2}$$

3.2.3 | Theil's entropy index

Entropy captures the degree of disorderliness in a system (Coulter, 1989). Maximum entropy is achieved when each probability of all the discrete values is $1/n$. n is the number of events.

$$E = -\sum s \ln s \tag{3}$$

where S denotes the probability of a discrete event. Therefore, the higher the entropy level, the higher the level of competition (Nissan & Caveny, 1993). The index can be further defined as

$$E = \sum_{i=1}^{n} S_i \log(1/S_i) \tag{4}$$

where S_i is the share of sales and n refers to the number of firms in an industry at time t. The index captures the size differences between firms in an industry. When all firms have equal share then $E = \log n$, implying entropy is maximised and concentration minimised. The reverse is true when a firm controls all the sales in an industry, $E = 0$.

3.2.4 | Herfindahl–Hirschman index (HHI)

We follow Fresard (2010) and Valta (2012) and estimate the Herfindahl–Hirschman index. HHI is calculated by summing the square of firms' proportion of sales within an industry. It can be presented as follows:

$$HHI = \sum_{i=1}^{n} S_i^2, \frac{1}{n} \leq H \leq 1 \tag{5}$$

where S refers to the market share of the ith firm in an industry and n is the number of firms.

3.3 | Empirical method

To test our first hypothesis, we commence by identifying periods of high competition intensity. We capture firm-years with increased competition intensity by identifying industry-years where there are changes in the adopted measures of competition that indicate increased competition. For instance, for industry-years where there is a new entrant into the industry, we define such industry-years as periods of increased competition. Similarly, for other measures of competition—Gini coefficient, Theil entropy index and HHI—we identify years with changes in the industry value that indicate increased competition intensity. In essence, we define industry-years where changes in the Gini coefficient, Theil entropy index and HHI suggest increased competition intensity as 'treated'. Industry years without changes in competition are 'untreated'. From the 'untreated' industry observations, we construct a matched sample. We use a similar matching approach to Frésard and Valta (2016) and match firms based on total debt, total assets, market capitalisation and net income. The matching was conducted through a matching algorithm that minimises the Mahalanobis distance.[7] Table 1 reports a comparison and summary of the results of the matching.

TABLE 1 Comparison of differences between treated and matched sample

Concentration (ICI)				HHI			
	Treated	Matched	Difference		Treated	Matched	Difference
Cash holdings	0.1902	0.1841	0.0061***	Cash holdings	0.1585	0.1527	0.0057***
EBITDA	2,046,971	2,280,372	−233,401	EBITDA	13,000,000	13,500,000	−500,000
Total assets	9,995,654	10,200,000	−204,346	Total assets	139,000,000	140,000,000	−1,000,000
Market capitalisation	20,000,000	26,500,000	−6,500,000	Market capitalisation	74,300,000	75,400,000	−1,100,000
Market to book	2.7154	1.5626	1.1528***	Market to book	1.5488	1.4778	0.0710**
Net sales	26,800,000	40,800,000	−14,000,000	Net sales	108,000,000	113,000,000	−5,000,000
Size	10.70	11.46	−1.00	Size	12.83	13.15	−0.32
Total debt	4,683,395	5,595,968	−912,573	Total debt	27,400,000	33,700,000	−6,300,000
Net income	501,894	449,382	52,512	Net income	2,722,505	2,819,733	−97,228
Leverage	0.1580	0.1262	0.0317***	Leverage	0.2418	0.1794	0.0623**
Entropy				**GINI**			
	Treated	Matched	Difference		Treated	Matched	Difference
Cash holdings	0.1569	0.1537	0.0032***	Cash holdings	0.1557	0.1552	0.0005***
EBITDA	11,900,000	14,900,000	−3,000,000	EBITDA	13,700,000	12,800,000	900,000
Total assets	124,000,000	159,000,000	−35,000,000	Total assets	137,000,000	142,000,000	−5,000,000
Market capitalisation	69,500,000	81,400,000	−11,900,000	Market capitalisation	74,500,000	75,400,000	−900,000
Market to book	1.5663	1.4439	0.1223	Market to book	1.4888	1.5339	−0.045***
Net sales	98,700,000	126,000,000	−27,300,000	Net sales	113,000,000	108,000,000	5,000,000
Size	12.85	13.18	−0.33	Size	12.82	13.19	−0.37
Total debt	29,000,000	33,000,000	−4,000,000	Total debt	29,900,000	31,600,000	−1,700,000
Net income	2,686,406	2,883,183	−196,777	Net income	3,203,135	2,310,240	892,895
Leverage	0.2588	0.1473	0.1115***	Leverage	0.2660	0.1478	0.1182***

Note: The table presents the mean comparison of the treated and matched sample based on four measures of competition (increase in concentration, HHI, entropy and Gini coefficient). Using the Mahalonobis matching algorithm, the firms are matched on the basis of total debt, total assets, market capitalisation and net income. Significance of the difference in mean are reported in asterisk.

Following the results of our matching procedure, we estimate a difference-in-differences model to test hypotheses 1 and 2:

$$C_{i,j,t} = \beta I_{i,j,t} + \theta X_{i,j,t} + \eta_j + \delta_t + \varepsilon_{i,j,t}, \tag{6}$$

where i, j and t are firm, industry and time, respectively. C is cash and equivalent deflated by total assets. I is a dummy variable that is 1 for treated firm and industry-years (i.e. if the industry in which a firm operates experienced an increase in competition) and zero for matched-firms. The vector X captures control variables known to determine firm cash holdings. We follow the literature on the determinants of cash holdings (see, for instance, Opler et al., 1999 and Ozkan & Ozkan, 2004). Details of the variable definitions are reported in Appendix B. We control for firm lagged cash holdings, market-to-book ratio, leverage, size, ROA and dividend. Similarly, we control for industry effect η_j to capture time-invariant differences across industries. In addition, we control for year effect δ_t to control for the difference in time periods.

To examine the impact of cash holdings on firm competitiveness (Hypothesis 3), we follow a similar model to Fresard (2010) and focus on the effect of cash on adjusted market share growth. If cash is a valuable strategic instrument in the product market, firms with large cash reserves should be able to increase their market share at the expense of their rivals (Fresard, 2010).

$$\Delta M_{i,t} = \alpha_i + \eta_t + \vartheta(Cash_{i,t-1}) + \lambda' X_i + \varepsilon_{i,t}, \tag{7}$$

where ΔM is the industry-adjusted sales growth. Firm and year are denoted as i and t respectively. The parameter of interest is ϑ. Cash is the ratio of cash (and equivalents) to total assets. Since cash and market share can be endogenous, we proceed by estimating a two-stage least square (2SLS) model in which cash is instrumented by its own lagged value and asset tangibility. As in MacKay and Phillips (2005) and Fresard (2010), we also calculate the Z-score for cash to ensure we characterise a firm's cash position relative to its rivals. Zcash is computed by subtracting the industry-year mean from lagged cash holdings and dividing the difference by the industry-year standard deviation.

The vector X_i captures control variables known to drive product market performance. This variable may be correlated with market

share and firms' cash position, we proceed by instrumenting with their two-year lagged value. Controls are firm size, debt, market-to-book ratio, past market share growth and capital expenditure. We account for the invariant firm and time trends by including the vector α_i and η_t.

4 | RESULTS

Cash holdings levels reported in this study differ from those of other UK studies (Florackis & Sainani, 2018; Ozkan & Ozkan, 2004). Figure 1 illustrates the upward trend in cash reserves by UK firms during the period of the study.

Table 2 presents summary statistics and the correlation matrix. Panel A details the summary statistics for dependent, explanatory and control variables. The correlation matrix is presented in Panel B. The coefficients reported for our measures of competition show that our adopted approaches to estimating the degree of competition are not closely correlated (Table 2).

For our baseline model, we focus on the Industry Concentration Index, which captures the number of firms in an industry-year whilst our other measures are sensitive to industry-wide sales. One limitation of studies of industry concentration is that data on unlisted companies are rarely available. Our data cover a period during which most of the largest companies are listed. However, the intuition behind the use of the ICI is that an increase in firms within an industry signifies a reduction in concentration (Huang & Lee, 2013). In our sample, we only identify 44 firm-years out of 79,433 firm-years that identify as monopolistic or oligopolistic structures. To cater for this issue, we exclude cases where the number of firms in an industry is less than three. Despite imposing this restriction there was no material impact on our results.[8]

4.1 | Responses to increased competition

The results of the difference-in-difference models are presented in Table 3. Column 1 reports a coefficient of 0.043 for our variable of interest *Increased competition*. The coefficient is statistically significant at the 1% level. The estimate implies that due to increased competition firms increase their cash reserves by 4.3% thus confirming Hypothesis 1. Since the reported result may be driven by the lagged value of cash holdings, we run another regression where it is excluded, and despite this restriction, our results remain consistent. The result of this estimation is reported in Appendix C. To cater for possible bias in our difference in difference regression, we estimate our model parameters using OLS regression. Despite this additional analysis, our findings are robust and consistent. The results are presented in Appendix D. Since our results may be sensitive to our choice of industry classification, we perform an additional analysis using the Fama and French industry classification, ICB classification, Thomson Reuter level 3 and 4 industry classification and find similar results (see Appendix E).

Our findings complement the findings of Valta (2012). As a result of the increasing cost of debt during periods of increased competition firms respond by increasing internal finance. Lyandres and Palazzo (2016) also conjecture that firms' cash holdings are dictated by the expected intensity of competition. Our finding reaffirms this view. Firms with large cash reserves make gains at the expense of their rivals in the product market, and these gains are amplified during periods of increased competition (Fresard, 2010). Hence, to strategically position themselves, firms increase their cash reserves. Analogously, Bolton and Scharfstein (1990) argue that firms with large cash reserves utilise their funds to finance competitive strategies. Such strategies include aggressive pricing, investment in capabilities or simply increasing cash holdings to convey a competitive signal. To remain competitive, firms increase cash as competition increases.

4.1.1 | Increased competition, predation threat and cash holdings

To evaluate how firms' responses to increased competition vary with the degree of product differentiation, we follow a similar approach to that of Alimov (2014) and estimate the absolute value of the deviation of a firm's capital to labour ratio from the industry median. Large values for this deviation imply a firm utilises a production technology that is dissimilar to the rest of the industry and hence is exposed to a lower risk of losing investment opportunities to industry rivals.

If the values of deviations are small, firms can be interpreted as using production techniques similar to the industry standard and as

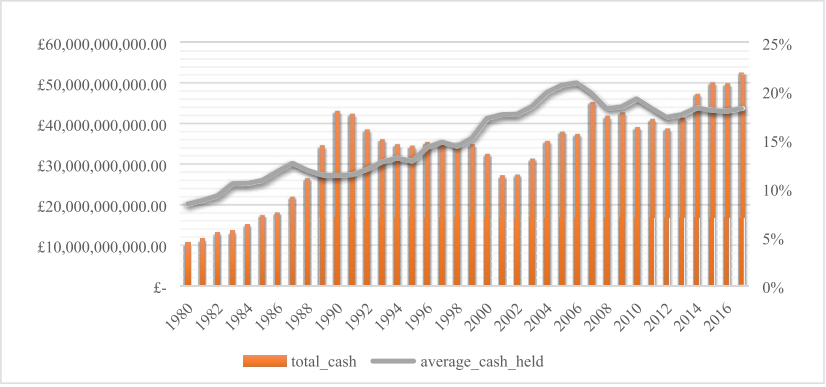

FIGURE 1 Cash holdings and total cash reserve of UK non-financial firms

TABLE 2 Descriptive statistics

Panel A: Summary statistics

	Obs	Mean	St. dev	Min	P25	P50	P75	Max
Cash holdings	76,128	0.155	0.178	0	0.038	0.095	0.2	1.268
Size	76,128	12.998	3.431	0.693	10.37	12.593	15.408	26.746
Market share	76,128	0.141	0.687	−1.016	−0.076	0.021	0.164	4.93
ROA	76,128	0.049	0.323	−1.396	−0.032	0.025	0.116	1.711
Leverage	76,128	0.141	0.156	0	0.007	0.1	0.216	0.773
Market to book	76,128	1.31	1.628	0.065	0.447	0.8	1.466	10.682
CAPEX	76,128	0.245	0.974	−0.758	−0.045	0.049	0.197	7.549
HHI score	76,128	0.407	0.275	0	0.181	0.329	0.584	0.885
No. of firms in industry	76,128	48	39	2	21	39	59	182
Gini	76,128	0.029	0.027	0	0.013	0.021	0.033	0.25
Entropy	76,128	0.055	0.05	0	0.019	0.04	0.075	0.366

Panel B: Correlation table

	Cash holdings	Size	Market share	ROA	Leverage	Market to book	CAPEX	Enterprise value	HHI score	No. of firms in industry	Gini
Size	−0.148***										
Market share	0.104***	−0.121***									
ROA	0.0107**	0.0900***	0.00761								
Leverage	−0.227***	0.310***	−0.0321***	−0.0262***							
Market to book	0.430***	−0.194***	0.138***	0.0311***	−0.184***						
CAPEX	0.0676***	−0.0968***	0.366***	0.0109**	−0.0390***	0.112***					
HHI score	−0.00584	−0.0115**	0.0054	−0.0362***	0.0337***	0.00331	0.00162	−0.00780*			
No of firms in industry	0.139***	−0.250***	0.0794***	0.148***	−0.115***	0.112***	0.0363***	−0.225***	−0.105***		
Gini	−0.0787***	0.148***	−0.0357***	−0.0690***	0.0606***	−0.0628***	−0.0173***	0.132***	0.336***	−0.577***	
Entropy	−0.105***	0.176***	−0.0434***	−0.0544***	0.0572***	−0.0808***	−0.0116**	0.157***	−0.428***	−0.520***	0.379***

Note: Panel A presents the summary statistics. Cash holdings refer to the ratio of cash to total assets. The market to book ratio is the ratio of the market value of equity to the book value of assets. Leverage is the ratio of debt to total assets. Sales growth is the industry-adjusted value of sales growth. ROA is the industry-adjusted ratio of return on assets. Investment refers to changes in PPE. Size is the log of total assets. HHI Score is the sum of the square of market share by industry. Firms in industry refer to the number of firms in an industry. Gini refers to the Gini coefficient of an industry. Entropy is Theil's entropy index for an industry year. Panel B presents the correlation matrix for variables in the study.

*Significant at <0.10.

**Significant at <0.05.

***Significant at <0.01.

TABLE 3 Increased competition and cash holdings

	Concentration	Entropy	Gini	HHI
Increased competition	0.0433*** (3.31)	0.0047*** (6.22)	0.0078*** (9.36)	0.0022*** (2.78)
Cash holdings *t-1*	0.7702*** (328.26)	0.7694*** (327.92)	0.7358*** (300.41)	0.7356*** (300.16)
Leverage	−0.0335*** (−17.43)	−0.0335*** (−17.45)	−0.0350*** (−17.26)	−0.0351*** (−17.28)
Size	−0.0007*** (−5.97)	−0.0008*** (−6.10)	−0.0005*** (−3.43)	−0.0004*** (−3.16)
ROA	−0.0013*** (−3.36)	−0.0013*** (−3.32)	0.0000 (0.08)	0.0000 (0.09)
Market to book	0.0004*** (6.23)	0.0004*** (6.23)	0.0010*** (14.81)	0.0011*** (15.03)
Investment	−0.0000*** (−9.27)	−0.0000*** (−9.24)	0.0000*** (4.28)	0.0000*** (4.31)
Dividend	−0.0056*** (−5.58)	−0.0054*** (−5.39)	−0.0171*** (−15.99)	−0.0171*** (−16.04)
Industry	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
Intercept	−0.6724*** (−7.89)	−0.7715*** (−8.89)	−0.7230*** (−7.49)	−0.4917*** (−5.29)
Observation	67,383	67,440	63,879	63,892
Adjusted R^2	0.66	0.66	0.64	0.63

Note: The table presents the results of the difference in differences regression. Using four distinct measures of competition (number of firms in industry, Theil entropy index, Gini coefficient and HHI index), we demonstrate the relationship between cash holdings and increased competition. Following a treated and matched sample created by the Mahalanobis distance algorithm, observations found in the treatment group were matched by a corresponding observation within the same industry. The treatment group contains firms found in years where there was an increase in competition. Increase in competition in Models 1, 2, 3 and 4 were derived by identifying periods in which there was an increase in competition in an industry using the above measures of competition. The dependent variable in the model is cash holdings levels. An increase in competition is a dummy variable the captures period of increased competition as 1 and otherwise as 0. Cash holdings refer to the lag of the ratio of cash to total assets. Leverage refers to the ratio of debt to total assets. Size refers to the log of total assets. ROA refers to industry adjusted value of the ratio of EBITDA to Total assets. Market to book ratio refers to the ratio of the market value of equity to book value of total assets. Investment refers to changes in PPE. Dividend is a dummy variable that takes the value of 1 if a firm pays dividend and 0 otherwise. *t* statistics are reported in parentheses.
**Significant at <0.05.
***Significant at and <0.01.

such are exposed to high degrees of predation. Competitors may be able to seize market share in such a situation (MacKay & Phillips, 2005). To ensure our insights are robust, we proceed by estimating an alternative measure of predatory threat. Our second measure is the correlation of a firm's stock return with an equally weighted industry return index. As in Alimov (2014), stocks whose returns are more highly correlated with the industry return are exposed to higher predatory threat. Table 4 presents the result of splitting the data according to the degree of exposure to predatory threat. Across both measures of predation, the results indicate that in response to the risk associated with high predatory threat and exposure to loss of investment opportunities to rivals, firms increase their cash reserves at a faster rate than firms with lower exposure. The results are consistent with Hypothesis 2a.

4.1.2 | Increased competition, financing frictions and cash holdings

Table 5 reports the models of cash holdings with increased competition as the explanatory variable in three scenarios of financial frictions. The first measure of financing frictions we examine is hedging need. We begin by evaluating how firms with high hedging requirements respond to increased competition. We follow Moyen (2004), Almeida et al. (2004) and Carpenter and Guariglia (2008) and take the correlation between cash flow and investment opportunities as the firms hedging need.

The findings in Table 5 suggest that firms with high hedging need respond to increased competition by increasing their cash reserves whilst firms with lower hedging requirements do not increase their cash reserves. This lends support to the argument of Acharya et al. (2007). Firms with high hedging requirements favour cash over other forms of finance. In addition, our results support their view that cash can be used as a hedging tool. Cash reserves can be used flexibly depending on future states of the world.

The next measure of financing frictions that we consider in Table 5 is firm size. We follow Almeida et al. (2004) and divide the sample on the basis of size. The results suggest that both unconstrained/larger firms and constrained/smaller firms respond to increased competition by increasing their cash holdings. The coefficient is marginally higher for the larger firms but is significant at the 1% level for both large and small firms.

For the final measure of financing frictions, we evaluate how the response to competition differs with a firm's debt capacity. The results indicate that firms with higher debt capacity increase cash at a greater rate than firms with low debt capacity. Firms with high debt capacity have lower exposure to interest payments. Therefore, because of this flexibility, they are able to build up their cash reserves quicker than firms with low debt capacity. To this effect, Zou and Adams (2008) argue that debt capacity is related to the cost of debt since firms with

TABLE 4 Increased competition, cash holdings and predatory risk

	Capital-labour deviation from industry		Correlation between firm and industry stock returns	
	High predatory risk	Low predatory risk	High predatory risk	Low predatory risk
Increased competition	0.0838***(3.75)	0.0475*** (3.46)	0.0490*** (4.04)	0.1410 (1.25)
Cash holdings	0.7569***(230.01)	0.7788*** (281.22)	0.8016*** (178.69)	0.7273*** (150.31)
Leverage	−0.0397*** (−14.78)	−0.0323*** (−14.18)	−0.0287*** (−7.87)	−0.0555*** (−11.80)
Size	−0.0008*** (−4.83)	−0.0009*** (−4.88)	0.0011*** (5.54)	−0.0012*** (−4.30)
ROA	−0.0011*** (−2.27)	−0.0009 (−1.56)	0.0010 (0.30)	−0.0015 (−1.06)
Market to book	0.0001 (0.98)	0.0022*** (16.28)	0.0012*** (6.33)	0.0031*** (9.87)
Investment	−0.0000*** (−8.04)	−0.0001*** (−12.19)	−0.0000** (−1.88)	−0.0001*** (−9.81)
Dividend	−0.0034*** (−2.46)	−0.0085*** (−7.15)	−0.0041** (−1.88)	−0.0040** (−1.94)
Industry	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
Intercept	−0.5965*** (−4.85)	−0.7300*** (−7.26)	0.5363** (1.95)	0.2000 (0.55)
Observation	35,790	47,502	16,378	17,390
Adjusted R squared	0.64	0.68	0.68	0.65
p-value of (high-low)		0.0***		−0.0***

Note: The table presents results of the difference in differences regression of splitting the sample based on two measures of exposure to predatory risk (i.e. capital to labour ratio and the correlation of a firm's stock returns with that of their industry). Following a treated and matched sample created by the Mahalanobis distance algorithm, observations found in the treatment group were matched by a corresponding observation within the same industry. The treatment group contains firms found in years where there was an increase in competition. The dependent variable is cash holdings. Increase in competition is a dummy variable the captures period of increased competition as 1 and otherwise as 0. Cash holdings refer to the lag of the ratio of cash to total assets. Leverage refers to the ratio of debt to total assets. Size refers to the log of total assets. ROA refers to the industry-adjusted value of the ratio of EBITDA to total assets. Market to book ratio refers to the ratio of market value of equity to book value of total assets. Investment refers to changes in PPE. Dividend is a dummy variable that takes the value of 1 if a firm pays dividends and 0 otherwise. The *p*-value of the difference between the coefficient of increased competition in high and low exposure to predatory risk is reported above. *t* statistics are reported in parentheses.
**Significant at <0.05.
***Significant at and <0.01.

high debt capacity are less exposed to bankruptcy risk. In general, our results indicate we cannot reject Hypothesis 3a.

4.2 | Cash holdings and market share

Our approach to potential endogenous effects between cash and market share within our models is similar to Berger et al. (1996) and Fresard (2010). The method involves two steps. First, we estimate the exogenous portion of cash holdings by regressing cash on asset tangibility and lagged values of cash holding.[9] The estimated cash holdings from this procedure enters our equation as an instrument (see Equation 7).

Further, to evaluate the relative impact of cash holdings, we follow Fresard (2010) and estimate the *Z*-score for cash. Since cash may be endogenous with market share, we proceed by *Z*-scoring cash and instrument cash by the estimated value of the *Z*-scored of cash.

Presented in Table 6 are instrumental variable estimates of the impact of cash holdings on firms' competitiveness. Column 1 reports the result of the absolute value of cash holdings whilst column 2 reports the values after *Z*-scoring cash. Both coefficients are significantly positive. The results indicate that cash-rich firms make substantial gains in market share at the expense of rivals. The coefficient for Zcash in Panel B column 2 indicates that all things being equal, a one standard deviation increase in cash relative to rivals in year *t-1* results in market share gains of 5.6% in year t. The magnitude reported in our study exceeds that reported in Fresard (2010). The results reported also confirm Hypothesis 2b. Bolton and Scharfstein (1990) argue that such increases in cash may be used to fund competitive strategies and investments which result in gains in market share. As previously discussed, documented methods for deploying cash in the product market include aggressive pricing, employment of more skilled employees, using cash to signal aggressive behaviour, using cash as a pre-emptive device, or using cash to develop capacity (Benoit, 1984; Bolton & Scharfstein, 1990; Campello, 2006).

4.3 | Market share, cash holdings, predatory threat and financing frictions

We proceed by examining if increases in cash holdings result in gains in market share and if gains differ with the degree of exposure to predatory risk and financing frictions. Table 7 shows the results of splitting the sample on the basis of predatory risk. The results indicate that firms exposed to a higher degree of predatory risk make lower gains in market share by increasing cash reserves compared to firms with low exposure. The findings are consistent with those in Table 4.

TABLE 5 Increased competition, cash holdings, and financing frictions

	Cash flow sensitivity		Total Assets		Debt	
	High hedging need	Low hedging need	Big firms	Small firms	Low debt capacity	High debt capacity
Increased competition	0.0440*** (4.09)	0.0315 (1.36)	0.0548*** (4.72)	0.0489*** (3.13)	−0.0113 (−0.41)	0.0927*** (2.51)
Cash holdings	0.7828*** (226.15)	0.7644*** (286.48)	0.8192*** (286.37)	0.7580*** (269.11)	0.7436*** (162.07)	0.7541*** (145.58)
Leverage	−0.0363*** (−12.15)	−0.0339*** (−15.68)	−0.0285*** (−12.78)	−0.0301*** (−12.97)	0.0086*** (4.45)	−4.5590*** (−5.85)
Size	0.0005*** (3.13)	−0.0014*** (−9.22)	0.0006*** (4.00)	−0.0020*** (−7.84)	0.0008*** (4.12)	−0.0019*** (−3.64)
ROA	−0.0030 (−1.16)	−0.0013*** (−3.09)	−0.0004 (−0.20)	−0.0012*** (−2.66)	0.0052*** (7.66)	−0.0020*** (−2.99)
Market to book	0.0022*** (15.74)	0.0004*** (5.61)	0.0022*** (13.73)	0.0004*** (5.10)	0.0015*** (7.26)	0.0000 (0.07)
Investment	−0.0000*** (−6.53)	−0.0000*** (−8.25)	−0.0000** (−1.79)	−0.0000*** (−8.65)	−0.0001*** (−17.15)	−0.0000*** (−2.94)
Dividend	−0.0053*** (−3.33)	−0.0042*** (−3.70)	−0.0082*** (−7.88)	−0.0036*** (−2.86)	−0.0055*** (−3.86)	−0.0003 (−0.11)
Industry	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
Intercept	−0.1184	−0.8351***	0.0775	−1.0235***	−0.1227	−0.9622***
Observation	(−0.67) 31342	(−6.20) 53035	(1.13) 35798	(−8.75) 49033	(−1.04) 17054	(−2.99) 15694
Adjusted R^2	0.66	0.65	0.734	0.64	0.63	0.61
p-value of the difference between high and low		0.0***		0.0***		0.0***

Note: The table presents the results of the difference in differences regression. Following a treated and matched sample created by the Mahalanobis distance algorithm, observations found in the treatment group were matched by a corresponding observation within the same industry. The treatment group contains firms found in years where there was an increase in competition. Firm-years are divided based on the degree of exposure to financing frictions measured by a firm's cash flow sensitivity, total asset and debt. The dependent variable is cash holdings. Increase in competition is a dummy variable the captures period of increased competition as 1 and otherwise as 0. Cash holdings refer to the lag of the ratio of cash to total assets. Leverage refers to the ratio of debt to total assets. Size refers to the log of total assets. ROA refers to the industry-adjusted value of the ratio of EBITDA to total assets. Market to book ratio refers to the ratio of market value of equity to book value of total assets. Investment refers to changes in PPE. Dividend is a dummy variable that takes the value of 1 if a firm pays dividends and 0 otherwise. The *p*-value of the difference between the coefficient of increased competition in high and low exposure to financing frictions is reported above. *t* statistics are reported in parentheses.
**Significant at <0.05.
***Significant at and <0.01.

To compensate for the risk of losing investment opportunities to rivals, firms with such exposure increase their cash reserves strongly. However, because investment opportunities are easily replicated in such industries, gains associated with increasing cash are less pronounced. The result supports the argument of Haushalter et al. (2007), that predatory risk is informative in understanding corporate finance policy choices and investment behaviour.

In Table 8, we report the results of subsamples based on hedging requirements and financial constraints. The results indicate that increased cash reserves offer more return for firms with low hedging needs. Our results are consistent with the view of Acharya et al. (2007) that firms with high hedging needs prefer cash to debt. During periods of increased competition associated with financing frictions, cash offers opportunities for gains in market share. The benefits of holding cash are magnified among firms operating under constraints (Fresard, 2010; Lyandres & Palazzo, 2016). In summary, the results reported are consistent with Hypothesis 3b.

4.4 | Cash holdings and competition regimes: A quasi natural experiment

As a robustness test, we use UK Competition Acts as exogenous indicators of changes in competition intensity. The UK Competition Act 1998 and the Enterprise Act 2002 were introduced to enhance competitiveness among firms by introducing fairer trading conditions (Graham, 2004). Since these acts were introduced to improve competition, we identify periods prior to the implementation of these acts as

TABLE 6 Two-stage least square regression

Panel A: First stage regression		
Cash holdings (*t*-2)		0.657*** (221.25)
Asset tangibility (*t*-2)		−0.000*** (−2.22)
Intercept		0.0551*** (59.56)
N		61,663
Adjusted R^2		0.63
Panel B: Cash holdings and competitiveness	**(1)**	**(2)**
Cash holdings	0.4005*** (17.65)	
Zcash		0.0557*** (14.81)
Size	−0.0138*** (−15.60)	−0.0155*** (−17.48)
Leverage	0.1385*** (7.80)	0.1154*** (6.52)
Market share	0.0474***	0.0491***
	(12.90)	(13.37)
Market to book	0.0365*** (20.10)	0.0437*** (25.61)
Investment	0.1251*** (42.59)	0.1252*** (42.53)
Year	Yes	Yes
Industry	Yes	Yes
Intercept	−1.5597*** (−3.12)	−3.3379*** (−6.68)
N	60,617	60,436
Adjusted R^2	4.80%	4.85%
J statistics	0.48	0.33

Note: The table presents the first stage estimate used in predicting the lagged value of cash holdings. We follow Berger et al. (1996) and Fresard (2010). We predict cash using the lagged value of cash holdings and asset tangibility. *t* statistics are reported in parentheses. The table presents the result of the 2SLS IV panel regressions examining the effect of cash holdings on market share. Market share refers to the industry-adjusted value of sales growth. Cash holdings refer to the predicted lag of the ratio of cash to total assets. Zcash refers to the predicted lag of the standardised value of cash. Zcash is the *Z* score of cash standardised by the industry-adjusted value of cash standardised by industry year standard deviation. Leverage refers to the lag of the ratio of debt to total assets. Market to book is the lag ratio of market value of equity to book value of assets. Investment refers to the lag of the ratio of the growth in PPE. *t* statistics are reported in parentheses.
**Significant at <0.05.
***Significant at and <0.01.

less competitive compared to periods after the implementation of the act. Based on these legal regimes, we estimate the difference in difference model as follows:

$$C_{i,j,t} = \beta I_{j,t} + \mu X_{i,j,t} + \eta_j + \delta_t + \varepsilon_{i,j,t,} \quad (8)$$

where *i*, *j* and *t* represent firm, industry, and time, respectively. *C* is cash and cash equivalent deflated by total assets. *I* is a dummy variable that takes the value of 1 for firm-year observations after the introduction of a competition regime and 0 for matched-firm industry-year observations (i.e. before the introduction of a new competition act/law).[10] The vector X captures control variables known to determine firms' cash holdings. We control for firms' lagged cash holdings, market-to-book ratio, leverage, size, ROA and dividends. Industry effects η_j are employed to capture time-invariant differences across industries and for year effects δ_t.

The result of this analysis is presented in Table 9. We find that firms increase their cash holdings to adjust to increased competitive pressure. The results in Table 9 confirm the result in Table 3 and are consistent with the findings of Valta (2012). Due to increased competition, the cost of debt financing increases, and the market share of a company is threatened. To mitigate the effect of the increased competition, companies increase cash held.

4.5 | Increased competition, profitability and sales

Increased cash holdings may be a manifestation of increased profitability in the industry. Hence, new entrants may just be motivated to enter the industry because of increased profitability, and this manifests in cash holdings. To evaluate if increases in cash holdings are the result of such an effect, we examine whether profitability increases during periods of increased competitive pressure. To do this, we estimate the following regression:

$$P_{i,j,t} = \beta I_{j,t} + \theta X_{i,j,t} + \eta_j + \delta_t + \varepsilon_{i,j,t,} \quad (9)$$

where *P* represents firm profitability, measured as the natural log of EBITDA. *i*, *j* and *t* represent firm, industry and time, respectively. *I* is a dummy variable that takes a value of 1 for treated firm industry-years (i.e. if the industry in which a firm operates experienced an increase in competition) and zero for matched firms. The vector X captures control variables known to determine firm profitability.

Similarly, because increased cash holdings may be an expression of increased sales, we estimate the following model to evaluate if sales increase during periods of increased competitive pressure.

$$S_{i,j,t} = \beta I_{j,t} + \theta X_{i,j,t} + \eta_j + \delta_t + \varepsilon_{i,j,t,} \quad (10)$$

where S refers to sales, measured as the natural log of sales. *i*, *j* and *t* are firm, industry and time, respectively. I is a dummy variable that takes a value of 1 for the treated firm industry-years (i.e. if the industry in which a firm operates experienced an increase in competition) and zero for matched firms. The vector X captures control variables known to determine firm sales.

The results of equations 9 and 10 are presented in Table 10. We find that there is no significant difference in EBITDA and sales during periods of increased competition. Increases in cash are not motivated by increases in profitability or sales in an industry.

TABLE 7 Cash holdings, competitiveness, and predatory threat

	Capital-labour deviation from industry		Correlation between firm and industry stock returns	
	High predatory risk	Low predatory risk	High predatory risk	Low predatory risk
Zcash	0.0496*** (5.89)	0.0627*** (7.63)	0.0426*** (6.74)	0.0871*** (9.92)
Size	−0.0189*** (−10.38)	−0.0212*** (−9.41)	−0.0136*** (−8.36)	−0.0176*** (−10.30)
Leverage	0.1337*** (3.72)	0.0673** (1.92)	0.1787*** (4.89)	0.1356*** (3.77)
Market share	0.0038 (0.55)	0.0440*** (6.17)	0.0622*** (8.30)	0.0320*** (4.54)
Market to book	0.0438*** (9.96)	0.0531*** (17.24)	0.0490*** (12.94)	0.0411*** (10.91)
Investment	0.1217*** (22.31)	0.1121*** (20.37)	0.1138*** (20.20)	0.1565*** (26.60)
Year	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes
Intercept	−2.6139*** (−2.32)	−2.1152*** (−2.25)	−0.2305 (−0.13)	−8.6311*** (−4.22)
Obs	17,855	14,063	14,797	15,236
Adjusted R^2	0.07	0.11	0.10	0.10
p-value of (low – High)		0.0***		0.0** 0.44
J statistics	0.33	0.47	0.52	

Note: The table presents the result of the 2SLS panel regressions examining the effect of cash holdings on market share based on the degree of exposure to predatory risk (i.e. capital to labour ratio and the correlation of a firm's stock returns with that of their industry). Market share refers to the industry-adjusted value of sales growth. Cash holdings refers to the predicted lag of the ratio of cash to total assets. Zcash refers to the predicted lag of the standardised value of cash. Zcash is the *Z* score of cash standardised by the industry-adjusted value of cash standardised by industry year standard deviation. Leverage refers to the lag of the ratio of debt to total assets. Market to book is the lag ratio of market value of equity to book value of assets. Investment refers to the lag of the ratio of the growth in PPE. *t* statistics are reported in parentheses. The *p*-value of the difference between the coefficient of increased competition in low and high exposure to predatory risk is reported above.
**Significant at <0.05.
***Significant at and <0.01.

TABLE 8 Cash holdings, competitiveness and financing frictions

	Cash flow sensitivity		Total asset		Debt	
	High hedging need	Low hedging need	Big firms	Small firms	Low debt capacity	High debt capacity
Zcash	0.0390***(7.02)	0.0408*** (5.24)	0.0246*** (6.49)	0.0935*** (8.40)	0.0558*** (6.39)	0.0623*** (6.77)
Size	−0.0090***(−6.09)	−0.0134*** (−8.89)	−0.0125*** (−9.00)	−0.0648*** (−7.20)	−0.0213*** (−10.81)	−0.0229*** (−7.87)
Leverage	0.1917*** (5.25)	0.0855*** (2.71)	0.0743*** (3.88)	0.1207*** (1.96)	−0.0384 (−1.32)	−0.1896*** (−2.00)
Market share	0.1155*** (13.65)	0.0266*** (3.76)	0.0259*** (3.26)	0.0220*** (2.63)	0.0126** (1.70)	0.0322*** (4.11)
Market to book	0.0542*** (11.73)	0.0335*** (8.85)	0.0298*** (12.95)	0.0413*** (8.96)	0.0454*** (11.35)	0.0444*** (12.79)
Investment	0.0752*** (12.69)	0.0973*** (17.38)	0.1722*** (28.23)	0.0939*** (13.13)	0.1477*** (26.33)	0.1196*** (17.81)
Year	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes
Intercept	10.1135*** (4.54)	7.1586*** (2.06)	−0.7436 (−1.49)	−3.5324** (−1.73)	−1.9241** (−1.94)	−8.3142*** (−4.90)
Obs	12,329	15,988	18,011	10,839	16,029	12,784
Adjusted R^2	0.08	0.05	0.09	0.06	0.09	0.07
p-value of (low-high)		0.0***		0.0***		0.0***
J statistics	0.56	0.68	0.78	0.85	0.55	0.33

Note: The table presents the result of the 2SLS IV panel regressions examining the effect of cash holdings on market share after dividing firms on the basis of their exposure to financing frictions measured by a firm's cash flow sensitivity, total asset and debt. Market share refers to the industry-adjusted value of sales growth. Cash holdings refer to the predicted lag of the ratio of cash to total assets. Zcash refers to the predicted lag of the standardised value of cash. Zcash is the *Z* score of cash standardised by industry-adjusted value of cash standardised by industry year standard deviation. Leverage refers to the lag of the ratio of debt to total assets. Market to book is the lag ratio of market value of equity to book value of assets. Investment refers to the lag of the ratio of the growth in PPE. *t* statistics are reported in parentheses.
**Significant at <0.05.
***Significant at and <0.01.

TABLE 9 Robustness check: Cash holdings and increased competition

	Competition act 98	Enterprise act 2002
Increased competition	0.0057*** (4.02)	0.0036*** (2.62)
Cash holdings *t-1*	0.5930*** (197.11)	0.5932*** (197.19)
Leverage	0.0010*** (2.64)	0.0010*** (2.67)
Size	−0.0068*** (−24.46)	−0.0067*** (−24.37)
ROA	−0.0008*** (−3.57)	−0.0008*** (−3.48)
Market to book	0.0004*** (5.93)	0.0004*** (6.04)
Investment	−0.0000*** (−7.74)	−0.0000*** (−7.73)
Dividend	0.0027*** (2.16)	0.0027*** (2.17)
Industry	Yes	Yes
Year	Yes	Yes
Intercept	−0.4100*** (−2.65)	−0.5682*** (−3.65)
Obs	67,569	67,569
Adjusted R^2	0.61	0.62

Note: The table presents the results of the difference in difference regression. Using two competition regimes the Competition Act of 1998 and the Enterprise Act of 2002, we demonstrate the relationship between cash holdings and increased competition. Increase in competition in the Models was derived by identifying periods before and after the implementation of the competition act. The dependent variable in the model is cash holdings levels. Increase in competition is a dummy variable the captures period of increased competition as 1 and otherwise as 0. Periods before the act were denoted with the variable 1 and periods after the act was ascribed the value of 1. Cash holdings refer to the lag of the ratio of cash to total assets. Leverage refers to the ratio of debt to total assets. Size refers to the log of total assets. ROA refers to industry adjusted value of the ratio of EBITDA to Total assets. Market to book ratio refers to the ratio of market value of equity to book value of total assets. Investment refers to changes in PPE. Dividend is a dummy variable that takes the value of 1 if a firm pays dividend and 0 otherwise. *t* statistics are reported in parentheses.
**Significant at <0.05.
***Significant at and <0.01.

TABLE 10 Robustness check: Profitability, sales and increased competition

	EBITDA	Sales
Increased competition	0.1742 (1.40)	0.1005 (1.06)
Cash holdings	0.9951*** (31.80)	0.4564*** (20.09)
Leverage	−0.8745*** (−30.12)	−0.0732*** (−3.76)
Size	0.9466*** (662.91)	0.9884*** (969.85)
Market capitalisation	0.0740*** (45.37)	0.0562*** (45.17)
Market to book	−0.0000*** (−7.45)	0.0000 (0.56)
Investment	−0.0006*** (−4.67)	−0.0004*** (−6.30)
Dividend	0.3384*** (28.16)	0.3114*** (38.08)
Market share	0.0002 (0.84)	−0.0000 (−0.26)
Year	Yes	Yes
Industry	Yes	Yes
Intercept	−2.9721*** (−71.82)	−2.2167*** (−73.56)
N	51,766	56,568
Adjusted R^2	0.92	0.96

Note: Columns one and two present the result of the difference in differences regression of increase in competition on net income and EBITDA. Following a treated and matched sample created by the Mahalanobis distance algorithm, observations found in the treatment group were matched by a corresponding observation within the same industry. The treatment group contains firms found in years where there was an increase in competition. The dependent variable is net income and EBITDA, respectively. Increase in competition is a dummy variable the captures period of increased competition as 1 and otherwise as 0. Cash holdings refer to the lag of the ratio of cash to total assets. Leverage refers to the ratio of debt to total assets. Size refers to the log of total assets. ROA refers to industry adjusted value of the ratio of EBITDA to total assets. Market to book ratio refers to the ratio of market value of equity to book value of total assets. Investment refers to changes in PPE. Dividend is a dummy variable that takes the value of 1 if a firm pays dividend and 0 otherwise. *t* statistics are reported in parentheses.
**Significant at <0.05.
***Significant at and <0.01.

5 | CONCLUSION

Using a large data set covering the period 1980 to 2017, we provide empirical evidence on the relationship between competition and cash holdings amidst financing friction and predatory threat. Using a quasi natural experiment, we test whether firms increase cash holdings in response to increased competition. Firstly, we show that firms increase their cash reserves during periods of increased competition intensity. In addition, we find that firms exposed to high predatory risk increase their cash reserves at a greater rate than firms exposed to lower predatory risk. Correspondingly, firms with high hedging requirements respond to increased competition by increasing cash at a higher rate than firms with lower hedging needs. We also document that unconstrained firms increase cash at a higher rate than constrained firms.

Next, we evaluate the impact of cash in the product market. Our results suggest that cash holdings offer competitive advantages in the acquisition of market share as cash-rich firms can make gains at the expense of their counterparts. Further, we find that the gains increase if a firm is less exposed to predatory risk, constrained by financing frictions, or has low hedging requirements.

Our results reaffirm the view that cash is an important strategic tool in the product market. We reveal the impact of predatory risk and financing frictions on a firm's cash holdings policies in the presence of product market competition. Whilst we use UK data to provide a novel empirical explanation for the increasing level of cash, our results could reasonably be extended to other market-based economies such as the United States. Our findings and the ensuing discussion are also valuable to managers and practitioners. Our recommendation to managers of firms faced with increased competition is to build up cash reserves to buffer the adverse impact of competition intensity. And to competition regulators, we suggest that protecting companies' ability to hold cash, especially from takeover threats that arise simply due to holding cash as reserves against predatory threats, should be a priority.

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ORCID

Gbenga Adamolekun https://orcid.org/0000-0002-6540-1310
Edward Jones https://orcid.org/0000-0001-9694-3086
Hao Li https://orcid.org/0000-0002-6352-7753

ENDNOTES

[1] Financing frictions refer to financial constraints and all other challenges associated with the ease of access to the financial market.

[2] Similarly, the then Shadow Chancellor of the Exchequer of the UK, John McDonnell, raised concerns about cash hoarding by UK firms in 2016 (https://www.prospectmagazine.co.uk/economics-and-finance/why-are-britains-corporations-sitting-on-so-much-cash).

[3] EU competition law continued to apply in the United Kingdom until 31 December 2020, the agreed end date of the Transition Period.

[4] We measured this in two ways: firstly, we rank firms based on their capital to labour deviation; firms with high deviation are less prone to predatory threat. Secondly, we rank firms according to the coefficient of correlation between their returns and a portfolio containing other companies in their industry; companies with low coefficient are less exposed to predatory threat.

[5] To measure financing friction, we estimate the correlation between cash flow and investment opportunities. We also use firm size and debt capacity as proxies for financing friction.

[6] Symmetric industries are industries where rivals are similar in size whereas nonsymmetric industries refer to industries where competitors are not similar in size (for instance, two big firms and a couple of small firms).

[7] Mahalonobis distance could be defined as $[X_i + \overline{X})^t\, C^1(X_i - \overline{X})]^{0.5}$, where X_i = an object vector and $\overline{X}$ = arithmetic mean vector and C is the covariance matrix of the sample (Varmuza & Filzmoser, 2016).

[8] Our models using this indicator implicitly assume that unlisted competition changes at the same rate as listed competition.

[9] Asset tangibility is expressed as a function of receivables, inventory and fixed capital (Berger et al., 1996; Fresard, 2010).

[10] Using the Mahalonobis algorithm, we match treated observations with their nearest untreated observation based on total asset, total debt, market capitalisation and net income.

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APPENDIX A

TABLE A1 Industry classification (Thomson Reuter: Level 5)

Thomson Reuters' level 5 sector name	Firm year per industry	Per cent
Aerospace	863	1.1%
Airlines	490	0.6%
Alt. Electricity	325	0.4%
Alternative fuels	200	0.3%
Aluminium	178	0.2%
Apparel retailers	840	1.1%
Auto parts	538	0.7%
Automobiles	849	1.1%
Biotechnology	1383	1.8%
Brewers	353	0.5%
Broadcast & Entertain	1744	2.2%
Broadline retailers	884	1.1%
Building mat. & fix.	1649	2.1%
Bus. Train & Employment	892	1.1%
Business support Svs.	4056	5.2%
Clothing & Accessory	1200	1.5%
Coal	328	0.4%
Comm. Vehicles, trucks	690	0.9%
Commodity chemicals	758	1.0%
Computer hardware	711	0.9%
Computer services	1712	2.2%
Con. Electricity	1270	1.6%
Consumer electronics	523	0.7%
Containers & package	476	0.6%
Defence	300	0.4%
Delivery services	179	0.2%
Diamonds & Gemstones	248	0.3%
Distillers & vintners	402	0.5%
Divers. Industrials	1572	2.0%
Drug retailers	64	0.1%
Dur. Household prod.	589	0.8%
Elec. Office equip.	205	0.3%
Electrical equipment	1608	2.1%
Electronic equipment	1161	1.5%
Exploration & Prod.	2565	3.3%
Farm fish plantation	598	0.8%
Fixed line telecom.	1534	2.0%
Food products	2052	2.6%
Food retail, wholesale	880	1.1%
Footwear	87	0.1%
Forestry	86	0.1%
Gambling	508	0.6%
Furnishings	470	0.6%
Gas distribution	260	0.3%
General mining	2005	2.6%
Gold mining	1741	2.2%

TABLE A1 (Continued)

Thomson Reuters' level 5 sector name	Firm year per industry	Per cent
Healthcare providers	493	0.6%
Heavy construction	1140	1.5%
Home construction	945	1.2%
Home improvement ret.	420	0.5%
Hotels	772	1.0%
Industrial machinery	3263	4.2%
Industrial suppliers	1197	1.5%
Integrated oil & gas	761	1.0%
Internet	456	0.6%
Iron & Steel	642	0.8%
Marine transportation	507	0.6%
Media agencies	1232	1.6%
Medical equipment	930	1.2%
Medical supplies	376	0.5%
Mobile telecom.	789	1.0%
Multiutilities	503	0.6%
Nondur.Household prod	219	0.3%
Nonferrous metals	511	0.7%
Oil equip. & services	743	0.9%
Paper	490	0.6%
Personal products	408	0.5%
Pharmaceuticals	1955	2.5%
Pipelines	18	0.0%
Plat.& precious metal	437	0.6%
Publishing	1634	2.1%
Railroads	88	0.1%
Real estate hold, dev	68	0.1%
Recreational products	287	0.4%
Recreational services	909	1.2%
Renewable energy Eq.	159	0.2%
Restaurants & Bars	1307	1.7%
Semiconductors	1228	1.6%
Soft drinks	191	0.2%
Software	3194	4.1%
Spec.Consumer service	237	0.3%
Specialty chemicals	1660	2.1%
Specialty retailers	1544	2.0%
Telecom. Equipment	1337	1.7%
Tires	144	0.2%
Tobacco	331	0.4%
Toys	236	0.3%
Transport services	827	1.1%
Travel & Tourism	504	0.6%
Trucking	245	0.3%
Waste, disposal Svs.	205	0.3%
Water	836	1.1%
Total	78,404	100%

APPENDIX B

TABLE B1 Variable definition

Variable	Definition
Cash holdings	Cash and cash equivalent/Total asset
Zcash	Cash holdings - average industry cash holdings/year industry-standard deviation of cash holdings
Size	The log of total asset
Market share	Growth in sales - industry growth in sales
ROA	(EBITDA/Total asset) - (average industry ROA)
Leverage	Debt/total asset
Market capitalisation	Annual share price multiplied by total shares in issue
Market to book	Market value of assets divided by book value of total assets
Dividend	A binary variable that takes the form of 1 if a firm pays dividend and zero otherwise
CAPEX	Growth in property plant and equipment

APPENDIX C

TABLE C1 Cash holdings and increased competition

	Concentration	Entropy	Gini	HHI
Increased competition	0.0089*** (6.64)	0.0166*** (9.44)	0.0030*** (2.39)	0.0115*** (6.51)
Leverage	−0.1020*** (−34.61)	−0.1272*** (−28.90)	−0.1274*** (−41.31)	−0.1309*** (−28.70)
Size	−0.0035*** (−16.53)	−0.0113*** (−30.35)	−0.0065*** (−28.83)	−0.0115*** (−29.87)
ROA	−0.0027*** (−4.69)	0.0060*** (5.05)	−0.0034*** (−5.57)	0.0057*** (4.75)
Market to book	0.0022*** (22.17)	0.0105*** (42.15)	0.0028*** (26.35)	0.0103*** (39.80)
Investment	−0.0000 (−0.66)	−0.0000 (−0.95)	−0.0000 (−0.75)	−0.0000 (−1.00)
Dividend	−0.0348*** (−22.20)	−0.0541*** (−25.19)	−0.0578*** (−35.21)	−0.0509*** (−23.01)
Year	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes
Intercept	0.1528*** (18.86)	0.2916*** (28.21)	0.2623*** (34.42)	0.2911*** (27.17)
Observation	67,096	37,972	65,114	35,684
Adjusted R^2	0.240	0.194	0.130	0.187

Note: The table presents the results of the difference in differences regression. Using four distinct measures of competition (number of firms in industry, Theil entropy index, Gini coefficient and HHI index), we demonstrate the relationship between cash holdings and increased competition. Following a treated and matched sample created by the Mahalanobis distance algorithm, observations found in the treatment group were matched by a corresponding observation within the same industry. The treatment group contains firms found in years where there was an increase in competition. Increase in competition in columns 1, 2, 3 and 4 was derived by identifying periods in which there was an increase in competition in an industry using the above measures of competition. The dependent variable in the model is cash holdings levels. Increase in competition is a dummy variable the captures period of increased competition as 1 and otherwise as 0. Cash holdings refer to the ratio of cash to total assets. Leverage refers to the ratio of debt to total assets. Size refers to the log of total assets. ROA refers to industry adjusted value of the ratio of EBITDA to Total assets. Market to book ratio refers to the ratio of the market value of equity to the book value of total assets. Investment refers to changes in PPE. Dividend is a dummy variable that takes the value of 1 if a firm pays dividends and 0 otherwise. *t* statistics are reported in parentheses. **Significant at <0.05. ***Significant at and <0.01.

APPENDIX D

TABLE D1 Competition intensity and cash holdings: OLS

	Concentration	Concentration	HHI	HHI	Entropy	Entropy	Gini	Gini
Increase in competition	0.0141*** (3.36)	0.0422*** (6.32)	−0.0017*** (−1.97)	0.0020 (1.50)	0.0031*** (3.65)	0.0057*** (4.20)	0.0022*** (2.44)	0.0099*** (7.05)
Cash holdings (t-1)	0.7490*** (289.32)		0.7492*** (289.45)		0.7491*** (289.43)		0.7490*** (289.25)	
Leverage	−0.0257*** (−12.78)	−0.0958*** (−30.07)	−0.0258*** (−12.83)	−0.0960*** (−7.89)	−0.0258*** (−12.82)	−0.0961*** (−30.15)	−0.0258*** (−12.81)	−0.0960*** (−30.14)
Size	−0.0010*** (−7.29)	−0.0074*** (−35.57)	−0.0010*** (−7.39)	−0.0074*** (−22.13)	−0.0010*** (−7.39)	−0.0074*** (−35.76)	−0.0010*** (−7.41)	−0.0074*** (−35.85)
ROA	−0.0006*** (−2.21)	−0.0011*** (−2.72)	−0.0005*** (−2.13)	−0.0011 (−1.46)	−0.0006*** (−2.16)	−0.0011*** (−2.62)	−0.0005*** (−2.14)	−0.0011*** (−2.58)
Market to book	0.0001 (1.10)	0.0019*** (18.43)	0.0001 (1.16)	0.0019 (1.23)	0.0001 (1.14)	0.0019*** (18.53)	0.0001 (1.13)	0.0019*** (18.44)
Investment	−0.0000*** (−8.47)	−0.0000 (−0.28)	−0.0000*** (−8.47)	−0.0000 (−0.31)	−0.0000*** (−8.46)	−0.0000 (−0.26)	−0.0000*** (−8.47)	−0.0000 (−0.29)
Dividend	0.0000 (0.18)	0.0000 (0.71)	0.0000 (0.17)	0.0000 (0.90)	0.0000 (0.17)	0.0000 (0.69)	0.0000 (0.17)	0.0000 (0.70)
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Intercept	0.0374*** (6.13)	0.1812*** (18.69)	0.0389*** (6.35)	0.1820*** (27.10)	0.0365*** (5.97)	0.1803*** (18.56)	0.0366*** (5.96)	0.1763*** (18.10)
N	54,548	54,548	54,548	54,548	54,548	54,548	54,548	54,548
Adjusted R^2	0.676	0.178	0.676	0.177	0.676	0.177	0.676	0.178

Note: The table presents the result of the OLS estimations for the relationship between cash holdings and increased competition. Using four measures of competition (i.e. number of firms in industry, Theil entropy index, Gini coefficient and HHI index). The variable of interest is an increase in competition; it identifies intensely competitive industry years. *t* statistics are reported in parentheses.
**Significant at <0.05. ***Significant at and <0.01.

APPENDIX E

TABLE E1 Cash holdings and increased competition: Other industry classification

	ICB industry class	Thomson Reuter level 3 industry class	Thomson Reuter level 4 industry class	Fama and French industry class
Increase in competition	0.0069*** (7.21)			
Increase in competition		0.0029*** (3.66)		
Increase in competition			0.0019***	
			(2.62)	
Increase in competition				0.0026*** (3.05)
Cash holding (*t*-1)	0.7568*** (457.87)	0.7573*** (470.83)	0.7492*** (442.46)	0.7733*** (486.12)
Leverage	−0.0359*** (−26.66)	−0.0290*** (−22.35)	−0.0345*** (−24.07)	−0.0334*** (−26.72)
Size	−0.0008*** (−9.31)	−0.0011*** (−12.37)	−0.0012*** (−12.30)	−0.0014*** (−14.69)
ROA	−0.0008*** (−2.33)	−0.0004 (−1.19)	0.0001 (0.31)	0.0049*** (5.96)
Market to book	0.0008*** (13.21)	0.0009*** (15.45)	0.0009*** (15.73)	0.0010*** (17.87)
Investment	−0.0000*** (−7.90)	−0.0000*** (−6.30)	−0.0000*** (−7.94)	−0.0000*** (−9.90)
Dividend	−0.0057*** (−8.54)	−0.0049*** (−7.31)	−0.0045*** (−6.33)	−0.0049*** (−7.82)
Intercept	0.0340*** (8.33)	0.0609*** (17.80)	0.0439*** (12.84)	0.0485*** (14.18)
Industry	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
N	142,747	149,709	139,029	146,967
Adjusted R^2	0.67	0.68	0.69	0.67

Note: As an additional filter of robustness, we use four other industry classifications (ICB Industry Classification, Thomson Reuters Level 3 Classification, Thomson Reuters Level 4 Classification and the Fama and French Industry Classification). Following a treated and matched sample created by the Mahalanobis distance algorithm, observations found in the treatment group were matched by a corresponding observation within the same industry. The treatment group contains firms found in years where there was an increase in competition. Increase in competition in Models I, II, III and IV were derived by identifying periods in which there was an increase in firms within an industry. Periods of intense competition were identified in models by capturing years where there was an increase in the number of firms in the industry. The dependent variable in the models is cash holdings levels. Increase in competition is a dummy variable the captures period of increased competition as 1 and otherwise as 0. Cash holdings refer to the lag of the ratio of cash to total assets. Leverage refers to the ratio of debt to the total asset. Size refers to the log of total assets. ROA refers to industry adjusted value of the ratio of EBITDA to Total assets. Market to book ratio refers to the ratio of the market value of equity to the book value of the total asset. Investment refers to changes in PPE. Dividend is a dummy variable that takes the value of 1 if a firm pays dividends and 0 otherwise. *t* statistics are reported in parentheses. **Significant at <0.05. ***Significant at and <0.01.