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U.S., Anglo-Saxon European, and non-Anglo-Saxon European cash holdings around the financial crisis

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ABSTRACT

For the period 2003–2018, we show that U.S. firms have a higher cash-to-assets ratio than European firms have—in particular, among firms with high R&D expenditures and those in industries with high cash flow volatility, indicating the potential roles of precaution and uncertainty respectively in cash holding. We find evidence that industry cash flow volatility is relevant throughout the period, while R&D seems to matter only during the crisis years of 2008–2009. With respect to European cash holdings, there are slight differences between Anglo-Saxon European and non-Anglo-Saxon European firms.

1. Introduction

Following a strong increase of cash ratios globally from the 1990s onwards, interest in research identifying potential determinants of corporate cash holdings across countries has soared. Cash holdings of U.S. firms have been intensively discussed in the literature, and a growing number of scholars have analyzed how cash holding behavior differs globally. The cash holding of Anglo-Saxon and non-Anglo-Saxon European firms deserves special attention in this respect. We aim to identify whether firm-level R&D intensity or industry cash flow volatility is more important in explaining the difference in cash holdings between U.S. firms and European firms. Changes in cash holding behavior over time are interesting, and it is worthwhile to study how the 2008–2009 global financial crisis has affected this behavior.

Various perspectives have been explored to explain the differences in cash holdings across firms and/or regions. Scholars have analyzed the effects of taxation (Faulkender, Hankins, & Petersen, 2018; Foley, Hartzell, Titman, & Twite, 2007), bank risk-taking (Adachi-Sato & Vithessonthi, 2021), diversification (Duchin, 2010; Fernandes & Gonenc, 2016), culture (Alves, 2018; Chen, Dou, Rhee, Truong, & Veeraraghavan, 2015), governance (Lin, Chang, Yu, & Kao, 2019; Orlova & Sun, 2018), and even demographics (Cunha & Pollet, 2020)—and, importantly, the precautionary motive for cash holding. This motive predicts that firms hold cash to fund themselves in times of financial distress or when external financing is not available (Keynes, 1937). In addition, firms operating in industries experiencing high volatility in their cash flows will hold more cash to finance their investments and thus avoid high opportunity costs.

Bates, Kahle, and Stulz (2009) show that firm-specific attributes changed over time, increasing U.S. firms' need for cash holding. The authors identify increasing cash flow volatility due to higher idiosyncratic firm risk as a major determinant of rising cash levels, a cause that coincides with precautionary motives for cash holding. Another major factor is increased R&D expenditures. R&D intensity

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(the ratio of R&D expenditures to total assets or sales) has been found to be positively related to cash holding. Brown, Fazzari, and Petersen (2009) show that R&D investments are usually financed using cash flow or equity. Since these are highly volatile sources of funding, firms must hold precautionary cash to ensure stable financing of R&D projects (Brown & Petersen, 2011). Lei, Qiu, and Wan (2018) argue and show empirically that firms have to hold more cash when they have lesser tangible assets, since intangible assets cannot easily be used as collateral for a loan. Pinkowitz, Stulz, and Williamson (2013) compare true cash holdings with those predicted by a model based on an earlier period. They find that abnormal cash holdings increased more in the United States than elsewhere. U.S. firms with very high R&D intensity contribute to this finding. Pinkowitz, Stulz, and Williamson (2016) show that the high cash holdings of U.S. firms relative to foreign firms belong to those with high R&D intensity and observe that even within industries the cash flow volatility of U.S. firms is much higher than that of their foreign peers. More importantly, the authors show that country-level factors do not make much difference, in contrast to the findings of several other studies (Alves, 2018; Iskandar-Datta & Jia, 2012; Lozano & Yaman, 2020).

The precautionary motive has contributed greatly to explaining high cash holdings by firms all around the world. Studies indicate that cash holdings have developed similarly in the U.S and Europe over time but are higher in the former area than in the latter. In this study, we address a relatively similar research question to explain a potential difference in cash holding between U.S. firms and firms in (Western) Europe by distinguishing between Anglo-Saxon and non-Anglo-Saxon Europe. Also, although R&D intensity has been thoroughly connected to precautionary cash holdings, industry-level volatility in cash flows has not yet been given the attention that may be desirable. R&D expenditures would potentially be relevant for certain times such as economic downturns, while industry-level cash flow volatility may be relevant regardless of whether the economy is in an extreme state or not. Therefore, we structure our empirical analysis around the global financial crisis of 2008 and 2009.

During the crisis, the supply of finance through the banking system fell sharply and credit costs rose massively (Gorton, 2009). Harford, Klasa, and Maxwell (2014) show that the maturity of debt declined, owing to a supply shock or to considerations that the costs of long-term financing were too high. The authors hold that an important motive for cash holding is to ensure that investments can be undertaken in times of high refinancing risk. Bliss, Cheng, and Denis (2015) analyze the effect of the financial crisis on corporate payout. They find that a credit supply shock leads firms to decrease their payouts to investors and therefore retain more cash in the company. This cash is used as a substitute for external financing of current investments, but also to ensure that the firm can take advantage of investment opportunities when they arise in the future. The authors, however, also mention that the financial crisis was associated not only with a supply shock but also with a demand shock caused by a general reduction in wealth; and a demand shock lowers investment opportunities and thus the need for cash. Furthermore, Kahle and Stulz (2013) find that only levered firms that depend on bank financing hoarded more cash during the crisis. We use a large firm-level panel dataset from 2003 to 2018 to study potential differences between U.S. and European firms—and between Anglo-Saxon and non-Anglo-Saxon European firms—in the effects of firm-level determinants of cash ratio, specifically, R&D intensity and industry cash flow volatility. We estimate our regression equation for three sample periods around the financial crisis of 2008–2009.

This study contributes to the literature by providing a distinct view on cash holdings of U.S. firms versus European firms. We build upon the approaches of Bates et al. (2009), Iskandar-Datta and Jia (2012), and Pinkowitz et al. (2013, 2016). We also contribute to the literature analyzing the financial crisis and its consequences. And by using data up to 2018, we provide new insights into more recent dynamics in U.S., Anglo-Saxon European, and non-Anglo-Saxon European cash holdings.

The remainder of this article is structured as follows. Section 2 gives an overview on the data and variables used. Section 3 presents the empirical results on differences associated with firm characteristics, compares means and medians, and displays the findings from multivariate regressions. In Section 4, we discuss the findings and implications of this study.

2. Data and variables

We use financial data for a sample of firms from the United States and 17 (Western) European countries from 2002 until 2018. We divide the European countries into two major subgroups: Anglo-Saxon European countries including the U.K. and Ireland, versus non-Anglo-Saxon European countries including France, Spain, Portugal, Italy, Greece, Germany, Austria, Switzerland, Denmark, Sweden, Norway, Finland, the Netherlands, Belgium, and Luxemburg. We use this separation because people in the U.K. and Ireland are traditionally considered culturally more similar to those in the U.S. in their behavior than are people in other European countries. Accordingly, we create the binary variables *Anglo* (-Saxon Europe) and *Non-Anglo* (-Saxon Europe), which are dummies equal to one if the firm is headquartered in the region indicated.

The firm-level data for U.S. and European firms are gathered from Compustat-Capital IQ North America and Global, respectively. We collect the data for the market values of European firms from Thomson Reuters Datastream. As in previous studies, we exclude financial and utility firms (SIC industry codes starting with 49 and 6) because of their high degree of regulation and special business model, and also leave out firms with total assets of less than USD 5 million. All variables are winsorized at the bottom and top 1% levels. Total assets reported in other currencies have been converted into USD using the average yearly exchange rate, obtained from the OECD database. Our final sample includes 66,275 firm-year observations from 9965 unique firms.

We rely on a model proposed by Bates et al. (2009), Iskandar-Datta and Jia (2012), and Pinkowitz et al. (2013, 2016). They use a variety of firm-level variables to proxy the different motives for holding cash. These include the size of the firm measured as the natural logarithm of total assets (*Size*), a dummy indicating whether a firm pays dividends (*Dividends*), the ratio of cash flow to assets (*Cashflow*), industry cash flow volatility in two-digit SIC industries (*IndVolatility*), the ratio of net working capital less cash to assets (*NWC*), the ratio of capital expenditures to assets (*CaptX*), the leverage ratio (*Leverage*), the market-to-book ratio (*MB Ratio*), the ratio of R&D expenditures to assets (*R&D*), and the ratio of acquisitions to assets (*Acquisitions*). Table 1 provides the detailed definitions for

these firm-level variables. We also include *GDP Growth* and the U.S. Federal Reserve funds rate (*Fed Rate*) as controls for the economic cycle and the interest rate level, respectively. Data for GDP growth come from the World Bank database, and the Federal Reserve funds rate from the Federal Reserve Economic Data.

Table 2 displays the summary statistics on the firm level for the full sample as well as for the U.S. and European subsamples. Considering the cash-to-assets ratio (*Cash*), we observe that the median is much lower than the mean—a right-skewed distribution also observed by Pinkowitz et al. (2016). The mean (median) cash ratios are 0.187 (0.105) for the whole sample and 0.212 (0.119) and 0.129 (0.087) for U.S. and European firms, respectively. As we expected, the differences in the means and medians of the cash ratio between the two subsamples are statistically significant at the 1% level. The U.S. mean and median cash ratios are the highest. Especially the R&D ratio, and also the volatility of industry cash flows, are higher for U.S. firms than for European firms. Interestingly, the medians for R&D are close to zero, meaning that many firms spend little or nothing on R&D. The mean and median values of *IndVolatility* are higher for U.S. firms than those for European firms and could thus also explain the higher average U.S. cash holding (Pinkowitz et al., 2016). The difference in the ratio of dividend-paying firms is striking. While in the U.S. only 30% of the firms pay dividends, in Europe 89% do so. The net working capital ratio of U.S. firms is lower than that of their European counterparts, and their average cash flow ratio is even negative. Together with higher capital expenditures, leverage ratios, acquisitions, and market-to-book ratios for U.S. firms, all of the significant differences in these determinants of cash holdings may help to explain the higher cash holdings of U.S. firms.

The summary statistics on a country level are shown in Table 3. There are 46,154 firm-year observations from the United States; the remaining 20,121 are from the 17 European countries, of which respectively 6835 and 13,286 firm-year observations pertain to Anglo-Saxon and non-Anglo-Saxon European countries. Even though Anglo-Saxon European firms have on average a slightly lower mean cash ratio (0.122) than their non-Anglo-Saxon counterparts (0.132), Irish firms have on average a ratio that is very high, but still lower than the average for U.S. firms. The R&D ratio and the volatility of industry cash flows are little higher in the Anglo-Saxon Europe subsample than in the non-Anglo-Saxon Europe subsample. The capital expenditures ratio, the leverage ratio, and especially the net working capital ratio are lower for the Anglo-Saxon European firms, whereas their market-to-book ratio, acquisitions ratio, and cash flow ratio are higher.

Table 4 reports the pairwise correlations for all variables. Most correlations are significant at the 1% level, but none are excessive. Column 1 of Table 4 displays pairwise correlations with the independent variable *Cash*. The firm-level variables all show major correlations with *Cash* and may hence be suitable explanatory variables. The strongest correlation is that for R&D. Interestingly, *Cashflow* has a strong negative correlation with R&D, meaning that R&D-intensive firms have relatively very low cash flows. In contrast, the correlation of *IndustryVol* with R&D is positive, indicating that R&D-intensive firms have a relatively risky business model, in line with the precautionary motive for cash holding. Even though the correlation coefficients for the vast majority of the variable pairs are high and significant, we also report the variance inflation factor (VIF) values that are associated with the regressions. There is no VIF value indicating multicollinearity concerns in our multivariate analysis.

3. Empirical results

In this section, we investigate whether the cash holding behavior of European firms differs from that of U.S. firms in the sample period considered and whether any differences can be explained by differences in firm characteristics. First, we compare the mean and median cash ratios for U.S. and European firms as well for Anglo-Saxon and non-Anglo-Saxon European firms across three different subperiods. Second, using multivariate OLS regressions, we analyze whether firm characteristics explain the differences across regions for the full sample period as well as for the three subperiods.

Table 1
Definition and data source of firm-level variables.

Variable	Definition
<i>Cash</i>	Cash and cash equivalents (CHE) divided by the book value of assets (AT).
<i>Size</i>	The natural logarithm of total book value of assets (AT), converted to USD at average year exchange rates, obtained from the OECD database.
<i>R&D</i>	Ratio of R&D expenses (XRD) to the book value of assets (AT); missing values are set to zero.
<i>CaptX</i>	Ratio of capital expenditures (CAPX) to the book value of assets (AT).
<i>Leverage</i>	Long-term debt (DLTT) plus debt in current liabilities (DLC), standardized by the book value of assets (AT).
<i>NWC</i>	Current assets (ACT) net of cash (CHE), minus current liabilities (LCT), standardized by the book value of assets (AT).
<i>Acquisitions</i>	Ratio of acquisitions (AQC) to the book value of assets (AT); missing values are set to zero.
<i>MB Ratio</i>	Market value of common shares, plus total assets (AT) minus book value of common equity (CEQ), divided by the total book value of assets (AT). <i>U. S. firms</i> : The market value is calculated as fiscal year end price of equity (PRCC_F) multiplied by shares outstanding (CSHO). <i>European firms</i> : The market value data are collected from Thomson Reuters Datastream. If currencies did not match with the Compustat data, the market value was converted at the average yearly exchange rate provided by the OECD.
<i>Dividends</i>	Binary variable equal to 1 if the firm pays dividends in the given year (DVC).
<i>Cashflow</i>	Operating income before depreciation (OIBDP), minus interest and related expenses (XINT), income taxes (TXT), and dividends (DVC), standardized by the book value of assets (AT).
<i>IndVolatility</i>	The standard deviation of industry-level <i>Cashflow</i> is calculated for each firm and each year for the previous 10 years (starting in 1992 for 2002). At least 5 observations are required to compute a standard deviation. Then, the year averages across two-digit SIC industry codes are computed.

Notes: Letters in brackets are Compustat IDs. If not specified differently, the data source is Compustat Global for European firms and Compustat North America for U.S. firms.

Table 2
Firm-level summary statistics, 2003–2018.

Variable	Whole Sample (N = 66,275)			U.S. (N = 46,154)		Europe (N = 20,121)		Difference (U.S.–Europe)	
	Mean	Median	St.Dev	Mean	Median	Mean	Median	Mean	Median
Cash (%)	18.69	10.49	21.51	21.23	11.87	12.85	8.71	8.38***	3.16***
Total Assets (Billion)	3278.58	382.98	9272.95	2867.24	338.97	4222.12	503.91	−1354.88***	−164.94***
Size (Ln)	6.003	5.948	2.142	5.841	5.826	6.376	6.222	−0.534***	−0.396***
R&D (%)	4.94	0.00	11.34	6.25	0.19	1.96	0.00	4.29***	0.19***
CaptX (%)	4.86	3.06	5.77	4.90	2.89	4.75	3.43	0.15***	−0.53***
Leverage (%)	22.66	18.66	22.42	23.48	18.44	20.78	19.01	2.70***	−0.57***
NWC (%)	3.49	3.09	19.22	3.42	3.08	3.65	3.09	−0.23	−0.02***
Acquisitions (%)	2.20	0.00	5.74	2.35	0.00	1.84	0.00	0.51***	0.00***
MB Ratio	1.967	1.489	1.484	2.119	1.584	1.618	1.319	0.501***	0.265***
Dividends (%)	47.79	0.00	49.95	29.78	0.00	89.11	100.00	−59.33***	−100.00***
Cashflow (%)	0.27	6.17	23.34	−2.17	5.92	5.84	6.50	−8.01***	−0.58***
IndVolatility (%)	8.16	7.19	4.32	8.59	7.63	7.17	5.85	1.43***	1.77***

Notes: The data refer to firms headquartered in the U.S. or in Western Europe (U.K., Ireland, Portugal, Spain, France, Italy, Greece, Belgium, the Netherlands, Luxemburg, Germany, Austria, Switzerland, Denmark, Sweden, Norway, and Finland). All variables are winsorized at the 1% level. Total assets are given in million USD. Firms with total assets of less than 5 million USD, as well as utility and financial firms, are excluded. All variables are defined as in Table 1. For means, a two-tailed t-test is conducted to determine whether the means differ significantly. Wilcoxon rank-sum tests are conducted to test for differences in medians per country group. Significance at the 1% level is indicated as ***.

3.1. Mean and median comparisons among crisis, precrisis, and postcrisis periods

In the following analysis, we compare the cash ratio of U.S. firms to that of European firms without controlling for firm-level characteristics. Table 5 depicts the means and medians for the United States, Europe, non-Anglo-Saxon Europe, and Anglo-Saxon Europe in three subperiods: precrisis (2003–2007), crisis (2008 and 2009), and postcrisis (2010–2018). Our definition of the crisis follows that of Kahle and Stulz (2013) and Jang (2017). We test for differences in the mean with a two-tailed t-test and for differences in the median with a Wilcoxon rank-sum test.

The results for U.S. firms show that the means and medians of the cash ratio do not differ statistically significantly before and during the crisis, but both mean and median increase by around 0.5% to 0.6% after it. Differences in the mean and median values are statistically significant between the postcrisis and crisis periods and the postcrisis and precrisis periods. However, European firms' average cash ratios decreased during the financial crisis relative to the precrisis period, especially for Anglo-Saxon European firms. The latter held more cash after the crisis than either before it or during it, while firms in non-Anglo-Saxon European countries increased their cash holdings only from the crisis period to the postcrisis period. Overall, the results in Table 5 indicate differences in the cash holding behavior of U.S. and European firms surrounding the global financial crisis years; accordingly, we can expect regional differences in the effects of determinants of the cash ratio during the three subperiods.

3.2. Multivariate regression analysis

3.2.1. Baseline model

To analyze regional as well as temporal differences in the sensitivities of the cash ratio to its main determinants, we use a multivariate regression model based on those of Bates et al. (2009), Iskandar-Datta and Jia (2012), and Pinkowitz et al. (2013, 2016). These authors proxy various motives for cash holding with firm characteristics that have been found to be determinants of the cash ratio: information asymmetry, future investment opportunities, cash flow, cash flow volatility, cash substitutes, firm size, and access to external markets. We also include GDP growth to control for different economic cycle stages (cf. Pinkowitz et al., 2016), and the Federal Reserve base rate to account for effects of differing interest rates (cf. Stone, Gup, & Lee, 2018). Interest rates are directly related to cash holdings, as they affect the value and costs of cash.

Our baseline regression model for firm i and time t is specified as follows:

$$\begin{aligned}
 \text{Cash}_{it} = & \beta_0 + \beta_1 \times \text{Europe} (\beta_1 \times \text{Non-Anglo}_c + \beta_2 \times \text{Anglo}_c) + \beta_3 \times \text{Size}_{i,t-1} + \beta_4 \times \text{R\&D}_{i,t-1} + \beta_5 \times \text{CaptX}_{i,t-1} + \beta_6 \times \text{NWC}_{i,t-1} \\
 & + \beta_7 \times \text{Leverage}_{i,t-1} + \beta_8 \times \text{Acquisitions}_{i,t-1} + \beta_9 \times \text{CashFlow}_{i,t-1} + \beta_{10} \times \text{CashFlowVol}_{j,t-1} + \beta_{11} \times \text{Dividends}_{i,t-1} \\
 & + \beta_{12} \times \text{MB ratio}_{i,t-1} + \beta_{13} \times \text{GDP Growth}_{c,t-1} + \beta_{14} \times \text{Fed Rate}_{t-1} + \varepsilon_{it},
 \end{aligned} \quad (1)$$

where the subscript i denotes the firm, j the industry, and c the country. Definitions of all variables are given in Table 1. Since cash levels and other firm-level variables such as leverage and investment are often seen as being jointly determined, we lag explanatory variables by one year to prevent inconsistent estimations. The sample period is from 2003 to 2018.

3.2.2. Regression results

Table 6 shows the results of the multivariate regressions based on eq. 1, defined above. The bivariate comparison including fixed effects in column 1 confirms the findings of previous studies as well as the findings from the mean and median comparison. Firms headquartered in the European countries considered hold on average 6.33% less cash in relation to assets than U.S. firms do. More

Table 3

Numbers of firm-year observations (N) per country and mean values of all variables, 2003–2018.

Countries	Obs.	Firms	Cash (%)	Size (Ln)	R&D (%)	CaptX (%)	Leverage (%)	NWC (%)	Acquisi- tions (%)	MB Ratio (%)	Dividends (%)	Cashflow (%)	IndVola- tility (%)	Fed Rate (%)	GDP Growth (%)
<i>U.S.</i>	46,154	6426	21.23	5.841	6.25	4.90	23.48	3.42	2.35	2.119	29.78	-2.17	8.59	1.993	1.457
<i>Europe</i>	20,121	3539	12.85	6.376	1.96	4.75	20.78	3.65	1.84	1.618	89.11	5.84	7.17	1.731	1.485
<i>Anglo</i>	6835	1171	12.16	6.280	1.98	4.58	19.83	0.83	2.14	1.698	88.97	6.24	7.52	2.185	1.442
<i>U.K.</i>	6278	1095	11.59	6.177	1.75	4.63	19.58	0.88	2.04	1.673	90.95	6.39	7.39	1.948	1.455
<i>Ireland</i>	557	76	18.64	7.439	4.56	3.97	22.69	0.33	3.32	1.983	66.61	4.64	8.96	4.858	1.295
<i>Non-Anglo</i>	13,286	2368	13.21	6.425	1.95	4.84	21.27	5.10	1.69	1.577	89.18	5.64	6.99	1.498	1.507
<i>Austria</i>	287	47	10.96	6.585	0.74	7.16	22.68	5.28	0.94	1.276	96.17	7.87	5.65	1.537	1.368
<i>Belgium</i>	437	70	11.97	6.782	2.52	6.35	21.41	1.47	1.66	1.667	94.51	7.44	6.34	1.460	1.524
<i>Denmark</i>	650	107	13.48	5.861	3.57	5.56	19.74	7.13	1.47	1.820	86.15	6.11	7.48	1.224	1.481
<i>Finland</i>	944	131	11.97	6.152	2.54	4.90	22.38	6.16	1.66	1.544	94.49	4.81	6.47	1.590	1.534
<i>France</i>	1309	337	14.37	6.492	1.48	4.35	20.61	3.28	1.81	1.449	92.97	5.05	7.57	1.431	2.254
<i>Germany</i>	2631	422	13.84	6.674	2.35	4.63	19.44	8.33	1.42	1.448	90.80	6.04	7.54	1.252	1.332
<i>Greece</i>	563	142	11.24	5.799	0.15	8.68	32.48	1.73	0.61	1.259	82.24	4.52	4.97	0.982	2.082
<i>Italy</i>	780	182	12.91	6.674	0.81	4.15	21.71	4.29	0.78	1.402	87.05	4.75	6.37	0.233	1.384
<i>Luxembourg</i>	178	35	12.44	7.720	0.90	6.11	27.30	1.36	1.78	1.469	71.35	7.27	5.96	2.632	1.038
<i>Netherlands</i>	805	137	11.84	6.928	1.99	4.69	23.04	2.81	2.46	1.644	79.38	5.93	7.24	1.294	1.503
<i>Norway</i>	603	122	13.46	6.419	0.66	6.44	23.40	0.35	1.26	1.525	87.40	5.32	6.98	1.585	1.423
<i>Portugal</i>	176	28	10.14	7.021	0.12	4.73	33.90	-7.13	0.18	1.260	97.73	6.10	4.27	0.289	1.150
<i>Spain</i>	456	89	10.16	7.242	0.32	5.42	24.37	1.61	1.08	1.755	94.30	6.58	5.48	1.778	1.570
<i>Sweden</i>	2153	326	13.50	5.562	2.37	3.34	17.55	6.21	2.61	1.822	88.02	4.59	7.19	2.313	1.277
<i>Switzerland</i>	1314	193	15.27	6.871	2.71	4.55	20.56	6.88	2.05	1.719	89.04	6.79	7.71	1.756	1.468

Notes: Variables are defined as in Table 1. The variable *Europe* refers to all European countries considered. *Anglo* refers to Anglo-Saxon European countries (GBR and IRL). *Non-Anglo* refers to all European countries other than GBR and IRL; figures for these are given separately in the last section of the table.

Table 4
Pairwise correlations between all variables, 2003–2018.

	VIF	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	
Cash	[1]	1											
Size	[2]	1.39	−0.3147***	1									
R&D	[3]	2.03	0.5853***	−0.2824***	1								
CaptX	[4]	1.06	−0.1898***	0.0656***	−0.1378***	1							
Leverage	[5]	1.19	−0.2894***	0.1906***	−0.0941***	0.1143***	1						
NWC	[6]	1.25	−0.2158***	0.0137***	−0.2370***	−0.0998***	−0.2430***	1					
Acquisitions	[7]	1.22	−0.1266***	0.0990***	−0.0689***	−0.0810***	0.0780***	0.0012	1				
MB Ratio	[8]	1.03	0.3764***	−0.1793***	0.3738***	0.0054	−0.0489***	−0.2184***	−0.0267***	1			
Dividends	[9]	1.27	−0.2917***	0.3771***	−0.2876***	−0.0048	−0.0349***	0.1168***	0.0111***	−0.1501***	1		
Cashflow	[10]	2.01	−0.4258***	0.3689***	−0.6409***	0.0836***	−0.0633***	0.3278***	0.0834***	−0.3118***	0.2681***	1	
IndVolatility	[11]	1.26	0.3917***	−0.2213***	0.4033***	−0.0617***	−0.1001***	−0.1455***	0.008	0.2539***	−0.2638***	−0.2920***	1

Notes: All firm-level variables are defined as in Table 1. *** indicates significance at the 1% level.

Table 5

Means and medians of the cash-to-assets ratio for U.S. firms in comparison to two different groups of European countries, before, during, and after the crisis.

	Precrisis (< 2008)			Crisis (2008–2009)			Postcrisis (2009 >)			Crisis – Precrisis		Postcrisis – Precrisis		Postcrisis – Crisis	
	N	Mean	Median	N	Mean	Median	N	Mean	Median	Mean	Median	Mean	Median	Mean	Median
U.S.	16,467	0.2110	0.1159	6050	0.2083	0.1169	23,637	0.2143	0.1213	–0.0027	0.0009	0.0032	0.0054***	0.0059*	0.0045
Europe	7751	0.1315	0.0835	2434	0.1195	0.0814	9936	0.1284	0.0906	–0.0119***	–0.0022	–0.0031	0.0071***	0.0089***	0.0093***
Non-Anglo	4907	0.1318	0.0855	1663	0.1233	0.0870	6716	0.1344	0.0993	–0.0085**	0.0015	0.0026	0.0139***	0.0111***	0.0123***
Anglo	2844	0.1308	0.0800	771	0.1114	0.0723	3220	0.1159	0.0761	–0.0195***	–0.0077**	–0.0149***	–0.0038	0.0046	0.0039*

Notes: The group non-Anglo Saxon Europe includes fifteen countries: France, Germany, Spain, Italy, Greece, Portugal, Austria, Switzerland, the Netherlands, Belgium, Luxemburg, Denmark, Sweden, Norway, and Finland. Anglo-Saxon Europe includes two countries (U.K. and Ireland). A two-tailed t-test is conducted to determine whether the means differ significantly. Wilcoxon rank-sum tests are conducted to test for differences in medians by country group and time period. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 6Effect of firm characteristics and regional dummies on the cash-to-assets ratio, for U.S., Anglo-Saxon European (*Anglo*), and non-Anglo-Saxon European (*Non-Anglo*) firms.

	(1)	(2)	(3)	(4)
<i>Europe</i>	-0.0633*** [0.0037]	-0.0200*** [0.0030]		
<i>Anglo</i>			-0.0720*** [0.0053]	-0.0376*** [0.0038]
<i>Non-Anglo</i>			-0.0588*** [0.0042]	-0.0110*** [0.0032]
<i>Size</i>		-0.0056*** [0.0007]		-0.0056*** [0.0007]
<i>R&D</i>		0.6376*** [0.0203]		0.6367*** [0.0203]
<i>CaptX</i>		-0.4525*** [0.0176]		-0.4543*** [0.0176]
<i>Leverage</i>		-0.2394*** [0.0070]		-0.2402*** [0.0071]
<i>NWC</i>		-0.1544*** [0.0077]		-0.1572*** [0.0077]
<i>Acquisitions</i>		-0.3058*** [0.0106]		-0.3039*** [0.0106]
<i>MB Ratio</i>		0.0199*** [0.0010]		0.0198*** [0.0011]
<i>Dividends</i>		-0.0349*** [0.0030]		-0.0347*** [0.0030]
<i>Cashflow</i>		-0.0335*** [0.0089]		-0.0324*** [0.0089]
<i>IndVolatility</i>		0.6107*** [0.0360]		0.6156*** [0.0360]
<i>GDP Growth</i>		-0.0012*** [0.0004]		-0.0008** [0.0004]
<i>Fed Rate</i>		-0.0028*** [0.0005]		-0.0030*** [0.0005]
<i>Constant</i>	0.1667*** [0.0261]	0.2174*** [0.0067]	0.1681*** [0.0265]	0.2173*** [0.0067]
<i>Adj. R-squared</i>	0.236	0.496	0.236	0.497
<i>Observations</i>	66,275	66,275	66,275	66,275
<i>Year Fixed Effects</i>	Yes	No	Yes	No
<i>Industry Fixed Effects</i>	Yes	No	Yes	No
Chi ² statistics (Europe = Anglo)		55.7***		
Chi ² statistics (Europe = Non-Anglo)		52.3***		
F statistic (Anglo = Non-Anglo)			5.51***	56***

Notes: This table presents results from multivariate linear regressions based on eq. (1). Variable definitions are given in Table 1. Explanatory variables are lagged by one period to minimize an endogeneity bias. Robust standard errors in parentheses are clustered on the firm level. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

interestingly, the outcomes presented in column 2 suggest that even after we control for firm-level characteristics, as well as GDP growth levels and Federal Reserve funds rates, European firms still seem to have significantly lower cash holdings than U.S. firms. This could indicate that other country-level factors affect the cash holding of European and U.S. firms. However, the coefficient in column 2 is much weaker than the direct finding in column 1 (-0.0200 vs. -0.0633). Indeed, the lower European cash holdings can be explained in large part by the firm-level and country-level characteristics considered. Nevertheless, a difference of -0.0200 in the cash-to-assets ratio may still be considered economically significant, since it makes up 19% of the median cash holding ($0.0200/0.105 = 0.1905$), which might be considered more representative than the mean cash holding because the cash ratio distribution is right skewed.

Columns 3 and 4 show results for Anglo-Saxon European firms and non-Anglo-Saxon European firms, as defined above. The findings for Europe as a whole also hold for both groups separately, although the coefficients for Anglo-Saxon European countries are more negative than those for non-Anglo-Saxon European countries both with and without controls, so that the difference cannot be explained through major characteristics of corporate cash holdings. While the coefficient for Anglo-Saxon European countries (-0.0376) in column 4 is larger than that for Europe (-0.0200) in column 2, the coefficient for non-Anglo-Saxon European firms (-0.011) is smaller, and those differences are statistically significant, as is shown by the Chi² statistics reported at the bottom of the table. However, the latter group's value of -0.011 is more than 8% of the median cash ratio for these firms and may thus still be considered economically significant ($0.0110/0.132 = 0.0833$).

Regarding firm-level characteristics, the findings confirm our expectations. Both the market-to-book ratio as a proxy for growth opportunities and the R&D-to-assets ratio, which reflect the precautionary motive in terms of information asymmetry, positively influence the cash ratio. Also, industry cash flow volatility has a significantly positive influence on cash holding, confirming that firms need to hold more cash for precautionary reasons when the cash flow is more volatile. By contrast, firm size, capital expenditures, net working capital, acquisitions, and dividends negatively affect the cash ratio. The negative relationship found for leverage supports the

argument of Bates et al. (2009) that cash is used if debt is constraining. As a higher cash flow is associated with lower cash holding, cash flow may indeed be used as a substitute for holding cash.

Furthermore, GDP growth is negatively associated with the cash-to-assets ratio. This indicates that after we account for growth opportunities through other variables, firms seem to hold more cash in times of weak economic growth, perhaps because external financing is more costly (Harford et al., 2014). The Fed rate exhibits a negative relationship with cash, supporting the idea that higher interest rates increase the opportunity costs of holding cash. Hence, the low values of interest rates since the financial crisis can be assumed to be associated with increased cash holding by firms.

The regressions in columns 2 and 4 do not include fixed effects because of collinearity problems. The Federal Reserve funds rate varies only by the year, and the industry cash flow volatility is too highly correlated with industry dummies. The regressions are also run without these variables and with year fixed effects respectively industry fixed effects. The results are qualitatively the same.

In sum, the regression results clearly indicate that European firms, especially those located in Anglo-Saxon Europe, hold less cash than U.S. firms, even after we control for firm-level characteristics. However, one cannot directly presume that country-level factors determine this difference, as Pinkowitz et al. (2016) find that the relatively high U.S. cash ratios are driven entirely by high-R&D U.S. firms.

3.2.3. Separate analyses of country groups

To analyze how the influence of firm-level characteristics on cash holding may vary among the groups of countries considered, we follow the approach of Iskandar-Datta and Jia (2012) and conduct four separate regressions. The results are presented in Table 7. The signs of the estimated coefficients are the same for all firm-level characteristics, indicating that the firm attributes' effects on Cash take the same directions for both U.S. and European firms. The magnitudes of the effects, however, vary for Size, R&D, CaptX, Acquisitions,

Table 7

Effects of firm characteristics on the cash-to-assets ratio, for firms headquartered in the U.S. and in 17 European countries.

Regressions	U.S.	Europe	Non-Anglo-Saxon Europe	Anglo-Saxon Europe
<i>Size</i>	-0.0045*** [0.0010]	-0.0072*** [0.0008]	-0.0065*** [0.0014]	-0.0085*** [0.0010]
<i>R&D</i>	0.6280*** [0.0220]	0.5273*** [0.0540]	0.5388*** [0.0824]	0.5023*** [0.0702]
<i>CaptX</i>	-0.5250*** [0.0205]	-0.1921*** [0.0300]	-0.2256*** [0.0448]	-0.1925*** [0.0381]
<i>Leverage</i>	-0.2421*** [0.0081]	-0.2300*** [0.0112]	-0.2086*** [0.0186]	-0.2486*** [0.0140]
<i>NWC</i>	-0.1571*** [0.0097]	-0.1353*** [0.0120]	-0.1515*** [0.0228]	-0.1435*** [0.0137]
<i>Acquisitions</i>	-0.3279*** [0.0126]	-0.2049*** [0.0169]	-0.2324*** [0.0266]	-0.1747*** [0.0217]
<i>MB Ratio</i>	0.0204*** [0.0012]	0.0186*** [0.0020]	0.0200*** [0.0027]	0.0175*** [0.0027]
<i>Dividends</i>	-0.0353*** [0.0035]	-0.0357*** [0.0053]	-0.0638*** [0.0104]	-0.0192*** [0.0061]
<i>Cashflow</i>	-0.0254*** [0.0098]	-0.0858*** [0.0221]	-0.0792** [0.0324]	-0.0738*** [0.0282]
<i>IndVolatility</i>	0.8111*** [0.0489]	0.2313*** [0.0429]	0.3447*** [0.0718]	0.1750*** [0.0521]
<i>GDP Growth</i>	-0.0018*** [0.0005]	-0.0007 [0.0005]	0.0020*** [0.0007]	-0.0021*** [0.0005]
<i>Fed Rate</i>	-0.0042*** [0.0006]	-0.0009 [0.0007]	-0.0013 [0.0011]	-0.0006 [0.0009]
Constant	0.2020*** [0.0087]	0.2223*** [0.0086]	0.2089*** [0.0150]	0.2348*** [0.0108]
Adj. R-squared	0.508	0.314	0.356	0.308
Observations	46,154	20,121	6835	13,286
Chi ² statistics	U.S. vs. Europe	U.S. vs. Non-Anglo	U.S. vs. Anglo	Non-Anglo vs. Anglo
<i>Size</i>	4.37***	1.29	8.23***	1.4
<i>R&D</i>	2.99*	1.1	2.92*	0.11
<i>CaptX</i>	84.1***	37.1***	59.2***	0.32
<i>Leverage</i>	0.76	2.74*	0.16	2.97*
<i>NWC</i>	2.0	0.05	0.66	0.09
<i>Acquisitions</i>	34.1***	10.6***	37.3***	2.83*
<i>MB Ratio</i>	0.57	0.01	0.95	0.43
<i>Dividends</i>	0.01	6.79***	5.28**	13.8
<i>Cashflow</i>	6.23***	2.52	2.63	0.02
<i>IndVolatility</i>	79.5***	28.9***	79.3***	3.66*

Notes: This table shows the results from multivariate linear regressions run separately for the four groups of countries. Variable definitions are given in Table 1. Explanatory variables are lagged by one period to minimize an endogeneity bias. Robust standard errors in parentheses are clustered on the firm level. Chi² statistics show statistical differences in effects of explanatory variables on the cash ratio between pairs of regions. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Cashflow and IndVolatility (cf. Iskandar-Datta & Jia, 2012). In general, it cannot be stated that the coefficients for Anglo-Saxon European firms are more similar to those for U.S. firms than are the non-Anglo-Saxon European firms' coefficients, as one might expect from the higher cultural proximity of especially the U.K. with the U.S. (see Pinkowitz et al., 2013). However, for IndVolatility, the coefficient for U.S. firms is 4.63 times higher than that for non-Anglo-Saxon European firms but only 2.35 times higher than that for Anglo-Saxon European firms. Chi² statistics show that these differences are statistically significant: U.S. firms hold much more cash for an additional unit of industry cash flow volatility than does either group of European firms. Iskandar-Datta and Jia (2012) observe that firms in some countries increase cash holding much more because of higher cash flow volatility.

One possible reason for the stronger sensitivity of U.S. firms to industry cash flow volatility, also based on Iskandar-Datta and Jia (2012), is associated with R&D expenses. A higher cash flow volatility sets more R&D projects at risk. Recall that the mean and median

Table 8
Effects of firm characteristics, regional dummies, and interaction terms on the cash-to-assets ratio, for firms from the U.S. and 17 European countries.

	(1)	(2)	(3)	(4)	(5)	(6)
Europe	0.0247*** [0.0049]	-0.0150*** [0.0030]	0.0241*** [0.0049]			
Anglo				-0.0055 [0.0067]	-0.0347*** [0.0039]	-0.0058 [0.0067]
Non-Anglo				0.0384*** [0.0053]	-0.0047 [0.0033]	0.0377*** [0.0053]
IndVolatility	0.8068*** [0.0479]	0.6194*** [0.0359]	0.7980*** [0.0481]	0.8057*** [0.0479]	0.6248*** [0.0359]	0.7967*** [0.0481]
IndVolatilityxEurope	-0.5983*** [0.0618]		-0.5587*** [0.0630]			
IndVolatilityxAnglo				-0.4128*** [0.0859]		-0.3972*** [0.0871]
IndVolatilityxNon-Anglo				-0.6789*** [0.0678]		-0.6218*** [0.0687]
R&D	0.6244*** [0.0203]	0.6547*** [0.0211]	0.6334*** [0.0214]	0.6239*** [0.0203]	0.6541*** [0.0211]	0.6335*** [0.0214]
R&DxEurope		-0.2036*** [0.0514]	-0.0968* [0.0560]			
R&DxAnglo					-0.0987 [0.0795]	-0.0277 [0.0844]
R&DxNon-Anglo					-0.2720*** [0.0632]	-0.1489** [0.0696]

	(1)	(2)	(3)	(1)	(2)	(3)
Size	-0.0054*** [0.0007]	-0.0055*** [0.0007]	-0.0054*** [0.0007]	-0.0056*** [0.0007]	-0.0056*** [0.0007]	-0.0055*** [0.0007]
CaptX	-0.4537*** [0.0175]	-0.4513*** [0.0176]	-0.4531*** [0.0175]	-0.4562*** [0.0175]	-0.4529*** [0.0176]	-0.4552*** [0.0175]
Leverage	-0.2385*** [0.0070]	-0.2391*** [0.0070]	-0.2384*** [0.0070]	-0.2394*** [0.0070]	-0.2399*** [0.0070]	-0.2393*** [0.0070]
NWC	-0.1514*** [0.0077]	-0.1525*** [0.0077]	-0.1507*** [0.0077]	-0.1542*** [0.0078]	-0.1553*** [0.0078]	-0.1534*** [0.0078]
Acquisitions	-0.3031*** [0.0107]	-0.3052*** [0.0106]	-0.3029*** [0.0107]	-0.3011*** [0.0107]	-0.3032*** [0.0106]	-0.3010*** [0.0106]
MB Ratio	0.0198*** [0.0010]	0.0200*** [0.0010]	0.0199*** [0.0010]	0.0198*** [0.0010]	0.0200*** [0.0010]	0.0199*** [0.0010]
Dividends	-0.0347*** [0.0030]	-0.0356*** [0.0030]	-0.0351*** [0.0030]	-0.0344*** [0.0030]	-0.0353*** [0.0029]	-0.0347*** [0.0030]
Cashflow	-0.0301*** [0.0089]	-0.0300*** [0.0090]	-0.0286*** [0.0090]	-0.0290*** [0.0089]	-0.0285*** [0.0090]	-0.0273*** [0.0090]
GDP Growth	-0.0011*** [0.0004]	-0.0011*** [0.0004]	-0.0011*** [0.0004]	-0.0008** [0.0004]	-0.0007** [0.0004]	-0.0007** [0.0004]
Fed Rate	-0.0030*** [0.0005]	-0.0030*** [0.0005]	-0.0031*** [0.0005]	-0.0032*** [0.0005]	-0.0031*** [0.0005]	-0.0032*** [0.0005]
Constant	0.2008*** [0.0071]	0.2152*** [0.0068]	0.2008*** [0.0071]	0.2013*** [0.0071]	0.2150*** [0.0068]	0.2012*** [0.0071]
Adj. R-squared	0.499	0.497	0.499	0.5	0.498	0.5
Observations	66,275	66,275	66,275	66,275	66,275	66,275
F Statistics						
IndVolatilityxEurope = R&DxEurope			24.7***			
IndVolatilityxAnglo = IndVolatilityxNon-Anglo				9.01***		6.36***
R&DxAnglo = R&DxNon-Anglo					3.1*	1.3

Notes: European countries are grouped into Anglo-Saxon Europe, abbreviated as Anglo, and non-Anglo-Saxon Europe, abbreviated as non-Anglo. Variable definitions are given in Table 1. Explanatory variables are lagged by one period to minimize an endogeneity bias. Robust standard errors in parentheses are clustered on the firm level. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

values for *R&D* and *IndVolatility* are highest in the U.S.; that is, the U.S. has more industries with very high cash flow volatilities, such as the pharmaceutical (SIC 28) and technological (SIC 73) sectors. These industries are also extremely R&D intensive. Hence, U.S. firms might on average be willing to hold more cash to ensure the stable financing of R&D projects. This reasoning accords with Pinkowitz et al.'s (2013, 2016) finding that higher U.S. cash ratios are determined by highly R&D intensive firms largely peculiar to the U.S.

Interestingly, we find that U.S. firms decrease their cash ratio more per additional unit of capital expenditures, net working capital, and acquisitions than European firms do. It may be that European firms having high cash balances were also able to invest more during the sample period, weakening the negative relationship. Especially during the financial crisis, ensuring the ability to invest was an important motive for holding cash (Bliss et al., 2015). Regarding the effect of being a dividend payer, the two groups of European countries seem to differ strongly. In the Anglo-Saxon European countries, being a dividend-paying firm decreases cash holding less than in the U.S, whereas the opposite holds for countries in non-Anglo-Saxon Europe. However, a test on the differences between the Anglo-Saxon Europe and non-Anglo-Saxon Europe subsamples finds no significant result.

In contrast to the firm attributes, GDP growth and the Federal Reserve fund rate affect cash holding differently in the three regions. For the United States and Anglo-Saxon European countries, we find a slightly negative relation between GDP growth and the cash-to-assets ratio, whereas the opposite is true for the non-Anglo-Saxon European countries. There are two possible explanations for this difference. It could be that in both the U.S. and the non-Anglo-Saxon European countries cash holding was lower during times of lower GDP growth such as the crisis period, which we can only confirm for the latter group however. More likely, it could be that firms increased cash holding more during times of higher growth to ensure the financing of investment opportunities when they might arise, as Fernandes and Gonenc (2016) propose. Regarding the Fed rate, we find that the coefficients are negative for all three regions but significant only for the U.S. Since the Federal Reserve is a U.S. institution, this finding is not surprising.

Overall, the cash holding behavior of U.S., non-Anglo-Saxon European, and Anglo-Saxon European firms seems to be determined by the same firm characteristics and in the same direction but not with the same magnitudes. Especially, industry cash flow volatility has a much stronger positive impact on cash holding in the U.S. than in either European region, perhaps because U.S. firms are likelier to have a strategic focus on ensuring stable financing of R&D investments.

3.2.4. The roles of industry-level cash flow volatility and R&D across regions

The separated regression analyses of U.S., non-Anglo-Saxon European, and Anglo-Saxon European firms indicate that the magnitude of the effect of certain firm characteristics on the cash-to-assets ratio varies strongly. A basic multivariate regression model such as the one used above does not allow for such variations (Pinkowitz et al., 2016). Therefore, we deploy a model including terms that interact the variables that show the most strongly differing magnitudes with indicator variables for the European sample as a whole, as well as for Anglo-Saxon European versus non-Anglo-Saxon European firms, and investigate whether the lower cash holdings of the European firms can be explained this way.

The regression results are presented in Table 8. Column 1 displays the results of the model including the interaction of *IndVolatility* with the *Europe* dummy. (Recall that the influence of *IndVolatility* on the cash ratio varies most across European and U.S. firms.) First of all, the variable *Europe*, indicating the difference in cash holdings between European and U.S. firms having low levels of *IndVolatility*, shows that European firms on average hold more cash than U.S. firms. The variable *IndVolatility* in column 1 indicates the effect of industry cash flow volatility for U.S. firms. The interaction variable *IndVolatilityxEurope* captures the difference in cash holdings between European and U.S. firms in industries with highly volatile cash flows. When we compare the estimated coefficient of this interaction variable (-0.5983) with that of the *Europe* dummy (0.0247), we can say that the difference in cash holdings between European and U.S. firms is negative with the latter holding more cash when *IndVolatility* is high, as our main regressions in Table 6 show. If we compare the estimated coefficient of the interaction variable with *IndVolatility* itself, we can interpret our finding as meaning that the firm's cash ratio is less sensitive to industry-level cash flow volatility for European firms than for U.S. firms.

In column 2 of Table 8, we analyze the role of R&D expenditures in explaining the differences in cash holdings between European firms and U.S. firms. We find results similar to those in column 1. First, at low R&D intensity the difference in cash holdings between the two types of firms decreases. The estimated coefficient of *Europe* is smaller than the estimated coefficient in Table 6 and is even negative. The negative and significant estimated coefficient of the interaction *R&DxEurope* implies that the difference is more negative when firm-level R&D expenditures are high because the sensitivity of cash ratio to R&D (the coefficient of *R&D* itself) is larger for U.S. firms. In column 3, we include both interactions with *IndVolatility* and *R&D* and provide F statistics at the bottom of the table to show which variable has a stronger effect. We find that the interaction between *Europe* and *IndVolatility* creates a stronger effect than the one between *Europe* and *R&D*.

The last three columns of Table 8 report a similar analysis performed separately for Anglo-Saxon and non-Anglo-Saxon European countries. Interestingly, we show in column 4 that the difference in cash holdings between Anglo-Saxon European and U.S. firms (the estimated coefficient of *Anglo*) is no longer statistically significant when we control for the effect of high *IndVolatility* in both groups. As in columns 1 to 3, our results in columns 4 to 6 show the effects of high levels of *IndVolatility* and *R&D* in explaining the differences, as well as the stronger role that *IndVolatility* plays in comparison to *R&D*.

Columns 2 and 5 of Table 8 present the results for the incremental effect of *R&D* on European firms. We find negative and significant coefficients on the interaction terms, but this effect is driven by the non-Anglo-Saxon European firms, with the much less negative result for Anglo-Saxon firms being insignificant. That is, Anglo-Saxon European firms do not hold significantly more or less cash per unit of *R&D* than do U.S. firms. Controlling for the interaction effects, the dummy for firms in non-Anglo-Saxon Europe is insignificant. Hence, while not relevant for the Anglo-Saxon European countries, the differing incremental effect of *R&D* expenses explains the lower cash holding of non-Anglo-Saxon European firms versus U.S. firms.

Lastly, columns 3 and 6 of Table 8 display the results of a model including both of the interaction effects analyzed above. The

Table 9

Effects of firm characteristics, regional dummies, and interaction terms on the cash-to-assets ratio for firms from the United States and 17 European countries, before, during, and after the crisis.

	Precrisis	Crisis	Postcrisis	Precrisis	Crisis	Postcrisis
<i>Europe</i>	0.0326*** [0.0065]	0.0228*** [0.0079]	0.0241*** [0.0066]			
<i>Anglo</i>				0.0098 [0.0087]	−0.0078 [0.0113]	−0.0123 [0.0090]
<i>Non-Anglo</i>				0.0447*** [0.0070]	0.0377*** [0.0086]	0.0411*** [0.0072]
<i>IndVolatility</i>	0.6542*** [0.0589]	0.6132*** [0.0719]	0.9928*** [0.0685]	0.6490*** [0.0589]	0.6092*** [0.0719]	0.9929*** [0.0685]
<i>IndVolatilityxEurope</i>	−0.5286*** [0.0777]	−0.5100*** [0.0966]	−0.6762*** [0.0946]			
<i>IndVolatilityxAnglo</i>				−0.4335*** [0.1066]	−0.3441** [0.1474]	−0.4473*** [0.1284]
<i>IndVolatilityxNon-Anglo</i>				−0.5625*** [0.0856]	−0.5517*** [0.1008]	−0.7787*** [0.1043]
<i>R&D</i>	0.6702*** [0.0322]	0.6250*** [0.0403]	0.6084*** [0.0277]	0.6706*** [0.0322]	0.6261*** [0.0404]	0.6087*** [0.0277]
<i>R&DxEurope</i>	−0.0244 [0.0743]	−0.3994*** [0.0836]	−0.0821 [0.0828]			
<i>R&DxAnglo</i>				−0.0452 [0.1143]	−0.2971** [0.1390]	0.0634 [0.1243]
<i>R&DxNon-Anglo</i>				−0.0055 [0.0909]	−0.4885*** [0.0898]	−0.1724* [0.0979]
<i>Size</i>	−0.0048*** [0.0009]	−0.0063*** [0.0011]	−0.0064*** [0.0009]	−0.0049*** [0.0009]	−0.0064*** [0.0011]	−0.0064*** [0.0009]
<i>CaptX</i>	−0.4493*** [0.0247]	−0.4182*** [0.0283]	−0.4953*** [0.0233]	−0.4521*** [0.0247]	−0.4213*** [0.0283]	−0.4967*** [0.0233]
<i>Leverage</i>	−0.2728*** [0.0102]	−0.2432*** [0.0124]	−0.2139*** [0.0086]	−0.2742*** [0.0102]	−0.2438*** [0.0124]	−0.2145*** [0.0086]
<i>NWC</i>	−0.1701*** [0.0096]	−0.1429*** [0.0136]	−0.1419*** [0.0107]	−0.1738*** [0.0097]	−0.1456*** [0.0137]	−0.1439*** [0.0107]
<i>Acquisitions</i>	−0.3274*** [0.0168]	−0.3054*** [0.0224]	−0.2891*** [0.0137]	−0.3300*** [0.0168]	−0.3008*** [0.0224]	−0.2842*** [0.0137]
<i>MB Ratio</i>	0.0200*** [0.0015]	0.0158*** [0.0021]	0.0205*** [0.0014]	0.0200*** [0.0015]	0.0160*** [0.0021]	0.0207*** [0.0014]
<i>Dividends</i>	−0.0392*** [0.0036]	−0.0396*** [0.0051]	−0.0322*** [0.0039]	−0.0385*** [0.0036]	−0.0394*** [0.0051]	−0.0320*** [0.0039]
<i>Cashflow</i>	−0.0279** [0.0134]	−0.0121 [0.0188]	−0.0250** [0.0119]	−0.0269** [0.0135]	−0.0102 [0.0189]	−0.0234** [0.0118]
<i>GDP Growth</i>	−0.0018* [0.0010]	0.0039** [0.0019]	0.0004 [0.0004]	0 [0.0010]	0.0007 [0.0018]	0.0006 [0.0004]
<i>Fed Rate</i>	−0.0007 [0.0007]	−0.0108*** [0.0016]	−0.0116*** [0.0028]	−0.0012* [0.0007]	−0.0084*** [0.0016]	−0.0120*** [0.0028]
Constant	0.2075*** [0.0095]	0.2602*** [0.0120]	0.1893*** [0.0089]	0.2052*** [0.0095]	0.2559*** [0.0119]	0.1893*** [0.0089]
Adj. R-squared	0.476	0.468	0.528	0.477	0.469	0.529
Observations	24,218	8484	33,573	24,218	8484	33,573
F statistics for coefficients between periods	Crisis vs. Pre-crisis	Postcrisis vs. Crisis	Post- vs Pre-crisis	Crisis vs. Pre-crisis	Postcrisis vs. Crisis	Post- vs. Pre-crisis
<i>IndVolatilityxEurope</i>	0.04	2.19	1.78			
<i>R&DxEurope</i>	15.6***	8.9***	0.27			
<i>IndVolatilityxAnglo</i>				0.37	0.42	0.01
<i>IndVolatilityxNon-Anglo</i>				0.01	3.47*	3.13*
<i>R&DxAnglo</i>				2.25	6.04***	0.39
<i>R&DxNon-Anglo</i>				22.7***	6.41***	1.57
F Statistics for coefficients between variables						
<i>IndVolatilityxEurope = R&DxEurope</i>	17.3***	0.6	19.5***			
<i>IndVolatilityxAnglo = IndVolatilityxNon-Anglo</i>				1.38	1.99	6.09***
<i>R&DxAnglo = R&DxNon-Anglo</i>				0.08	1.47	2.33

Notes: Periods are defined as precrisis (2003–2007), crisis (2008–2009), and postcrisis (2010–2018). European countries are grouped into Anglo-Saxon Europe, abbreviated as Anglo, and non-Anglo-Saxon Europe, abbreviated as non-Anglo. Variable definitions are given in Table 1. Explanatory variables are lagged by one period to minimize an endogeneity bias. Robust standard errors in parentheses are clustered on the firm level. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

coefficients of the interaction terms remain qualitatively the same in the full model. This holds especially for the incremental effect of *IndVolatility* on the cash ratio for the European firms, as well as for both the non-Anglo-Saxon firms and the Anglo-Saxon firms separately. However, as column 6 of Table 8 shows, the incremental effect of R&D on *Cash* for the European sample and its two subsamples is here much weaker than in the column 2 model including only the interaction with R&D. The coefficient on the interaction variable of R&D and *Anglo-Saxon* is negative and still insignificant. Nevertheless, the significantly negative incremental effects of R&D expenses and industry cash flow volatility for *Europe* and *Non-Anglo* seem to overlap. This supports the argument raised in the previous section, that U.S. firms hold more cash per unit of cash flow volatility in order to ensure their R&D leadership. Once we control for the differing effects of *IndVolatility* and R&D on *Cash*, we again find that non-Anglo-Saxon European cash ratios are significantly larger than U.S. cash ratios.

After we control for the differing effect of *IndVolatility* on *Cash*, the coefficient on the regional dummy capturing the unexplained differences in cash holding between the U.S. and Europe changes drastically from negative to positive. However, when we divide the European sample into non-Anglo-Saxon firms and Anglo-Saxon firms, the dummy becomes again negative but this time insignificant for both of the country groups. Either way, it is reasonable to suggest that the significantly lower cash holding of European firms can be explained by the differing effects of R&D and, especially, *IndVolatility*.

3.2.5. Periods analysis

We next split the sample into three subperiods: precrisis (2003–2007), crisis (2008–2009), and postcrisis (2010–2018) (see Table 9). As Table 5 shows, we do not find that average cash ratios have increased or decreased for U.S. firms and European firms over time, whether or not the latter are divided into non-Anglo-Saxon and Anglo-Saxon European firms. Also, we do not find remarkable differences of country group effects over time. Albeit with a slight drop during the crisis years, the European firms hold more cash than the U.S. firms do throughout our period, if controlling for interaction effects. This effect can be attributed to the non-Anglo-Saxon firms.

Although a slight downward trend seems to be visible, we do not show that the effect of R&D expenses on the cash ratio has changed significantly for the whole U.S. and European sample over time. However, the magnitude of the interaction variable *R&DxEurope* is interesting. While it was mostly insignificant before and after the crisis, it was negative in 2008–2009, for both non-Anglo-Saxon European firms and, albeit to a lesser extent, Anglo-Saxon European firms. In making R&D expenditures, European firms lessen their cash holdings relatively to U.S. firms. Holding cash to ensure the ability to invest during the financial crisis (Bliss et al., 2015) can thus be understood for European firms in terms of R&D expenses as well. The non-Anglo-Saxon European and the Anglo-Saxon European firms differ because the former are more bank dependent than the latter.

After a slight drop during the crisis, the effect of industry cash flow volatility on the cash ratio has increased since the crisis, especially among U.S. firms. The effect is reduced for European firms because of an interaction effect, as is shown by the magnitude of the *IndVolatilityxEurope* variable and its standard deviation. The effect is more visible for non-Anglo-Saxon European firms than for Anglo-Saxon European firms—again, because the former rely less on financial markets and more on bank financing.

4. Conclusion

Our results show that cash holding behavior in the United States differs from that in European countries, both Anglo-Saxon and non-Anglo-Saxon. Like Pinkowitz et al. (2013, 2016), we find significantly higher mean and median cash-to-assets ratios for U.S. firms across our full sample period. These findings persist when we control for varying firm characteristics, but the magnitude of the characteristics' effect differs strongly by region. Industry cash flow volatility is a major determinant of higher U.S. cash ratios: U.S. firms hold much more cash per unit of industry cash flow volatility than European firms do. Another major determinant is R&D expenditures. When we also control for them, U.S. firms hold even less cash than European firms do.

The increased cash ratios per unit of cash flow risk can be explained by a strategic aim of U.S. firms to ensure innovation leadership through stable financing of R&D projects. U.S. firms show the highest R&D-to-assets ratios and also the highest industry cash flow volatility. Thus, U.S. firms need the most financing for R&D but are also subject to the highest cash flow risk. This combination may induce a higher cash need per unit of cash flow volatility than in European firms—a strategy-based explanation that accords with Pinkowitz et al.'s argument about differing firm types (2016).

We document an increasing sensitivity of U.S. cash ratios to cash flow uncertainty from the precrisis years 2003–2007 to the postcrisis period 2010–2018, perhaps because the strategic focus on stable funding of R&D has become more distinct since the crisis. The United States is known widely for highly innovative firms that also hold high amounts of cash (Pinkowitz et al., 2013, 2016). During the financial crisis, European firms held less cash than U.S. firms when making R&D expenditures. Higher uncertainty, shorter financing horizons, and increased funding costs make it necessary for firms to hold cash in order to be able to finance upcoming investment opportunities in the future and to ensure their survival (Gorton, 2009; Harford et al., 2014). Our results are also in line with previous empirical studies showing that firms increased precautionary cash holding during the financial crisis (Bliss et al., 2015; Pinkowitz et al., 2013).

This work has several implications. First, we provide further evidence on the effect of the financial crisis on firm cash holding that supports the theoretical reasoning that holding cash has advantages in times of financial distress, which might underpin managers' decisions in determining the cash level to be held in an economic crisis. Second, for U.S. firms our findings suggest that high cash holdings, which have been criticized as being costly and reducing investment, might in fact be useful in ensuring their innovativeness. During our sample period of 2003–2018, European firms had much lower average R&D expenses and also lower cash flow volatilities. European firms might be able to increase their innovativeness by ensuring that R&D projects are steadily funded even when cash flows

are relatively risky. For example, they may want to increase cash-to-assets ratios in relation to cash flow volatility, or study alternative ways of funding and seek for stimulation by governmental bodies in this respect.

Finally, we feel that we have touched upon something important. Whereas the transaction motive for holding cash is still valid, in the current low-cost-capital world the precautionary motive seems to have become the prevailing one. This is largely related to a specific type of firm that has become more dominant and that assumes risks on investments and financing ever more readily. U.S. firms, especially, stand out here. We cannot show whether other effects are taking over from the precautionary effect, as Alves (2018) argues, and must leave this question to further research. However, we hold that the traditional classification of financial risk management as an aspect of cash management is a dead letter. Instead, it has become the other way around: nowadays cash management is part of financial risk management.

Declaration of Competing Interest

None.

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