Full Length Article

# The impact of the global financial crisis on corporate cash holdings: Evidence from Eastern European countries

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## Abstract

This study investigates the impact of the global financial crisis on the determinants of corporate cash holdings and adjustments towards target cash levels using a sample of Eastern European firms. Employing panel fixed effects and GMM estimations, the results reveal that firm-level determinants of cash holdings significantly differ for pre- and post-crisis periods. Moreover, we find significantly lower adjustment speed to attain the optimal cash level in the post-crisis period. Our results are robust to correction for endogeneity. These results hold important implications for Eastern European firms, which are significantly afflicted by the global financial crisis in terms of liquidity shortage and limited financial flexibility.

## 1. Introduction

Over the past twenty years, Eastern European firms have faced circumstances different from their counterparts in Western Europe while pursuing their corporate strategies. As the twenty-first century began, they have achieved an abundance of liquidity by taking advantage of globalization and integrating into the European economy. As their economies were restructured for participation in a market economy, the majority of non-financial firms as well as financial institutions transformed rapidly. Undoubtedly, capital inflows from West European banks and other financial institutions played an important role in this transition. As a result of this integration process, eleven Eastern European countries joined the European Union (EU) during the last fifteen years, and some of them even joined the European Monetary Union by replacing their national currency with the euro.

The 2008 global financial crisis has damaged the Eastern European economies the most among all those in continental Europe, with a rapid impact on their financial sector and the cessation of foreign currency flows to their firms. The withdrawal of cash inflows was not limited to the low-cost credits previously granted by EU institutions. Foreign direct investment (FDI), which had previously been in low supply, also decreased, and the cost of loans rapidly increased (Marer, 2010). Consequently, these emerging European economies experienced more significant output declines in 2008 and 2009 than any other region in the world.

In the aftermath of the global financial crisis, Eastern European countries significantly lost credibility due to insufficient liquidity, and as a result, their economies suffered a significant downturn. Fortunately, within a few years, economic recovery in EU countries helped them restore their

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economies thanks to their strong economic ties with Western Europe. After dealing with liquidity problems during the financial crisis, Eastern European countries benefited from the quantitative easing policies of the Fed and the European Central Bank (ECB), which boosted global liquidity and increased cash flows to emerging markets. However, in 2013, the Fed initiated its tapering policy, which reduced the amount of cash in the market and created short-term fluctuation in global liquidity. Inevitably, this instability in the cash flows strongly impacted corporate as well as cash holding policies of the corporations (Palazzo, 2012). Although a few studies investigate the determinants of cash holding policies of Eastern European firms (Hall et al., 2014; Yildiz & Karan, 2020), to the best of our knowledge, no study focuses on the impact of the global financial crisis on the determinants of cash holdings and adjustments towards target cash position before and after the crisis for Eastern European firms.

Corporate cash holding policies are generally explained by three important theories, namely trade-off theory, pecking order theory and free cash flow theory. The trade-off theory suggests the existence of an optimal level of cash, based on a trade-off between the costs and benefits of holding cash (e.g., Kim et al., 1998; Opler et al., 1999). Hence, the trade-off theory claims that when firms evaluate the marginal costs and benefits of holding liquid assets, they increase their cash levels until the marginal cost of holding cash reaches its marginal benefit. According to the pecking order theory, firms follow a hierarchy in their financial policies and prefer internal over external financing due to asymmetric information problems (Myers & Majluf, 1984). Importantly, information asymmetries can be more severe for firms with greater growth opportunities. Firms with valuable investment opportunities accumulate cash to avoid passing over value-enhancing investment opportunities. Therefore, firms with greater investment opportunities accumulate more cash to avoid cash shortage when they have potentially valuable projects. Finally, the free cash flow theory claims that managers prefer to hold more cash to gain power over corporate decisions and to manage more assets under their control (Jensen, 1986).

Several studies in the literature investigate the impact of the global financial crisis on corporate financial policies, including cash holdings. Lian et al. (2011) investigate the impact of the global financial on Chinese corporate cash holdings and find that Chinese firms increase their cash holdings during the financial crisis period. They also conclude that firms with greater growth opportunities and financial constraints tend to hold more cash. Brown and Petersen (2015) study the impact of the crisis on the investment policies including R&D investments of the corporations. They reveal that firms tend to cut their real investments during the financial crisis and do not use their cash reserves to protect their fixed investments. However, they allocate their cash reserves to buffer their R&D investments. In another study, Campello et al. (2010) find that constrained firms cut their tech and capital spending, dividend payments and marketing expenditures during the global financial crisis. They also reveal that constrained firms tend to burn their cash to finance their operations. In a recent study,

Tran (2020) investigate the relationship between shareholder protection and cash holdings during the financial crisis with an international sample including 40 countries. The results of the study show that the impact of shareholder protection on cash holdings is significantly mitigated by the global financial crisis. Finally, Yildiz (2018) show that adjustment towards target capital structure is significantly slower after the global financial crisis, implying that the global financial crisis not only was important in determining the factors affecting capital structure decisions but also had a significant influence on target adjustment behavior.

Using a sample of eleven East European countries and Turkey,[1] this study investigates the determinants of cash holdings during the 2003−2016 period and also for pre− and post-crisis periods. We also comparatively examine the adjustment speed towards target cash positions for the full sample period as well as sub-periods. We employ panel fixed effects and the generalized method of moments (GMM) estimations to investigate the determinants of cash holdings and adjustments toward target cash levels. Our results suggest that determinants of cash holdings significantly differ for pre and post-crisis periods. Specifically, R&D expenditures, leverage, dividend policies, debt maturity, and net working capital are the most important factors affecting the cash holding policies of Eastern European firms. However, only net working capital is significant in both of the sub-periods. Importantly, the speed of adjustment towards target cash positions is lower in the post-crisis period, which indicates that Eastern European firms face significant challenges in attaining their optimal cash levels after the crisis.

The study contributes to the existing literature in three distinct ways. First, using a large sample of firms, we provide a comprehensive overview of corporate cash policies of the Eastern European firms that face significant uncertainty in terms of cash inflows and outflows. Second, the study comparatively examines the determinants of corporate cash holdings in the periods before and after the crisis. By doing so, we expose how the global financial crisis has affected the cash holding policies of the corporations located in Eastern Europe. Finally, this study provides new evidence on how the global financial crises affected the optimal cash holding policies of the Eastern European firms, which are generally characterized by their facing unstable macroeconomic conditions due to their dependency on developed countries. This is also important to understand how corporations react to the global financial crisis by changing their corporate cash holding policies.

The study consists of six sections. Following the introduction, we discuss the cash flow patterns in Eastern European countries before and after the global financial crisis in Section 2. We discuss the data and methodology in Section 3. In Section 4 and 5, we present and discuss the results for determinants of cash holdings and target adjustment behavior, respectively. Section 6 concludes the paper.

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[1] Similar to the Eastern European countries, Turkey has long been restructuring its economy along EU principles and pursuing negotiations with the EU for full membership. Importantly, Turkish firms exhibit corporate characteristics similar to the Eastern European firms.

## 2. Cash flows in Eastern European countries before and after the financial crisis

In the early 2000s, Eastern European countries, which are also called transition economies, began integrating with the European economy. Within a few years, eleven of them joined the European Union, and five of them—Slovenia, Slovakia, Estonia, Latvia and Lithuania—joined the Eurozone. This integration has enabled free movement of capital and goods and enhanced their capital positions by facilitating capital inflows. On the other hand, countries without EU membership, such as Turkey, have reformed economically and have expanded the integration of their gross domestic product (GDP) into the European economy. The EU's share in Turkey's foreign trade has risen by over 50% in the first decades of the 2000s. Developing countries in Europe have received more cash inflows than those in both Latin America and Asia. Net capital inflows are at least 5% above the regional GDP and have exceeded their GDP by 10% in 2007 (Berglöf et al., 2009).

However, the fall of Lehman Brothers in 2008 sparked the global financial crisis, and cash flows to Eastern Europe abruptly ceased. Risk premiums of emerging market peaked, and all the indicators regarding exports and net foreign direct investments (FDI) turned negative. The countries that suffered the most were the small countries outside the Eurozone, especially the Baltic states. Fortunately, the quantitative easing (QE) policy of the Fed and the ECB measures implemented just after the crisis had a significant impact on the economies of emerging markets, including those in Eastern Europe. Along with the recovery in international financial markets, regional economic indicators started to rise in March 2009. The decline in industrial production slowed down or reversed in the majority of these countries. However, the effects of financial and real shocks were felt for a while in the corporate, household, and banking sectors, exacerbating the unemployment problems, corporate disputes, and nonperforming debts. Afterwards, the Fed's tapering policy was initiated in May 2013 to decrease liquidity in the market, leading to a concomitant rebalancing of global portfolios away from emerging market assets, resulting in capital outflows and currency depreciation in several large emerging countries. However, this policy did not adversely affect most of the countries in Eastern Europe; only Turkey experienced significant cash outflows due to weak macroeconomic indicators (Mishra et al., 2014).

## 3. Data and methodology

Our sample includes 1514 non-financial firms from 12 Eastern European countries including Turkey, which have unique characteristics in terms of their cash inflow and outflows. Following prior literature (e.g., Berglöf et al., 2009), we divide our sample period into two sub-periods: pre-crisis (2003−2007) and post-crisis (2010−2016). Our final sample includes 555 non-financial firms from Poland, 369 from Turkey, 161 from Bulgaria, 110 from Romania, 99 from Croatia, 47 from Hungary, 44 from Slovenia, 33 from the Czech Republic, 30 from Latvia, 27 from Lithuania, 27 from Slovakia, and 12 in Estonia. We obtain all firm-specific data from DataStream. To ensure data continuity and have a balanced panel data set: we exclude the firms from our final sample if there are missing data in any of the study variables. To eliminate the impact of extreme values on our results, we winsorize the firm-specific continuous variables at 1% and 99% levels.

The dependent variable of our models is the year-end cash ratio of the firms (CASH), which is defined as the ratio of cash and equivalents to total assets. We present the distribution of CASH over the sample period in Fig. 1. The average cash ratio is 6% in 2003, falling to the lowest level in 2008 at 3.11% and starting to increase after 2011. The highest cash ratio is observed in 2015 at 7.22%.

Untabulated statistics indicate that the average cash ratio is observed as 4.54% in Turkey, 4.96% in Poland and 4.66% in Bulgaria, which is quite lower than the statistics reported in prior studies. Al-Najjar (2013) reports 2.2%, 4.8%, 3.3%, 3.4% and 10.1 for Brazil, Russia, India and China, respectively. Regarding the cash ratios of Eastern European firms, Yildiz and Karan (2020) report 5.9% for oil and gas firms, which is much lower than the firms in other regions. These differences may originate from the differences in sample periods or different specifications of the cash ratio.

As determinants of corporate cash holdings, we include several firm and country-specific variables into our model, which are defined in Table 1.

The explanatory variables included into our model are as follows:

### 3.1. Research and development expenditures (RD)

Prior literature suggests that firms with high R&D expenditures are expected to hold more cash (Bates et al., 2009; Chen, 2008). According to the trade-off theory, companies with significant R&D expenditures hold an excessive amount of cash to manage risks associated with the R&D investments (Bates et al., 2009). Emphasizing the highly uncertain nature of R&D investments, Bates et al. (2009) assert that R&D intensive firms hoard cash to guard against possible shocks to their future cash flows. However, several studies in the literature provide evidence of an insignificant relationship between R&D spending and cash holdings, making the relationship between R&D investments and cash holdings ambiguous (Harford et al., 2008). Importantly, Brown and Petersen (2011) demonstrate that firms use cash reserves to smooth their R&D investments to decrease the volatility in R&D spending. As a similar argument, Brown and Petersen (2015) reveal that firms
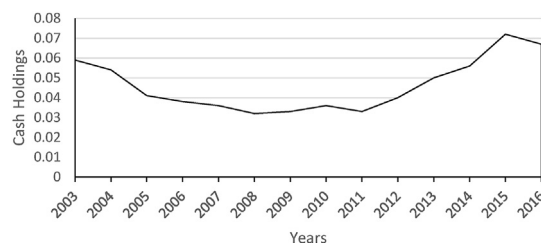


Fig. 1. Corporate cash holdings of Eastern European firms.

Table 1
Variables' definitions.

| | |
|---|---|
| Cash (CASH) | Cash and equivalents/Total assets |
| Research & Development (RD) | Dummy variable equals to 1 if firm invest in R&D and 0, otherwise |
| Growth opportunities (GRW) | Market value of equity/Book value of equity |
| Capital expenditures (CAPEX) | Capital expenditures/Total assets |
| Firm size (SIZE) | Natural logarithm of total assets in Euros |
| Leverage (LEV) | Total liabilities/Total assets |
| Dividend (DIV) | Cash dividends paid/Total assets |
| Debt maturity (MAT) | Short-term liabilities/Total liabilities |
| Cash flow (CF) | EBIT/Total assets |
| Cash flow volatility (CFV) | Standard deviation of cash flows (CF) for previous three years |
| Net working capital (NWC) | (Current assets − cash − current liabilities)/(total assets− cash) |
| Return on assets (%) (ROA) | Net income before extraordinary items/Total assets |
| Inflation (CPI) | Consumer price index |
| Domestic credit (DCR) | Domestic credit provided by the financial sector as a percentage of GDP |
| GDP growth (GDP) | Growth rate in GDP |
| Rule of law index (LAW) | Worldwide Governance Indicators (WGI) (Rule of Law Index) |
| Total market value (TMV) | Total market capitalization of listed firms/GDP |

This table presents the definitions of the variables used in this paper.

use their cash reserves to buffer their R&D investments during the financial crisis.

## 3.2. Growth opportunities (GRW)

Firms with high growth opportunities are generally argued to hold more cash to exploit value-enhancing investment opportunities (Al-Najjar & Belghitar, 2011; Ferreira & Vilela, 2004; Bigelli & Sánchez-Vidal, 2012). They are prudent in their cash holdings since they are more likely than other firms to experience a cash shortage and want to reduce the risk of financial distress by holding more cash (Harford et al., 2008; Ozkan & Ozkan, 2004). Moreover, it is also argued that firms with greater growth opportunities have higher bankruptcy costs (Ozkan & Ozkan, 2004). This means that firms with greater growth opportunities are more likely to accumulate cash to avoid bankruptcy. The trade-off theory and the pecking order theory both predict a positive relationship between growth opportunities and cash holdings. However, the free cash flow theory claims that a company with limited growth opportunities wants to exploit potential investments even if the net present values of these investments are negative. Therefore, firms with limited growth opportunities hold more cash according to the free cash flow theory. Another line of research investigates the investment decisions of firms in times of crisis. For example, Campello et al. (2010) find that financially constrained firms deploy their cash reserves to finance their operations. Importantly, their results reveal that financially constrained firms bypass valuable investment opportunities due to their limited access to external financing during the global financial crisis.

## 3.3. Capital expenditures (CAPEX)

The relationship between capital expenditures and cash holdings is not clear cut. For example, Opler et al. (1999) note a positive relationship between investments in fixed assets and cash holdings. However, Kim et al. (1998) report a negative relationship between capital expenditures and cash holdings. According to the pecking order theory, firms with higher capital expenditures have more debt; thus, they reduce their cash holdings given that cash is considered as negative debt (Dittmar et al., 2003).

## 3.4. Firm size (SIZE)

Prior studies suggest that firm size is an important determinant of cash holdings. Small firms are often suggested to have higher information asymmetries than large ones are (Al-Najjar & Belghitar, 2011). Therefore, smaller firms face higher costs of external financing, which motivate them to hold more cash. To avoid financial distress, smaller firms are expected to hold more cash than larger firms are, which implies a negative relationship between firm size and cash holdings. However, it is also argued that managers in large firms have higher financial flexibility in their financing and investment decisions, which motivates them to hold more cash (Al-Najjar, 2013).

## 3.5. Leverage (LEV)

Ozkan and Ozkan (2004) and Chen (2008) show that leverage is a substitute for cash, and holding excess cash costs higher than debt has. Therefore, financially healthy firms with greater investment opportunities need more capital than their cumulative profit, which motivates them to hold more cash. This implies a negative relationship between leverage and cash holdings (Al-Najjar & Belghitar, 2011; Opler et al., 1999). On the other hand, higher bankruptcy costs associated with high debt levels may motivate firms to hold more cash to avoid financial distress, which implies a positive relationship between leverage and cash holdings (Yildiz & Karan, 2020).

## 3.6. Dividend payout (DIV)

Opler et al. (1999) and Ferreira and Vilela (2004) find an inverse relationship of dividend payment to cash holdings, which supports trade-off theory. It can be argued that firms which regularly pay dividends can finance their operations by

cutting dividend payments when they face cash shortages. However, due to signaling effect of dividend payments, firms prefer to continue making payouts unless they face a severe financial crisis (Harford et al., 2008). In such a scenario, firms with higher dividend payments may hold more cash to support their payments, implying a positive relationship between dividends and cash holdings.

### 3.7. Debt maturity (MAT)

Short-term bank debts can be used by firms as a substitute for cash which suggests a negative relationship between debt maturity and cash holdings (Ferreira & Vilela, 2004; Ozkan & Ozkan, 2004). On the other hand, firms with a higher proportion of short-term debt may face financial difficulties as the repayment date of the debt approaches, which may motivate them to hold higher cash balances (García-Teruel & Martínez-Solano, 2008).

### 3.8. Cash flow (CF)

According to the trade-off theory, firms with higher levels of cash flows do not need to hold more cash because they can easily satisfy cash requirements with their current cash flows (Kim et al., 1998). However, pecking order theory claims that if the cash flow levels of the firms exceed their need, excess cash is maintained for either precautionary purposes or future investment, which implies a positive relationship between cash flows and cash holdings (Almeida et al., 2004; Kalcheva & Lins, 2007; Kim et al., 1998; Opler et al., 1999).

### 3.9. Cash flow volatility (CFV)

Firms with volatile cash flows are more likely to need more cash because of the lower predictability of their future cash flows (Ozkan & Ozkan, 2004; Pereira Alves & Morais, 2018). Therefore, firms with higher variability or uncertainty in their cash flows are expected to hold more cash (Al-Najjar, 2013; Guney et al., 2007; Opler et al., 1999). Contrary to expectations, Ferreira and Vilela (2004) observe a negative relationship between cash flow volatility and cash holdings. They suggest that firms with volatile cash flows have a higher cost of capital and that they are less likely to hold cash for precautionary purposes since the cost of holding cash is higher for them.

### 3.10. Net working capital (NWC)

Trade-off theory predicts a negative relationship between net working capital and cash holdings. Firms with more liquid assets hold less cash due to the substitute nature of other current assets (Almeida et al., 2004; Kalcheva & Lins, 2007; Kim et al., 1998; Opler et al., 1999). Supporting trade-off theory, the majority of the studies in the literature indicate a negative relationship between NWC and cash holdings (Chen, 2008; García-Teruel & Martínez-Solano, 2008; Ozkan & Ozkan, 2004).

### 3.11. Return on assets (ROA)

Similar to the arguments of the relationship between cash flow and cash holdings, profitable firms may maintain more cash that is available for future investments. On the other hand, profits can also be considered a substitute for accumulated cash in financing decisions, which implies a negative relationship between profitability and cash holdings.

### 3.12. Inflation rate (CPI)

The relationship between inflation rate and cash holdings is not clear cut. On one hand, firms are expected to increase their cash level as inflation rises to avoid costly external financing in the future (Graham et al., 2015). On the other, they may tend to buy raw materials as early as possible to avoid being affected by a spike in input prices. This implies a negative relationship between inflation rate and cash holdings (Wang et al., 2014).

### 3.13. Domestic credit (DCR)

High levels of domestic credit indicate a high degree of development in banking and financial services (Levine et al., 2000). The private sector can easily access bank credit at a lower cost, so the likelihood of debt as a cash substitute increases, implying a negative relationship between domestic credits and cash holdings (Pereira Alves & Morais, 2018). However, prior evidence in the literature does not always support this argument. For example, Ferreira and Vilela (2004) find a positive but tenuous relationship between the degree of development in the lending sector and cash holdings.

### 3.14. GDP growth (GDP)

Another important macroeconomic factor expected to impact corporate cash holdings is the GDP growth rate. Graham et al. (2015) find a positive relationship between the GDP growth rate and cash holdings for the US sample.

### 3.15. Rule of law index (LAW)

The rule of law index measures the law performance of countries and jurisdictions in terms of eight primary factors: constraints on government powers, absence of corruption, open government, basic rights, order and security, regulatory enforcement, civil justice, and criminal justice. As the rule of law index increases, firms are expected to hold less cash due to lower liquidity risk (La Porta et al., 1998).

### 3.16. Total market value (TMV)

The total market value of the stock exchanges in relation to GDP is an essential indicator of stock market development (La Porta et al., 1998). Accordingly, as stock markets develop, the number of and access to resources increase, indicating a

Table 2
Summary statistics.

|  | Mean | Median | Std. dev. | Min | Max |
|---|---|---|---|---|---|
| CASH | 0.039 | 0.014 | 0.065 | 0.000 | 0.426 |
| RD | 0.077 | 0.000 | 0.266 | 0.000 | 1.000 |
| GRW | 1.777 | 1.040 | 2.910 | −3.560 | 25.710 |
| CAPEX | 0.052 | 0.032 | 0.063 | 0.000 | 0.362 |
| SIZE | 4.693 | 4.712 | 0.715 | 2.347 | 6.472 |
| LEV | 0.214 | 0.178 | 0.187 | 0.000 | 0.943 |
| DIV | 0.011 | 0.000 | 0.031 | 0.000 | 0.252 |
| MAT | 0.585 | 0.587 | 0.331 | 0.000 | 1.000 |
| CF | 0.076 | 0.082 | 0.131 | −0.621 | 0.468 |
| CFV | 0.070 | 0.036 | 0.121 | 0.000 | 0.948 |
| NWC | 0.073 | 0.090 | 0.287 | −1.405 | 0.797 |
| ROA | 1.018 | 0.903 | 0.716 | 0.000 | 4.238 |
| CPI | 0.031 | 0.029 | 0.031 | −0.017 | 0.127 |
| DCR | 0.625 | 0.641 | 0.153 | 0.002 | 1.035 |
| GDP | 0.032 | 0.035 | 0.032 | −0.147 | 0.108 |
| LAW | 0.479 | 0.547 | 0.351 | −0.118 | 1.199 |
| TMV | 0.298 | 0.294 | 0.145 | 0.037 | 1.169 |

Variables' definitions are provided in Table 1.

negative relationship between stock market development and cash holdings (Pereira Alves & Morais, 2018).

Descriptive statistics of the variables used in this study are reported in Table 2. The mean value of CASH is approximately 3.9% with a maximum value of 42.6%.

Our study is conducted in two stages. The first stage regresses firm-and country-specific variables on CASH using a panel data methodology (Equation (1)). In addition to the explanatory variables, we also include firm and year dummies into our model to control for unobservable firm and year fixed effects.[2] To observe the impact of the global financial crisis on cash holdings, the sample period is divided into sub-samples for the pre-crisis and post-crisis periods. In the second stage, the generalized method of moments (GMM) approach is employed to investigate the adjustment speed towards target cash balances (Blundell & Bond, 1998). Another advantage of using the GMM model is to address the endogeneity issue by instrumenting the endogenous variables with their past realizations.

Our main panel regression model is as follows:

$$
\begin{aligned}
CASH_{it} = {} & \alpha + \beta_1\,RD_{it} + \beta_2\,GRW_{it} + \beta_3\,CAPEX_{it} \\
& + \beta_4\,SIZE_{it} + \beta_5\,LEV_{it} + \beta_6\,DIV_{it} + \beta_7\,MAT_{it} \\
& + \beta_8\,CF_{it} + \beta_9\,CFV_{it} + \beta_{10}\,NWC_{it} + \beta_{11}\,ROA_{it} \\
& + \beta_{12}\,CPI_{it} + \beta_{13}\,DCR_{it} + \beta_{14}\,GDP_{it} + \beta_{15}\,LAW_{it} \\
& + \beta_{16}\,TMV_{it} + \varepsilon_{it}
\end{aligned}
\tag{1}
$$

As discussed in the literature review, the trade-off theory claims that holding cash has marginal benefits and costs. Therefore, target cash holdings are partially adjusted because of transaction or adjustment costs (Myers & Majluf, 1984;

Ozkan & Ozkan, 2004). We include a one year lagged value of the dependent variable (CASH $_{t-1}$) into our model to account for the dynamic process. We treat all explanatory variables as endogenous and use their past realizations as instruments. Our GMM model is specified as follows:

$$
\begin{aligned}
CASH_{it} = {} & \delta\,CASH_{it-1} + \beta_1\,RD_{it} + \beta_2\,GRW_{it} + \beta_3\,CAPEX_{it} \\
& + \beta_4\,SIZE_{it} + \beta_5\,LV_{it} + \beta_6\,DIV_{it} + \beta_7\,MAT_{it} \\
& + \beta_8\,CF_{it} + \beta_9\,CFV_{it} + \beta_{10}\,NWC_{it} + \beta_{11}\,ROA_{it} \\
& + \beta_{12}\,CPI_{it} + \beta_{13}\,DCR_{it} + \beta_{14}\,GDP_{it} + \beta_{15}\,LAW_{it} \\
& + \beta_{16}\,TMV_{it} + \varepsilon_{it}
\end{aligned}
\tag{2}
$$

## 4. Main regression results

Before moving on to panel regression analysis, we conduct Fisher generalized Dickey-Fuller (ADF) to test the stationary of our data. The unit-root test results indicate that the majority of the variables are significant at the 1% level (p = 0.000). Only DCR is not significant at conventional levels based on the generalized Dickey-Fuller test. Therefore, we retest the first difference of this variable and obtain a significant value at the 1% level (p = 0.000).[3] Regarding the correlation coefficients among independent variables, we do not observe any coefficient greater than 0.5. Moreover, The Variance Inflation Factor (VIF) values are below 4, confirming the absence of a multicollinearity problem in our model.

According to the trade-off theory, companies with high R&D expenditures are more likely to hold excess cash as a precautionary motive, implying a positive impact on cash levels. However, we find that the coefficient of RD is negative in all of our specifications for the full sample period (Table 3 Column 1−2). In other words, firms with higher R&D expenditures tend to hold more cash than firms with no R&D spending, which contradicts our predictions. However, the impact of RD on cash holdings is significantly different between sub-periods. Specifically, it is only significant for the post-crisis period. To support their R&D investments, firms in Eastern European countries use their accumulated cash, particularly in the post-crisis period. The reason for this can be relatively low and unstable capital flows to these countries, which force firms to tap alternative financing channels such as cash holdings. As previously discussed, firms may prefer to use their cash reserves to smooth their R&D spending, particularly when the cash flows are less stable (Brown & Petersen, 2011, 2015). Apart from this, investments may share an endogenous relationship with and cash holdings, which can also cause a negative relationship between R&D spending and cash holdings. We address this issue by using GMM estimation, which will be discussed in the next section.

The coefficient of SIZE is surprisingly positive and significant for the full sample period, which implies that larger

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[2] We conduct Lagrange multiplier test on the model's estimates to decide on model specification. The test result indicates that the chi-square statistic is 622. 15, and the *p*-value is 0.000, which implies that fixed effect estimation is more appropriate.

[3] Our results do not change when we use first-differenced form of DCR in our estimations.

Table 3
Determinants of cash holdings.

| | (1) Full sample | (2) Full sample | (3) Pre-crisis (2003−2007) | (4) Post-crisis (2010−2016) |
|---|---|---|---|---|
| RD | −0.016[c] | −0.016[c] | 0.004 | −0.012[a] |
| | (0.005) | (0.005) | (0.008) | (0.007) |
| GRW | 0.000 | 0.000 | 0.001 | −0.000 |
| | (0.000) | (0.000) | (0.001) | (0.000) |
| CAPEX | −0.013 | −0.013 | −0.034 | 0.002 |
| | (0.013) | (0.013) | (0.027) | (0.019) |
| SIZE | 0.008[b] | 0.007[b] | 0.008 | 0.019[c] |
| | (0.004) | (0.004) | (0.010) | (0.006) |
| LEV | −0.060[c] | −0.059[c] | −0.061[c] | −0.061[c] |
| | (0.006) | (0.006) | (0.014) | (0.009) |
| DIV | 0.057[b] | 0.058[b] | −0.041 | 0.163[c] |
| | (0.029) | (0.029) | (0.055) | (0.042) |
| MAT | −0.005[b] | −0.006[b] | 0.001 | −0.014[c] |
| | (0.003) | (0.003) | (0.006) | (0.004) |
| CF | 0.035[c] | 0.035[c] | 0.056[c] | 0.021[b] |
| | (0.007) | (0.007) | (0.016) | (0.009) |
| CFV | 0.007 | 0.007 | 0.035 | 0.003 |
| | (0.007) | (0.007) | (0.022) | (0.010) |
| NWC | −0.040[c] | −0.040[c] | −0.028[c] | −0.053[c] |
| | (0.004) | (0.004) | (0.009) | (0.005) |
| ROA | 0.003 | 0.003 | −0.003 | 0.012[c] |
| | (0.002) | (0.002) | (0.006) | (0.003) |
| CPI | | 0.033 | 0.121 | −0.177 |
| | | (0.052) | (0.114) | (0.153) |
| DCR | | 0.015 | 0.004 | 0.008 |
| | | (0.014) | (0.028) | (0.026) |
| GDP | | 0.041 | 0.338[c] | −0.021 |
| | | (0.039) | (0.119) | (0.129) |
| LAW | | −0.007 | 0.027 | −0.018 |
| | | (0.011) | (0.050) | (0.021) |
| TMV | | 0.010 | 0.027 | 0.008 |
| | | (0.010) | (0.017) | (0.032) |
| Constant | 0.036[b] | 0.030[a] | −0.009 | −0.040 |
| | (0.017) | (0.018) | (0.052) | (0.037) |
| Firm-fixed | Yes | Yes | Yes | Yes |
| Year-fixed | Yes | Yes | Yes | Yes |
| N | 6440 | 6440 | 1784 | 3559 |
| Within R$^2$ | 0.071 | 0.072 | 0.102 | 0.095 |

Variables' definitions are given in Table 1.
[a] Denote significance levels at 10%, respectively.
[b] Denote significance levels at 5%, respectively.
[c] Denote significance levels at 1%, respectively.

firms in Eastern European countries have higher cash balances. Due to higher information asymmetries and financial distress, smaller firms are expected to hold more cash than larger firms do. However, the positive coefficient of SIZE implies that due to highly diversified nature of large firms, they are more likely to hold cash to finance their operations. This result agrees with the findings of Al-Najjar (2013). Regarding the sub-sample analysis, the positive impact of firm size on cash holdings is evidently only significant for the post-crisis period. Arguably, the need for large balances increased for the larger firms after the global financial crisis.

Negative coefficients of LEV in Table 3 Columns 1−2 mean that firms with higher debt levels hold less cash. As discussed in the previous section, the prior literature argues

that cash levels decrease with the higher levels of debt (Baskin, 1987). Additionally, Ferreira and Vilela (2004) also suggest that firms with higher levels of debt hold less cash due to greater monitoring of financial institutions. This result also supports the findings of earlier studies, which base their sample on emerging markets (e.g., Al-Najjar, 2013). Importantly, the coefficients and significance levels of LEV are almost identical in both pre- and post-crisis periods, suggesting that the global financial crisis does not alter the significance of leverage in determining the cash holdings.

As another important determinant of cash holdings, dividend payments (DIV) positively impact cash holdings for the full sample period. Arguably, dividend-paying firms hold more cash to support their dividend payments to avoid any cash shortage (Ozkan & Ozkan, 2004). However, similar to RD and SIZE, DIV is only significant for the post-crisis period. implying that the need for hoarding cash to support regular dividend payments gained significance only after the global financial crisis.

Debt maturity (MAT) significantly negatively impacts cash holdings, which means that firms with higher short-term debt relative to total debt hold more cash, which is surprising and also contrary to our predictions. Given that short-term borrowing can also be used as a proxy for information asymmetries, expecting a positive relationship between debt maturity and cash holdings is reasonable. One explanation for the negative relationship between debt maturity and cash holdings is that firms use their cash holdings to repay the short-term debt, resulting in a negative relationship between MAT and cash holdings. However, this negative relationship is observed only after the global financial crisis.

The positive coefficient of CF suggests that firms having higher cash flows hold more cash, which supports the view that firms prefer using internal funds to external funds. Moreover, cash flows can also serve as a proxy for growth opportunities, and a positive coefficient indicates that firms with higher growth opportunities tend to hold more cash to invest in potential value-enhancing projects (Ozkan & Ozkan, 2004). It should also be noted that CF is positive and significant in both pre- and post-crisis periods, suggesting that Eastern European firms' cash positions are significantly sensitive to their cash flows in both periods.

Based on the trade-off theory, a negative relationship between liquid assets and cash holdings is expected. Firms can use their liquid assets to substitute for cash and cash equivalents. The results reported in Table 3 support our predictions. The coefficient of NWC is consistently positive for the full sample period and also for our sub-periods.

The relationship between ROA and cash holdings is insignificant for the full sample period. However, it turns out to be significantly positive for the post-crisis period, supporting the predictions of the pecking order theory. According to the financing hierarchy view, profitable firms have the flexibility to pay their debt or dividends and stockpile cash, which suggests a positive relationship between profitability and cash

Table 4
Endogeneity and GMM estimations.

| | (1) Full sample | (2) Full sample | (3) Pre-crisis (2003–2007) | (4) Post-crisis (2010–2016) |
|---|---|---|---|---|
| $CASH_{t-1}$ | 0.442[c] | 0.464[c] | 0.473[c] | 0.501[c] |
| | (0.038) | (0.035) | (0.077) | (0.042) |
| RD | −0.002 | −0.002 | −0.010 | −0.001 |
| | (0.007) | (0.007) | (0.015) | (0.013) |
| GRW | 0.001[b] | 0.001[b] | 0.001 | 0.001 |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| CAPEX | −0.022 | −0.022 | −0.052 | 0.006 |
| | (0.020) | (0.020) | (0.040) | (0.032) |
| SIZE | 0.001 | −0.004 | 0.001 | −0.005 |
| | (0.003) | (0.003) | (0.006) | (0.005) |
| LEV | −0.062[c] | −0.059[c] | −0.042 | −0.073[c] |
| | (0.013) | (0.012) | (0.029) | (0.017) |
| DIV | 0.152[b] | 0.154[b] | 0.014 | 0.230[a] |
| | (0.074) | (0.071) | (0.092) | (0.128) |
| MAT | −0.016[c] | −0.018[c] | −0.009 | −0.031[c] |
| | (0.006) | (0.005) | (0.016) | (0.007) |
| CF | 0.021[a] | 0.023[a] | 0.094[b] | 0.002 |
| | (0.013) | (0.013) | (0.040) | (0.012) |
| CFV | −0.009 | −0.012 | −0.006 | −0.017 |
| | (0.014) | (0.014) | (0.034) | (0.017) |
| NWC | −0.049[c] | −0.047[c] | −0.050[c] | −0.052[c] |
| | (0.011) | (0.010) | (0.018) | (0.013) |
| ROA | 0.004 | 0.005* | 0.002 | 0.005 |
| | (0.003) | (0.003) | (0.006) | (0.004) |
| CPI | | −0.023 | 0.025 | −0.123 |
| | | (0.047) | (0.125) | (0.091) |
| DCR | | 0.003 | −0.015 | −0.008 |
| | | (0.011) | (0.047) | (0.013) |
| GDP | | 0.028 | 0.143 | 0.002 |
| | | (0.036) | (0.109) | (0.051) |
| LAW | | −0.001 | 0.007 | 0.000 |
| | | (0.004) | (0.013) | (0.005) |
| TMV | | 0.009 | 0.016 | 0.001 |
| | | (0.007) | (0.018) | (0.012) |
| Year-fixed | Yes | Yes | Yes | Yes |
| N | 5140 | 5140 | 1089 | 3086 |
| AR(1) p-value | 0.000 | 0.000 | 0.000 | 0.000 |
| AR(2) p-value | 0.497 | 0.455 | 0.225 | 0.243 |
| Hansen p-value | 0.154 | 0.234 | 0.055 | 0.367 |

Variables' definitions are given in Table 1.
[a] Denote significance levels at 10%, respectively.
[b] Denote significance levels at 5%, respectively.
[c] Denote significance levels at 1%, respectively.

levels (Al-Najjar, 2013). Positive and significant coefficient of ROA for the post-crisis period denotes that firms' cash holding decisions become more sensitive to their profits after the global financial crisis.

Growth opportunities (GRW), capital expenditures (CAPEX) and cash flow volatility (CFV) do not significantly explain the cash holding decisions of Eastern European firms probably due to the different institutional setting and macroeconomic conditions of these countries. Finally, we do not find any significant relationship between macroeconomic factors and cash holding policies for our full sample period as well as for sub-periods. The only exception is GDP, which positively impacts cash holdings only for the pre-crisis period.

## 5. Endogeneity and GMM estimations

The use of static models in studies on cash holdings is based on the assumption that firms are able to alter their cash positions immediately due to changes in their financial positions or macroeconomic shocks (Ozkan & Ozkan, 2004). However, it is unreasonable to assume that firms instantly adjust their cash positions without incurring any adjustment costs. In other words, firms partially adjust their current cash levels towards their target cash position due to transaction costs (Myers & Majluf, 1984).

One way to address this partial adjustment process is to include a one year lagged dependent variable ($CASH_{t-1}$) into the model (Equation (2)). Although dynamic models are widely used in the literature, they involve several estimation problems such as endogeneity of lagged dependent variable by construction. Following prior literature, (e.g., Martínez-Sola et al., 2013; Ozkan & Ozkan, 2004) we estimate using the system-GMM model, which allows us to address the endogeneity of the lagged dependent variable by instrumenting it with its past realizations. In our GMM model, in addition to lagged CASH ($CASH_{t-1}$), we treat all other covariates as endogenous and use their second-order lags as instruments. However, to achieve consistent estimates of parameters, instruments should satisfy validity conditions such as the absence of second order correlation and over-identification, depending on the choice of instruments. Therefore, we report both first- and second-order autocorrelation tests. We also report the significance level of the Hansen test used for testing over-identifying restrictions with a null hypothesis of validity of instruments. Test statistics reported in Table 4 suggest that all of our GMM models satisfy the absence of second-order correlation, which is evident by insignificant AR (2) value. Moreover, three out of our four models satisfy over-identifying restrictions (Hansen test), which indicates that the instruments are not correlated with the error terms. Only for the estimation for the pre-crisis period is the Hansen value significant at a 10% level.

The results in Table 4 reveal that the coefficient of $CASH_{t-1}$ is positive and significant in all of our models. Considering the results for the full sample period, the coefficients of $CASH_{t-1}$ are 0.442 and 0.464, which indicate that the adjustment speed to target cash position for Eastern European firms is approximately 55% ($1-\delta$). This result is similar to those of Venkiteshwaran (2011), suggesting that US firms approximately closes the gap between target and actual cash levels within two years. However, adjustment speeds for the post-crisis period (50%) are lower than those of the pre-crisis period (53%), which implies that the cost of adjusting to the target level for Eastern European firms increased after the global financial crisis. Eastern European firms significantly depend on other countries in terms of capital flows.

The results of GMM estimation suggest that the coefficients and significance levels of the majority of independent variables are similar to the results obtained from static fixed effects regression. Specifically, the coefficients of LEV, DIV,

MAT and NWC are quite similar to those of fixed effects estimations. However, RD and SIZE turn out to be insignificant in our GMM setting. Additionally, the coefficients of CF and ROA also become insignificant when we treat them as endogenous. Finally, none of the macroeconomic variables significantly explains the cash holding decisions of Eastern European firms, supporting our previous results. Overall, these results suggest that the global financial crisis not only affected the determinants of cash holdings but also changed the adjustment dynamics towards attaining target cash levels.

## 6. Discussion and conclusion

This study investigates the firm-specific and macroeconomic determinants of cash holdings of 1514 firms from East European countries including Turkey from 2003 to 2016. Additionally, we reveal the target adjustment process of cash holdings using dynamic GMM estimations. To unravel the impact of the global financial crisis on the determinants of cash holdings and target adjustment behavior, we split our sample period into pre-crisis and post-crisis periods and re-employed our panel fixed and GMM estimations for the sub-periods.

Our results show that firm size, leverage, dividend policies, debt maturity, net working capital and cash flows are the main determinants of cash holdings. We do not find any significance of macroeconomic variables in explaining corporate cash holdings. These results generally align with the results of prior studies. However, it is also evident that the impact of these firm-specific variables significantly differs for pre- and post-crisis periods. More specifically, the majority of these variables such as firm size, dividend policies, debt maturity and profitability are only significant for the post-crisis period. On the other hand, leverage, net working capital and cash flows are significant at conventional levels for both pre- and post-crisis periods.

In the second stage of the study, we investigate the speed of adjustment towards the target cash level using a dynamic GMM estimation. Our results reveal that adjustment speed to the target cash position is 55% in our full sample period. However, it is lower for the post-crisis period (50%) than the pre-crisis period (53%). This result shows that the time for firms to reach their optimal cash level increased significantly after the crisis period.

Overall, the findings of this study indicate that determinants of cash holdings of East European firms are generally consistent with previous research and existing hypotheses. However, it would be misleading to conclude without considering the impact of the global financial crisis on the determinants of cash holdings and also adjustment towards target cash levels. Our findings provide an understanding of how global financial crises have affected cash holding policies of the corporations located in countries experiencing significant liquidity problems.

Our paper is not without limitations. First, we rely on the available data, which is obtained from databases. Second, we are unable to differentiate the sources of cash as internal or external due to data unavailability. It would be important and interesting to identify the sources of cash in further studies and to investigate how other corporate decisions of Eastern European firms have been affected by the global financial crisis. This awaits further research.

## Declaration of competing interest

The authors declare that there is no conflict of interest.

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