Corporate Cash Holdings and Financial Crisis: An empirical investigation of Portuguese listed companies

Augusto Rafael dos Santos Borges[1]
e Jorge Bento Ribeiro Barbosa Farinha[2]

Abstract

Why do firms hold so many liquid assets on their balance sheets? The amount of a firm's liquidity depends on its treasury management policy. The finance literature highlights three theoretical models that explain how the companies' characteristics influence the levels of cash, which are the *trade-off, pecking order* and *free cash flow* theories. This paper tests, in the Portuguese context, the predictions resulting from several factors that are suggested by the above mentioned theories. We find that firm's growth opportunities, leverage and dividend payments have a positive impact on cash holdings. Additionally, longer debt maturity and the level of cash flow generated by the firm exert a negative effect. We conclude that the *trade-off* theory best explains the evolution of the liquidity of listed companies in Portugal. We also find that governance characteristics play a relevant role concerning the levels of cash. Moreover, we find that the 2008 financial crisis impacted on the firms' cash holdings and their determinants. In particular, growth opportunities cease to be a significant determinant of cash holdings in a post-crisis period, while the negative effect of the level of cash flow generated by the firm increases its significance in the post-crisis period.

Key-words: Cash holdings; *Trade-off* theory; *Pecking order* theory; *Free cash flow* theory; Corporate governance; Financial crisis of 2008
JEL Classification: G3, G32, G39

1. Introduction

In late 2000 the amount of cash or cash equivalents held by corporations in the European Monetary Union (EMU) amounted to 14.8% of their total book value of assets (Ferreira and Vilela, 2004). More recently, and regarding the U.S. market, in the year 2006 the average cash-to-assets ratio held by firms amounted to around 23% (Bates *et al.*, 2009). There are four broadly accepted motives for cash holdings: transaction, precautionary, the agency and tax motives (Keynes, 1936; Jensen, 1986; Foley *et al.*, 2007). The finance literature also identifies three theoretical models that can help to explain which firm characteristics influence cash holdings decisions. The *trade-off* theory suggests that firms identify an optimal level of cash holdings by weighing its costs and benefits (Ferreira and Vilela, 2004). Then, the *pecking order* theory (Myers, 1984) introduces the importance of asymmetric information. In order to minimise it, firms should finance their investments internally. Lastly, the *free cash flow* theory (Jensen, 1986) suggests that managers have incentives to accumulate large amounts of cash, in order to reduce pressure to improve their performance.

In this research, we examine the empirical characteristics of cash holdings, by testing factors that have been proposed by previous authors. The research sample is composed by 43 firms and comprises data over the period between 1995 and 2015. Considering the absence of

1- Faculdade de Economia, Universidade do Porto. E-mail address: rafael_borgesg@hotmail.com

2- Faculdade de Economia, Universidade do Porto and CEF-UP – Center for Economics and Finance at UP.E-mail address: jfarinha@fep.up.pt

studies examining the determinants of cash holdings of Portuguese listed firms over the period of financial crisis of 2008, which is characterized by a special liquidity crunch, it is also interesting to explore the effect of the financial crisis on the determining factors for cash holdings.

The main findings of our study are the positive and significant association between cash holdings and growth opportunities, leverage and dividend payments, while long debt maturity and cash flow generated by the firms exert a negative effect. Hence, it can be concluded that the *trade-off* theory collects the strongest support. In contrast, the model with least support is the *free cash flow* theory. In addition, we also conclude that governance factors play a significant role concerning cash levels. Moreover, we find that the financial crisis of 2008 influenced the relation between cash levels of Portuguese firms and their determining factors.

The structure of this study will proceed as follows: The second section presents the literature review. The third section presents our hypotheses. In the fourth section, we describe the data and the methodology adopted in the empirical study. Then the fifth section presents the results and its analysis. Finally, in section 6, we discuss the findings and provide suggestions for further research.

2. LITERATURE REVIEW

2.1. Theoretical Motives for Cash Holdings

Founded on the assumption of perfect financial markets, assuming no transaction costs, taxes, asymmetric information and bankruptcy costs, the capital structure does not affect firm value. Thus, there would be no reason to holding liquid assets, and companies' financial decisions would not impact on their value (Modigliani and Miller, 1958; Stiglitz, 1974)[3]. However, there are market imperfections which imply different motives for corporate cash holdings. The theory of demand for money by firms (Keynes, 1936) and the agency theory (Jensen, 1986) clarify why a firm would choose to hold cash.

According to Keynes (1936) there are two major motives for corporate cash holdings: the transaction costs and precautionary motives. The first states that a firm benefits from holding liquid assets because these provide a way to save on transaction costs: (i) the cost of raising external finance; (ii) the cost of liquidating assets. The second highlights the importance of anticipating future necessities and investment opportunities. Thus, precautionary cash holdings seek to self-insure against costly or unavailable external finance and provide financing in case of investment opportunities. The agency theory (Jensen, 1986) also offers another possible explanation for firms' cash holdings. In scenario of agency conflicts, such as asymmetric information or incomplete contracts, managers tend to accumulate cash in order to proceed with their strategies[4].

A fourth reason for holding liquidity is connected with a tax system argument. Multinational companies may collect cash in foreign subsidiaries to avoid the repatriation tax expense they would suffer if they were to repatriate the profits earned in foreign jurisdictions (Foley *et al.*, 2007).

3- The Modigliani and Miller theorem suggests that the value of an unleveraged firm is equals the value of a leverage firm (Modigliani and Miller, 1958).

4- Dittmar *et al.* (2003) emphasize the importance of the agency problems as a determining factor that influences cash holdings. Dittmar and Mahrt-Smith (2007) highlight the effect of governance on the value of excess cash, as they find that *"the value of a dollar of cash is substantially less if a firm has poor corporate governance"* (Dittmar and Mahrt-Smith, 2007, p. 627). In addition, they also find that entrenched managers are more likely to accumulate cash.

2.2. Cash Holdings Theories

The corporate cash holdings determinants are usually explained on the basis of three theories: the *Trade-off*, *Pecking Order* and *Free Cash Flow* Theories. In order to clarify the rationale behind each theory and to easily review the predictions by each one, we summarily present each of these in the following sub-sections.

2.2.1. *Trade-off Theory*

According to the *trade-off* theory, firms tend to establish an optimal cash level where they weigh the cash holdings' benefits and the cash holdings' costs (Opler *et al.*, 1999). Ferreira and Vilela (2004) suggest that the benefits of holding cash include a reduction in the likelihood of financial distress through the fact that cash holdings (i) act as a buffer against unexpected losses, (ii) minimize the costs of raising external funds and (iii) minimize the risks associated with the sale of company's assets in order to maintain the investment policy in case of financial distress. On the other hand, the main cash holding's cost is the opportunity cost associated to the low return of liquid assets. In addition, agency problems between the management team and shareholders may be exacerbated when cash levels are high (Opler *et al.*, 1999). Then, based on the *trade-off* theory, one can derive the expected relation between some firm characteristics and corporate cash holdings as follows:

a) Leverage – leverage can increase the likelihood of financial distress (Ferreira and Vilela, 2004). Thus, we should expect that companies with higher leverage will hold more cash as this acts as an insurance. However, "*to the extent that leverage ratio acts as a proxy for the ability of the firms to issue debt it would be expected that firms with higher leverage (higher ability to raise debt) hold less cash"* (Ferreira and Vilela, 2004, p. 299). Hence, the predicted relationship between cash holdings and leverage is ambiguous.

b) Size – Miller and Orr (1966) show that there are economies of scale associated with the cash levels, thus larger firms can keep lower cash holdings. Furthermore, raising funds is comparatively more expensive for smaller firms than larger firms (Barclay and Smith, 1996; Peterson and Rajan, 2002).

c) Cash flow – cash flow represents an extra source of liquidity for the firm, which can be seen as a cash substitute (Kim, Mauer, & Sherman, 1998). Therefore, a negative relation between cash flow and cash holdings is anticipated.

d) Debt maturity structure – Teruel and Solano (2008) suggest that the distribution of debt maturities between short and long terms can affect decisions regarding cash holdings. Firms that rely on short-term debt must periodically renegotiate their credit terms, and are subject to the risk of experiencing financial distress if constraints are met to the renewal of credit lines.

Thus, a negative relation between debt maturity and cash holdings is expected. However, Barclay and Smith (1995) find that firms with the highest credit risk issue more short-term debt, while intermediate credit risk firm issue long-term debt. If we consider that firms with the highest credit ratings have better access to borrowing, it is expected that these firms will hold less cash, thus the expected relation between debt maturity structure and cash levels is positive. Concluding, the sign of the association between the debt maturity structure and the levels of cash is ambiguous.

4- The CESR has been replaced on 1 January 2011 by the European Securities Market Authority (ESMA) in the role of supra-national securities authority. This interpretation should remain up-to-date pursuant to the MAR given the absence of change implemented by the latter on this subject.

5- CESR, Level 3 – *second set of CESR guidance and information on the common operation of the Directive to the market, ESMA/06-562b, July 2007, No. 1.5.* https://www.esma.europa.eu/sites/default/files/library/2015/11/08_717.pdf

6- VEIL, Rüdiger, in *European Capital Markets Law, pp.145, Hart Publishing, Oregon, 2013.*

e) Liquidity – the existence of liquid assets apart from cash and cash equivalents (e.g. debtors and inventories) could be considered cash substitutes. Therefore, a company with more non-cash liquid assets tends to reduce their cash holdings level (Ozkan and Ozkan, 2004).

f) Growth opportunities – Due to the fact that costly external financing raises the probability of a firm passing on sizeable investment opportunities, firms should hold sufficient liquid assets in order to be able to take advantage of the profitable opportunities (Opler *et al.*, 1999). Thus, firms with many investment opportunities would tend to accumulate larger amounts of cash.

g) Dividend payments – Ferreira and Vilela (2004) suggest that firms that pay dividends can raise funds at a low cost by reducing dividend payments, while firms that do not pay dividends would have to use external funding, which would be more costly. Consequently, we should expect a negative association between dividend payments and cash levels. However markets react negatively to a company's dividend cut announcement (Ghosh and Woolridge, 1988) and managers could accumulate cash in order to avoid a future dividend cut over a distress scenario. Brav et al. (2005) find that the majority of the interviewed executives would rather raise external capital before cutting dividends. Thus, the expected relation between dividend payments and cash levels is positive. Concluding, the sign of the association between the dividend payment and cash holdings is ambiguous.

2.2.2. *Pecking Order Theory*

The *pecking order* theory, proposed by Myers (1984), states that the information asymmetries between managers and shareholders make external financing costly. According to this *pecking order* theory, in a context of asymmetric information there is an optimal hierarchy regarding the firm's financing. To minimize asymmetric information costs and financing costs, firms should finance investments with retained earnings, then debt, and finally with equity. The determinants of cash holdings that are inferred from the pecking order theory are thus the following:

a) Leverage – debt will grow when investment exceeds retained earnings and will decrease when investment is less than retained earnings. Then, cash holdings will decrease when investment is bigger than retained earnings and will increase when the opposite happens (Opler *et al.*, 1999; Ferreira and Vilela, 2004). This relationship between cash, debt and investment suggests that there is a negative relation between cash and leverage.

b) Size – larger firms tend to be more successful, consequently should have higher levels of cash after controlling for investment (Opler, Pinkowitz, Stulz, & Williamson, 1999).

c) Cash flow – firms prefer to fund themselves with internal resources and so firms with larger amounts of cash flow will maintain higher cash levels.

d) Growth opportunities – according to Ferreira and Vilela (2004), in the presence of a huge set of investment opportunities firms require larger amounts of cash, because cash shortfalls would imply that the firms would have to sacrifice profitable growth opportunities. So, the expected relation between growth opportunities and cash holdings is positive[5].

5- The signal prediction is aligned with the *trade-off* theory, however the interpretation is different. The *trade-off* theory is based on transaction cost perspective, and the *pecking order* theory represents the precautionary motive of holding cash.

2.2.3. *Free Cash Flow Theory*

The *free cash flow* theory (Jensen, 1986), suggests that managers have incentives to hold a large amount of cash on a company's balance sheet, which implies a bigger discretionary power regarding company investment decisions[6]. Regarding the *free cash flow* theory, it is therefore important to take into account the following potential determinant factors for cash holdings:

a) *Leverage* – the agency perspective highlights the monitoring role of debt. The management team of a highly leveraged firm is disciplined through debt covenants and requirements that are imposed by creditors. Therefore, managers would have less discretionary power. Hence, the expected relation between leverage and cash holdings is negative (Opler *et al.*, 1999).

b) Size – larger firms tend to have a larger shareholder dispersion, which gives rise to superior managerial discretion due to the free riding problem. Consequently, it is expected that managers of larger firms have more discretionary power over the firm investment and financial policies, which leads to higher cash levels (Ferreira and Vilela, 2004).

c) Growth Opportunities – from an agency perspective, entrenched managers of firms with poor investment opportunities, tend to hold more cash in order to ensure an availability of funds to invest even in negative NPV projects (Ferreira and Vilela, 2004; Drobetz and Grüninger, 2007). Then, according to this perspective the relation between growth opportunities and cash holdings would be negative.

As it turns out, the impact of the firms' characteristics on cash holdings is not a consensual matter among these theories. The following table summarizes the impact of each variable among to the three above mentioned theories.

Table 1: Summary of models predictions

Variable	*Trade-off* Theory	*Pecking Order* Theory	*Free Cash Flow* Theory
Dividend payments	-/+	n.a.	n.a.
Growth opportunities	+	+	-
Liquidity	-	n.a.	n.a.
Leverage	-/+	-	-
Size	-	+	+
Cash flow	-	+	n.a.
Debt maturity	-/+	n.a.	n.a.

The table exhibits the different relations between firm factors and cash holdings across each theory. In the table, a "+" means that the firm factor is positively related to cash holdings. A "-" means a negative relation between the firm factor and cash holdings. A "n.a." means that the model in case does not make any assumptions regarding the variable in question. Source: Ferreira and Vilela (2004).

6- According to Jensen (1986) *"free cash flow is cash flow in excess of that required to fund all projects that have positive net present values when discounted at the relevant cost of capital"* (Jensen, 1986, p. 323).

2.3. Ownership and Board Structure

This section discusses the possible association between governance factors and corporate cash holdings. We focus on the presence of the largest shareholders and on the board structure.

The largest shareholders

One way to control the agency problems between managers and shareholders is to effectively monitor managers. However, an average shareholder might not have strong incentives to monitor managers, as the costs of monitoring are likely to outweigh the benefits (Grossman and Hart, 1988). In contrast, large shareholders, having claims on a large fraction of the firm's cash flows, can monitor managers more effectively. Consequently, in the presence of a large shareholder, managerial discretion is likely to be curbed and agency costs between management and shareholders are expected to be lower (Stiglitz, 1985; Shleifer and Vishny, 1986). This in turn suggests that the cost of external financing would be lower for firms with large shareholders, implying less need to hold substantial cash balances. However, one can also argue that large shareholders might have incentives to increase the amount of funds under their control for reasons of self-interest (Shleifer and Vishny, 1997). This argument would suggest a positive relationship between large shareholders and cash holdings. In order to control for this factor, we incorporate the percentage of the largest two shareholders' voting rights as an independent variable in our empirical analysis.

Board Structure

The literature in finance shows that the board composition can have an impact on the alignment between managers and shareholders' interests. Inside (executive) directors provide firm specific knowledge that assists the board in understanding the detailed aspects of the firm's business. On the opposite, outside (non-executive) directors can contribute with expertise and objectivity that ostensibly mitigates managerial entrenchment of firm resources (Harford *et al.*, 2008). It can be argued that outside directors are appointed to act in the shareholders' interests (Rosenstein and Wyatt, 1997; Mayers et al., 1997). In accordance with this, Harris and Raviv (2008) find that in a high agency costs scenario, outsider-control is optimal. However, Harris and Raviv (2008) also suggest that outside board control may be value -reducing[7].

Regarding the firm's board size, the literature suggests that increased board size has two competing effects: greater monitoring versus more rigid decision-making. Lipton and Lorsch (1992) and Jensen (1993) defend that board size affects corporate governance independently from other board attributes. Directors rarely criticize top managers and problems therefore tend to increase with the number of board members. Lipton and Lorsch (1992) also recommend limiting membership to seven or eight people. In addition, Jensen (1993) suggests that *"as groups increase in size they become less effective because the coordination and process problems overwhelm the advantages gained from having more people to draw on"* (Jensen, 1993, p. 865). Moreover, Yermack (1996) also finds that smaller boards are more efficient concerning decision-making matters, and Boone *et al.* (2007) find that firms in which managers' opportunities to consume private benefits are larger, or in which the cost of monitoring managers is small, have larger boards.

Additionally, they also find that larger and more diverse firms tend to have larger and more independent boards, whereas, in contrast, firms in which managers have substantial influence have less independent boards. In order to test the board structure role, the present study

7- "*In particular, if insiders have important information relative to that of outsiders, giving control to outsiders may result in loss of information that is more costly than the agency cost associated with inside control"* (Harris and Raviv, 2008, p.1830).

adopts two variables, the total number of board members and, as a measure of the degree of board independence, the percentage of independent non-executive directors on the total number of board members.

2.4. Empirical Evidence

Kim *et al.* (1998) report that firms with higher growth opportunities and lower returns on assets have significantly larger positions in liquid assets, while firm size appears to be negatively related to cash holdings, but never significant. (Kim *et al.*, 1998). Opler et al. (1999)Opler et al. (1999)Opler et al. (1999)Opler et al. (1999) Opler et al. (1999)Opler et al. (1999)Opler et al. (1999)Opler et al. (1999)Opler et al. (1999) Opler et al. (1999)Opler et al. (1999)Opler et al. (1999)Opler et al. (1999)Opler et al. (1999)

Opler *et al.*, (1999) find that firms with strong growth opportunities, riskier activities and small firms tend to hold more cash. In contrast, firms with good access to capital markets, such as large firms and those with good credit ratings, tend to hold less cash. In addition, using cross-sectional data for 1994, the authors are not successful in demonstrating that proxies for agency costs have a significant impact on cash holdings.

Dittmar *et al.* (2003) find that the firms in countries with low shareholder protection hold up to twice as much cash as firms in countries with high shareholder protection.
Dittmar and Mahrt-Smith (2007) added new findings concerning governance implications. They find that poorly governed firms and/or in absence of managers' monitoring rules, high levels of cash tend to be value reducing.

Ferreira and Vilela (2004) report that the amount of cash held by firms is positively affected by the investment opportunity set and cash flows. In contrast, the amount of cash held by firms is negatively affected by the amount of liquid asset substitutes, leverage and size. They also document a negative relation between the development of capital markets and cash levels.

Ozkan and Ozkan (2004) find that the existence of non-cash liquid assets and leverage has a negative influence on levels of cash. They also conclude that managerial ownership plays an important role regarding the cash holdings and find a non-monotonic association between both variables where firms with managerial ownership between 20% and 30% have the lowest cash levels. In addition, they provide evidence that firms controlled by families hold higher levels of cash and marketable securities.

Guney *et al.* (2007) establish that borrowing decision of firms exert a non-linear impact on cash holdings decisions. Hence, leverage can act as a substitute for cash holdings, but at same time increases the probability of financial distress, which suggests high levels of cash. "*Hence, one observes first a negative relationship at lower levels of leverage and the observed relation becomes positive at high leverage levels"* (Guney *et al.*, 2007, p. 59). Secondly, they also find that strong investor protection and high ownership concentration seem to lead firms to hold lower cash balances.

Regarding Swiss non-financial firms, Drobetz and Grüninger (2007) argue that dividend payments and operating cash flows are positively related to cash reserves. They also find a negative relation concerning the firm size. Moreover, they suggest a non-significant relation between cash holding and board size.

Teruel and Solano (2008) find a negative relation between bank debt and cash holdings and a positive one concerning cash levels and the existence of growth opportunities. Moreover, their results support the hypothesis that firms with more short-term debt also hold more cash. Lastly, the existence of cash substitutes exert a negative effect on firm's cash holdings.

Bates *et al.* (2009) highlight the evolution of the average cash-to-assets ratio, which increased by 0.46% per year from 1980 until 2006. According to their results, the main reasons for the positive cash ratio's evolution was the fact that firms' cash flows became riskier, with firms holding fewer inventories and receivables and increasing R&D expenses.

3. HYPOTHESES DEVELOPMENT

(i) Growth Opportunities

According to several studies[8] the existence of growth opportunities is an important factor, which positively affects cash levels. Myers and Majluf (1984) state that firms whose value is largely determined by their growth opportunities incur higher external financing. Thus, companies with greater growth opportunities should have higher external financing costs. As a consequence, we should expect that companies with greater opportunities to invest will keep higher levels of cash. Therefore we hypothesize:

Hypothesis 1 (H1):
There is a positive association between growth opportunities and cash holdings.

(ii) Firm size

Based on the economies of scale associated with the cash levels (Miller and Orr, 1966), the t*rade-off* theory suggests a negative association between cash holdings and firm size. Hence, larger firms can keep lower cash holdings. The empirical findings of Opler *et al.* (1999) and Ferreira and Vilela (2004) confirm evidence in favor of the *trade-off* theory. On the contrary, both the *pecking order* and *free cash flow* theories predict a positive association between cash levels and firm size. The former assumes that large firms are presumably more successful, so these should have been more able to accumulate higher cash reserves (Opler *et al.*, 1999). The latter, asserts that managers of larger firms have more discretionary power to hold excess cash without fearing a potential takeover. Consequently, we can also hypothesize the following:

Hypothesis 2 (H2):
There is a relation between firm and cash holdings, the sign of which is ambiguous.

(iii) Leverage

The empirical evidence (Kim *et al.*, 1998; Opler *et al.*, 1999; Ferreira and Vilela, 2004; Ozkan and Ozkan, 2004; Bates *et al.*, 2009) demonstrates a reduction in cash levels when firms increase their leverage. At the same time, Ferreira and Vilela (2004) suggest that firms with a high level of debt are not able to accumulate cash, because they are better monitored when compared to firms with relatively low debt. Thus, based on the previous empirical findings and on both the *pecking order* and *free cash flow* theories, we define the following hypothesis:

Hypothesis 3 (H3):
There is a negative relation between leverage and cash holdings.

(iv) Debt maturity structure

Teruel and Solano (2008) suggest that the firm's debt maturity structure can have a significant impact on cash holdings.

Firms that use more short-term debt, which means a shorter debt maturity ratio, are those that need to negotiate the renewal of their loans more often. Hence, firms with a large proportion of short-term debt will keep higher cash levels in order to avoid the financial distress in case of difficulties regarding the renewal of their lines of credit. Accordingly, our hypothesis becomes:

8- Such as: Kim *et al.*, 1998; Opler *et al.*, 1999; Ferreira and Vilela, 2004; Ozkan and Ozkan, 2004 and Guney *et al.*, 2007.

Hypothesis 4 (H4):
There is a negative relation between the ratio of long term debt over total debt and the dependent variable.

(v) Dividend payments

According to Opler *et al.* (1999) and Guney *et al.* (2007), a firm that pays dividends is able to hold less cash. In case of liquid assets' shortage, it can cope with the shortage by cutting dividends. The trade off theory suggests that a firm that currently pays dividends can raise funds at a low cost by reducing its dividend payments, in contrast to a firm that does not pay these. However, since cutting dividends can impact severely on share prices, dividend-paying firms may have large cash holdings to reduce the likelihood of a dividend reduction and related costs imposed on shareholders. Based on the trade off theory and previous empirical studies, the hypothesis is:

Hypothesis 5 (H5):
There is an association between dividend payments and cash holdings, the sign of which is ambiguous.

(vi) Non-cash liquid assets

The presence of non-cash liquid assets will provide a firms' safeguard because of the low cost to convert liquid assets to cash. Ferreira and Vilela (2004) suggest that in the case of a company cash shortfall, non-cash liquid assets can be easily converted into cash, as they are cash substitutes. Based on the *trade off* theory, and on the empirical studies of Opler *et al.* (1999), Ferreira and Vilela (2004) and Ozkan and Ozkan (2004) the hypothesis is then:

Hypothesis 6 (H6):
There is a negative relation between the presence of non-cash liquid assets and cash holdings.

(vii) Cash flow generated by the firm

Cash is an outcome of the financing and investment activities (Dittmar *et al.*, 2003) and based on the *pecking order* theory, firms prefer to fund themselves with resources generated internally before resorting to the market. Hence, firms with large cash flows will keep higher cash levels, as defended by Opler *et al.* (1999) and Ferreira and Vilela (2004). In contrast, and according to the *trade off* theory, Kim *et al.* (1998) suggest that cash flow provides a source of liquidity, which is a cash substitute, and argue in favor of a negative relation between cash flow and cash holdings. We accordingly hypothesize the following:

Hypothesis 7 (H7):
There is a relation between cash flow generated by the firm and cash holdings, the sign of which is ambiguous

(viii) Percentage of voting rights owned by the largest shareholders

In contrast to an average shareholder, a large one can easily monitor the management team. Consequently the agency costs are expected to be lower (Stiglitz, 1985; Shleifer and Vishny, 1986). This suggests that the cost of external financing would be lower for firms with large shareholders, implying less need to hold large cash balances. On the other hand, large shareholders might have incentives to increase the amount of funds under their control to invest according to their self-interests (Shleifer and Vishny, 1997).

These arguments suggest a positive relationship between large shareholders and cash holdings. Therefore we hypothesize the following:

Hypothesis 8 (H8):
The expected relation between the voting rights' percentage owned by the largest two shareholders and cash holdings is ambiguous.

(ix) Percentage of independent non-executive directors on the board

Independent non-executive directors add expertise and objectivity that ostensibly mitigates managerial entrenchment of firm resources (Harford *et al.*, 2008) and their goal is also to act in shareholders' interests. Hence, we expect that independent non-executive directors will minimize managers' autonomy, thus the anticipated relation between cash holdings and the percentage of independent non-executive directors on the board is negative.

Hypothesis 9 (H9):
There is a negative association between the percentage of independent non-executive directors on the board and cash holdings.

(x) Board size

The largest firms tend to have larger boards (Boone *et al.*, 2007). At the same time, if we assume that larger firms are more successful than small ones and larger boards are more efficient in their monitoring role, these would imply an easier access to financial markets. Hence, it is expected a negative relation between board size and cash levels, according to our next research hypothesis:

Hypothesis 10 (H10):
There is a negative relation between cash holdings and board size.

Additional Hypotheses

The financial literature suggests many motives for cash holdings assuming a stable economic environment. However, the existence of a financial crisis could modify the expectations concerning the cash holdings behavior. Almeida *et al.* (2004) suggest that constrained firms need to increase their liquid assets, and Campello *et al.* (2010) find that constrained firms suffer from limited access to external funding.

Concerning the growth opportunities, firm size, debt maturity structure, dividend payments, and non-cash liquid assets proxies we expect similar associations to the ones presented above. However, in the post-crisis period and considering the *trade-off* theory, we could also expect a weaker sign relatively to growth opportunities, and non-cash liquid assets variables, and either a weaker or stronger sign relative to dividends (depending on either we document a positive or negative relation with dividends in the pre-crisis period). This is due to the fact that financial constraints lead firms to increase their precautionary cash holdings. In comparison to the previous hypotheses, we thus expect different coefficient signs regarding leverage and cash flow generated by the firm variables[9].

(xi) Leverage

In a post-crisis period the "*new lending declined substantially across all types of loans"* (Ivashina and Scharfstein, 2010). Consequently, in order to minimize the likelihood of financial distress and due to the shortage of credit bank supply (Campello *et al.*, 2010), highly leveraged firms may tend to accumulate higher levels of cash. Moreover, Acharya *et al.* (2007) also predict a positive association between cash levels and leverage for constrained firms with high hedging needs. Then, for the post-crisis period we hypothesize:

Hypothesis 11 (H11):
A positive association between leverage and cash levels is expected in the post-crisis period.

xii) Cash flow generated by the firm

The post-crisis period is characterized by a more selective supply of credit by financial institutions. The cash flow generated by the firm

9- The analysis regarding the financial crisis only focuses on financial characteristics. Hence we won't hypothesize the impact of financial crisis on governance factors.

acts as a source of liquidity (Kim *et al.*, 1999), thus we expect a negative association between cash flow generated by the firm and cash holdings.

Hypothesis 12 (H12):
In the post-crisis period, the expected association between cash levels and cash flow generated by the firm is a negative one.

4. Data Description

The sample targets the firms listed in the *Euronext Lisbon*, excluding financial institutions because their balance sheet is affected by specific factors such as industry rules and regulatory laws. Regarding the sports firms, whose financial year is different from the civil year, we assume that the utilization of their data would not significantly affect the comparability with other firms. After these adjustments, the sample is a panel of 43 firms over the period of 1995 to 2015. The accounting data and the market value for equity are taken from *Datastream* database. Regarding the governance factors, we hand-collect data from the firms' Annual Reports and Annual Governance Reports available on their website.

4.1 Dependent Variable

As the purpose of this research is to study the determinant factors of cash holdings, the dependent variable will be cash holdings and is measured through a cash ratio. We follow the empirical studies of Kim *et al.* (1998), Ozkan and Ozkan (2004), Guney *et al.* (2007), and Bates, Kahle, and Stulz (2009) and define this variable as the ratio of cash and cash equivalents to total assets.

4.2 Independent Variables

We distinguish the independent variables across two main groups. The first one includes proxies for financial characteristics, and contains data concerning 43 firms over the period between 1995 and 2015. The second group is composed by governance data, and holds data for the period between 2004 and 2015. The following list introduces the financial characteristics that we study:

1. *Growth Opportunities (GROWOP)* – the proxy for growth opportunities that we use is the market-to-book ratio. We estimate the market value of firms' assets as the book value of assets minus the book value of equity plus the market value of equity. Then, the market-to-book ratio is given by the market value of assets divided by the book value of assets (Ferreira and Vilela, 2004).

2. *Firm Size (FIRMSIZE)* – the proxy used is the natural logarithm of total assets (Ferreira and Vilela, 2004; Ozkan and Ozkan, 2004).

3. *Leverage (LEV)* – We measure this using the ratio of total debt/total assets-cash and cash equivalents (Opler *et al.*, 1999).

4. *Debt Maturity Structure (DEBTMAT)* – the proxy for debt maturity is the ratio of the long-term debt/total debt (Teruel and Solano, 2008).

5. *Dividend Payments (DIVIDEND)* – the effects of dividend payments are measured by a dummy variable that is set to one if the firm paid dividends in each year and zero if it did not (Ferreira and Vilela, 2004).

6. *Non-cash liquid assets (LIQ)* – based on previous empirical studies (Opler et al., 1999; Ferreira and Vilela, 2004; Ozkan and Ozkan, 2004) the presence of non-cash liquid assets is measured by the ratio of working capital minus cash, over total assets.

7. *Cash Flow Generated by the Firm (CFLOW)* – the cash flow generated by the firm is measured by the ratio of pre-tax profits plus depreciation, deflated by total assets (Ozkan and Ozkan, 2004).

Regarding the governance variables, we use three governance factors to test the above mentioned hypotheses: (i) the *percentage of voting rights owned by the two largest shareholders (EOBS),* (ii) *board size (BSIZE),* measured by the total number of board members (Drobetz and Grüninger, 2007) and (iii) the *ratio of independent non-executive directors to the total number of board members (INED)*.

Additionally, in accordance with previous studies (Kim *et. al*, 1998; Drobetz and Grüninger, 2007) we also introduce an additional control variable, the *Return on Assets (ROA)*. This is measured by the ratio of net income to total assets. The ROA is a measure of how profitably assets are managed by the firm.

4.3. Descriptive statistics

Table 2 below presents the descriptive statistics for each of the variables we use in the analysis.

TABLE 2: DESCRIPTIVE STATISTICS

Variable	Mean	Median	Maximum	Minimum	Std. Dev.	Observations
CASH	0.062	0.039	0.614	0.000	0.073	633
CASH_2	0.075	0.041	1.595	0.000	0.130	633
GROWOP	1.211	1.067	17.179	0.474	0.772	633
FIRMSIZE	13.301	13.168	17.569	9.338	1.690	633
LEV	0.432	0.423	1.722	0.000	0.216	633
DEBTMAT	0.587	0.629	1.000	0.000	0.272	633
DIVIDEND	0.659	1.000	1.000	0.000	0.474	633
DIVI-DEND_2	0.012	0.005	0.215	0.000	0.021	633
LIQ	-0.111	-0.089	0.581	-1.779	0.220	633
CFLOW	0.065	0.072	1.725	-2.244	0.143	633
ROA	2.770	3.720	137.620	-90.850	9.850	633
ROA_2	0.036	0.047	1.664	-2.244	0.140	633
EOBS	0.663	0.688	1.200	0.101	0.239	302
BSIZE	9.119	8.000	25.000	2.000	4.312	302
INED	0.165	0.118	0.778	0.000	0.179	302

This table shows the sample characteristics for the 43 firms over the period 1995 to 2015 (except for EOBS, BSIZE and INED which were only available between 2004 and 2015). The dependent variable is CASH, measured as the ratio of cash and cash equivalents to total assets. CASH_2 is the ratio of cash and cash equivalents to net assets, where net assets is the difference between total assets and cash and cash equivalents. GROWOP is the ratio of book value of assets minus book value of equity plus market value of equity to book value of assets. FIRMSIZE is the natural logarithm of total assets. LEV is the ratio of total debt to total assets minus cash and cash equivalents. DEBTMAT is the ratio of long-term debt to total debt. DIVIDEND is a dummy variable that is set to one if the firm paid dividends in each year and set zero otherwise. DIVIDEND_2 is the ratio of the dividends paid over to total assets. LIQ is the ratio of working capital minus cash to total assets. CFLOW is the ratio of pre-tax profits plus depreciation to total assets. EOBS is the percentage of the voting rights owned by the largest two shareholders. BSIZE is the total number of board members. INED is the percentage of non-executive independent members on the board. ROA is the ratio of net income to total assets. ROA_2 is the ratio of EBIT[10] to total assets.

10- EBIT – Earnings before interests and taxes.

Table 2 exposes that 6.2% of the total firm's assets are cash and cash equivalents, which is lower than the value obtained by some authors in some similar studies, e.g. Kim *et al.* (1998), Ozkan and Ozkan (2004) and Bates *et al.* (2009). However, the maximum value is 61.4% which undoubtedly states the importance of cash balances on the firms' balance sheet. In addition, Ferreira and Vilela (2004) find that for Portuguese firms the mean of the ratio of cash and cash equivalents to net assets is 5.1% which is lower than the mean of our variable CASH_2.

4.4. Methodology

This study intends to analyze and test a number of hypotheses through panel data methodology. In order to take the most advantage of the sample observations and get the most possible reliable results, we will perform a basic model and then an alternative specification. Thus, the first one will use as independent variables the financial factors described in earlier sections. The alternative model, while applied to a smaller period, will also focus on corporate governance factors, while maintaining the financial factors as independent variables. The basic empirical model is as follows:

$$\begin{aligned} CASH_{i,t} = c + \beta_1 GROWOP_{i,t} + \beta_2 FIRMSIZE_{i,t} + \beta_3 LEV_{i,t} \\ + \beta_4 DEBTMAT_{i,t} + \beta_5 DIVIDEND_{i,t} + \beta_6 LIQ_{i,t} \\ + \beta_7 CFLOW_{i,t} + \beta_8 ROA_{i,t} + \mu_{i,t} \end{aligned} \quad (4.4.1)$$

where *i* refers to the firm and *t* to the year time period. $CASH_{i,t}$ is the dependent variable, the cash ratio of the firm *i* and year *t*. Concerning the content of the right side of the equation, c is the constant term. The remaining variables are the firm characteristics, $GROWOP, FIRMSIZE, LEV, DEBTMAT,$ being respectively, growth opportunities, firm size, leverage and debt maturity. $DIVIDEND$ is a dummy variable that is set to one if the firm paid dividends in each year and zero otherwise. $LIQ, CFLOW$ and ROA refer to non-cash liquid assets, cash flow generated by the firm and return on assets, respectively. Finally, $\mu_{i,t}$ is the error term.

Then, based on the equation (4.4.1) we perform a sensitivity analysis by adding corporate governance factors. The alternative model is as follows:

$$\begin{aligned} CASH_{i,t} = c + \beta_1 GROWOP_{i,t} + \beta_2 FIRMSIZE_{i,t} + \beta_3 LEV_{i,t} \\ + \beta_4 DEBTMAT_{i,t} + \beta_5 DIVIDEND_{i,t} + \beta_6 LIQ_{i,t} \\ + \beta_7 CFLOW_{i,t} + \beta_8 ROA_{i,t} + \beta_9 EOBS_{i,t} + \beta_{10} BSIZE_{i,t} \\ + \beta_{11} INED_{i,t} + \mu_{i,t} \end{aligned} \quad (4.4.2)$$

The governance factors added to the previous model are: $EOBS, BSIZE$ and $INED$, and these represent, respectively, the percentage of voting rights owned by the largest two shareholders, the total number of board members and the percentage of independent non-executive directors on the board.

The last goal of the present study is to understand the influence of the financial crisis of 2008 on the behavior of cash holdings.

In order to do that, we will use the model in equation (4.4.1) along the two different time periods, and perform separated analyses.

5. EMPIRICAL RESULTS AND ANALYSIS

5.1. Basic Empirical Model

We start by running equation (4.4.1) with pooled OLS, fixed effects and random effects models. The following table 3 presents the estimation outputs.

TABLE 3: ESTIMATION OUTPUT OF EQUATION (4.4.1)

Independent variable	Pooled OLS		Fixed Effects		Random Effects	
constant	0.051119	**	0.049647		-0.026411	
	(0.025728)		(0.062250)		(0.041171)	
GROWOP	0.009487	**	0.003838	**	0.003641	*
	(0.004202)		(0.001884)		(0.001880)	
FIRMSIZE	-0.003970	*	-0.001713		0.004052	
	(0.002173)		(0.004781)		(0.003383)	
LEV	0.029037		0.105160	***	0.090658	***
	(0.037195)		(0.030181)		(0.033581)	
DEBTMAT	0.020923	*	-0.032327	**	-0.014140	
	(0.010953)		(0.014305)		(0.014401)	
DIVIDEND	0.040965	***	0.017346	***	0.016701	***
	(0.008164)		(0.006128)		(0.005687)	
LIQ	-0.032822		0.040510		0.007780	
	(0.020656)		(0.026938)		(0.023915)	
CFLOW	-0.169049	***	-0.111136	***	-0.138636	***
	(0.038524)		(0.035798)		(0.035621)	
ROA	0.002778	***	0.001610	***	0.002040	***
	(0.000733)		(0.000525)		(0.000533)	
R-squared	0.149298		0.654213		0.119747	
Adjusted R-squared	0.109861		0.611143		0.108461	
Obs.	633		633		633	
F-statistic	3.785772	***	15.18968	***	10.61085	***
F-test	19.5388	***				
LM test					543.561	***
Hausman test					161.011	***

Table 3 presents the estimates of the parameters in equation (4.4.1) with pooled OLS, fixed effects and random effects models. The dependent variable is CASH, measured as the ratio of cash and cash equivalents to total assets. C is the constant term. GROWOP is the ratio of book value of assets minus book value of equity plus market value of equity to book value of assets. FIRMSIZE is the natural logarithm of total assets. LEV is the ratio of total debt to total assets minus cash and cash equivalents. DEBTMAT is the ratio of long-term debt to total debt. DIVIDEND is a dummy variable that is set to one if the firm paid dividends in each year and set zero otherwise. LIQ is the ratio of working capital minus cash to total assets. CFLOW is the ratio of pre-tax profits plus depreciation to total assets. ROA is the ratio of net income to total assets. Standard errors robust to heteroscedasticity are reported in parenthesis under each coefficient. Statistical significance is represented by * at 10%, ** at 5% and *** at 1%. In addition, the table also presents the outputs estimation of F-test, Breush-Pagan Lagrande Multiplier (LM) and Hausman tests.

In order to identify the most suitable model, we perform three statistic tests: F-test, Breush-Pagan Lagrande multiplier (LM) and the Hausman tests. The results suggest that the most appropriate model is the fixed effects model. Hence, our main focus is on the results of the fixed effects model, however the pooled OLS and random effects are displayed as well, but only for comparison purposes. The model includes additional year dummies to control for variables that are constant across firms but evolve over time and to capture the influence of aggregate time-series trends. We also perform standard errors robust to heteroscedasticity in order to validate our inference. The probability of a Wald test equaling 0.01 suggests that the year dummies are globally significant (Annex, table 6)[11].

In accordance with our hypothesis 1 (H1), the regression results suggest that firms with better growth opportunities (GROWOP) have larger cash holdings. The positive and significant coefficient for GROWOP variable is consistent with previous findings (e.g. Kim *et al.*, 1998; Opler *et al.*, 1999; Ozkan and Ozkan, 2004; Ferreira and Vilela, 2004). The variable coefficient is also in agreement with the expected signal for the *trade-off* and *pecking order* theories, and contradicts the *free cash flow* theory.
We hypothesize in (H2) an ambiguous relation between cash levels and firm size (FIRMSIZE), and according to our estimation outputs, there is no statistically significant relation between both variables. However, if we ignore firm heterogeneity, the firm size variable has a negative and statistically significant relation with cash levels. These results support the *trade-off* theory and coincides with previous findings (e.g. Opler *et al.* (1999) and Ferreira and Vilela (2004)).

Contrary to our hypothesis 3 (H3), the sign of leverage (LEV) variable is positive. This result contradicts the empirical evidences of Opler *et al.* (1999), Ferreira and Vilela (2004) and Ozkan and Ozkan (2004), and the *pecking order* and *free cash flow* theories. The *trade-off* theory is not clear regarding the predicted sign for this relation, but the argument that highly leveraged firms need higher cash balances to prevent financial distress, as Lins et al. (2010)[12], Ozkan and Ozkan (2004) and Guney *et al.* (2007) also refer in their empirical work, could be an explanation for this variable's coefficient sign.

The association between cash holdings and debt maturity structure (DEBTMAT) is aligned with hypothesis 4 (H4) and it is also consistent with the empirical findings of Teruel and Solano (2008), which suggest that firms with a shorter debt maturity structure keep higher levels of cash in order to avoid financial distress in case of difficulties regarding the renewal of their credits.

11- Concerning collinearity, we perform the variance inflation factor (VIF) (Annex, table 7) among the explanatory variables in a regression and all VIF's are below the value of 10, therefore it is reasonable to assume that there are no major issues regarding collinearity (Wooldridge, 2013).

12- Lins, et al. (2010) survey chief financial officers from 29 countries to study whether and why firms use lines of credit versus excess cash for their liquidity. They conclude that excess cash protects against *"future cash flow shocks in bad times"* (Lins, et al, 2010, p. 175), while credit lines give firms the option to exploit future business opportunities. These findings might be in agreement with a possible positive interaction between cash levels and leverage, namely if we assume that high levered firms have more default risk, as suggested by *trade-off* theory. In contrast, this might also explain the negative association between cash levels and growth opportunities expected by the *free cash flow* theory.

We hypothesize (H5) either a positive or a negative relation between the dividend payments (DIVIDEND) and cash holdings as inferred from the *trade-off* theory. The results show a positive and significant relation which is in accordance with the findings of Drobetz and Grüninger (2007). This result suggests that the dividend paying firms may be particularly averse to omitting dividends and tend to hold larger amounts of cash (Drobetz and Grüninger, 2007).[13]

The expected association between non-cash liquid assets (LIQ) and cash levels is negative, as stated in hypothesis 6 (H6). Against our expectations, the estimation output suggests a positive relation, but it is statistically non-significant.

Finally, the cash flow generated by the firm (CFLOW) is negatively related with cash holdings. This conclusion being in line with the *trade-off* theory and the empirical findings of Kim *et al.* (1998) and Guney *et al.* (2007). On the other hand, this result contradicts the *pecking order* theory.

Overall, we can conclude that the characteristics of corporate cash holdings among the Portuguese listed firms are mostly in line with the expectations of the *trade-off* theory.

5.2. Alternative Model

Concerning the analysis of the governance characteristics, we estimate equation (4.4.2). The following table presents the corresponding results:

13- In section 5.3. we perform a robustness check substituting the dummy variable for dividend payments (DIVIDEND) by a new proxy measured by the ratio of the dividend paid over total assets (DIVIDEND_2). In contrast with the dummy variable, we do not find a significant relation between the amounts of dividend paid and cash levels.

Table 4: Estimation output of equation (4.4.2)

Independent variable	Pooled OLS		Fixed Effects		Random Effects	
constant	0.174345	***	-0.187034		0.034789	
	(0.052676)		(0.176535)		(0.074366)	
GROWOP	0.002843		-0.024262		0.000817	
	(0.015780)		(0.015215)		(0.013971)	
FIRMSIZE	-0.009729	***	0.019229		0.001259	
	(0.003431)		(0.013694)		(0.005972)	
LEV	0.074882		0.167192	***	0.127533	**
	(0.049859)		(0.050981)		(0.062327)	
DEBTMAT	0.003936		-0.047493	*	-0.027608	
	(0.021071)		(0.028057)		(0.023978)	
DIVIDEND	0.053375	***	0.022037	*	0.033545	***
	(0.011297)		(0.012949)		(0.012057)	
LIQ	-0.026986		0.061379		0.026181	
	(0.028000)		(0.039979)		(0.039273)	
CFLOW	-0.167423	***	-0.167943	***	-0.151967	***
	(0.044557)		(0.057605)		(0.054933)	
RoA	0.002676	***	0.002451	***	0.002388	***
	(0.000832)		(0.000783)		(0.000801)	
EOBS	-0.106870	***	-0.017585		-0.072914	*
	(0.029636)		(0.023849)		(0.039453)	
BSIZE	0.002117	*	-0.003782		-0.000618	
	(0.001158)		(0.003405)		(0.002309)	
INED	0.013459		0.091517	*	0.096333	*
	(0.033838)		(0.050741)		(0.054012)	
R-squared	0.354974		0.721122		0.195664	
Adjusted R-squared	0.308569		0.647858		0.164836	
Obs.	299		299		299	
F-statistic	7.649521	***	9.842720	***	6.346906	***
F-test	7.562	***				
LM test					60.632	***
Hausman test					168.908	***

Table 4 above presents the coefficient estimates of equation (4.4.2) with pooled OLS, fixed effects and random effects models. The dependent variable is CASH, measured as the ratio of cash and cash equivalents to total assets. C is the constant term. GROWOP is the ratio of book value of assets minus book value of equity plus market value of equity to book value of assets. FIRMSIZE is the natural logarithm of total assets. LEV is the ratio of total debt to total assets minus cash and cash equivalents. DEBTMAT is the ratio of long-term debt to total debt. DIVIDEND is a dummy variable that is set to one if the firm paid dividends in each year and zero otherwise. LIQ is the ratio of working capital minus cash to total assets. CFLOW is the ratio of pre-tax profits plus depreciation to total assets. ROA is the ratio of net income to total assets. EOBS is the percentage of the voting rights owned by the largest two shareholders. BSIZE is the total number of board members. INED is the percentage of independent non-executive members on board. Standard errors robust to heteroscedasticity are reported in parenthesis under each coefficient. Statistical significance is represented by * at 10%, ** at 5% and *** at 1%. In addition, the table also presents the outputs estimation of F-test, Breush-Pagan Lagrande Multiplier (LM) and Hausman tests.

The previous estimation is the output of the equation (4.4.2) with the pooled OLS, fixed effects and random effects models. The estimation contains data regarding the time between 2006 and 2015[14]. In the same way as in estimation of equation (4.4.1.), to identify the most suitable model we perform three statistic tests: F-test, Breush-Pagan Lagrande multiplier (LM) and the Hausman test (Breusch and Pagan, 1980; Hausman, 1978). The results are in line with the previous estimation, the most suitable model according to this criteria being again the fixed effects model. The estimation of equation (4.4.2) also includes year dummies to control for variables that are constant across firms but evolve over time and to capture the influence of aggregate time-series trends. The standard errors are robust to heteroscedasticity thus helping to validate our inferences.

The comparison between the common variables among the estimation's output of equation (4.4.1) and the estimation's output of equation (4.4.2) shows that the variables LEV and CFLOW maintain equal statistical significance and the coefficients' sign. Additionally, the variables DEBTMAT and DIVIDEND lose part of their statistical significance. However, they continue to be significant and maintain the coefficient's sign equal to the previous estimation. In contrast with the expectation in equation (4.4.1), the variable GROWOP is not statistically significant[15]. A justification for this variation could be the different period of analysis of the equation (4.4.2). In accordance with the equation (4.4.1), the variables FIRMSIZE and LIQ are not statistically significant.

Regarding the meaning of the governance variables, the relation between the percentage of voting rights owned by the largest two shareholders (EOBS) and cash holdings is not statistically significant. However, if we ignore firm heterogeneity, the variable EOBS is statistically significant and has a negative sign. This suggests that firms with larger shareholders tend to hold less cash. This result is in accordance with the argument that firms with larger shareholders tend to efficiently monitor managers, which implies lower agency costs (Stiglitz, 1985; Shleifer and Vishny 1986) and consequently a cheaper access to external financing. The result is in line with the findings of Ferreira and Vilela (2004) and Guney *et al.* (2007) regarding the impact of ownership concentration.

In contrast to the findings of Ozkan and Ozkan (2004), our results suggest a significant relation between the percentage of independent non-executive directors on the board (INED) and cash levels. However, the sign contradicts hypothesis 9 (H9). This result is aligned with the findings of Harris and Raviv (2008) which suggest that outside board control could be value-reducing.

In a similar way as in Ozkan and Ozkan (2004), the board size variable (BSIZE) is not statistically significant. However, if we consider the pooled OLS model, the variable BSIZE has a positive impact on cash levels, which contradicts hypothesis 10 (H10) and suggests that firms with larger boards tend to accumulate higher levels of cash. If we assume the amount of cash holdings proxy for agency costs, then this result is in line with the observations of Lipton and Lorsch (1992) and Jensen (1993) about the performance of large firms, and the results of Yermack (1996) which suggest that smaller boards are more efficient regarding decision-making matters.

The previous results suggest that governance factors play an interesting role in determining the cash holdings in our sample of Portuguese listed firms.

14- Due to scarcity of governance data, the estimation excludes the years 2004 and 2005.

15- This result is in line with the estimation concerning the post-crisis period, see section 5.4.

5.3. Robustness Checks

In this section we perform five robustness checks in order to verify the evidence presented above. First, we change the proxy for the dependent variable by using the ratio of cash and cash equivalents to net assets (CASH_2) instead, where net assets is the difference between total assets and cash and cash equivalents[16]. Next, we again run the estimation of the models substituting the independent variable DIVIDEND by the ratio of the dividend paid over the total assets (DIVIDEND_2). Then, we run the estimation of the models by excluding sports firms. As mentioned before, sports firms have a different financial year, their financial year starts in July and ends in June. Next, we exclude the yearly dummy for controlling unobserved effects. Lastly, aiming at understanding whether the control variable influences our results, we again run the estimation of the models substituting the control variable by the ratio of EBIT to total assets.

Table 5 exhibits the output of the regression estimations[17] of the equation (4.4.1), where the specification (1) introduces a change in the dependent variables, in specification (2) we substitute the dividend proxy. The specification (3) applies the estimation to a sample without sports firms, and specification (4) excludes the yearly dummy variables. Finally the specification (5) we substitute the control variable.

16- Opler *et al*. (1999), and Ferreira and Vilela (2004) used the previous ratio as proxy for cash holding in their empirical studies.

17- The robustness analysis is made through the model analysed before, the fixed effects model. The panel tests rejected pooled OLS and random effects models.

TABLE 5: ROBUSTNESS CHECKS OF EQUATION (4.4.1)

Independent variable	*(1)*		*(2)*		*(3)*		*(4)*		*(5)*	
constant	0.046780		0.023315		0.042360		-0.035515		0.101734	
	(0.101503)		(0.064220)		(0.065997)		(0.051590)		(0.073078)	
GROWOP	0.005517	**	0.003100	*	0.004285	**	0.003068		0.003432	**
	(0.002704)		(0.001936)		(0.001896)		(0.001948)		(0.001937)	
FIRMSIZE	-0.002791		0.001281		-0.001070		0.004345		-0.005487	
	(0.007665)		(0.004831)		(0.004995)		(0.004040)		(0.005491)	
LEV	0.214904	***	0.101907	***	0.115976	***	0.108014	***	0.115522	***
	(0.084669)		(0.030403)		(0.031870)		(0.029932)		(0.030195)	
DEBTMAT	-0.060322	**	-0.034565	**	-0.038761	**	-0.023163	*	-0.039805	***
	(0.029042)		(0.014335)		(0.015614)		(0.014437)		(0.014468)	
DIVIDEND	0.023486	**	-		0.017221	***	0.014325	**	0.020777	***
	(0.010280)		-		(0.006386)		(0.005771)		(0.006373)	
DIVI-DEND_2	-		0.149204		-		-		-	
	-		(0.128640)		-		-		-	
LIQ	0.081098		0.043895		0.051776		0.027838		0.052038	*
	(0.049473)		(0.025889)		(0.029782)		(0.021966)		(0.032628)	
CFLOW	-0.188429	***	-0.111679	***	-0.124597	***	-0.133486	***	-0.162767	**
	(0.061332)		(0.036126)		(0.040101)		(0.036519)		(0.079602)	
ROA	0.002779	***	0.001624	***	0.001903	***	0.001904	***	-	
	(0.000893)		(0.000512)		(0.000643)		(0.000522)		-	
ROA_2	-		-		-		-		0.001493	**
	-		-		-		-		(0.000744)	
Year dummies	Yes		Yes		Yes		No		Yes	
R-squared	0.673283		0.649956		0.654865		0.637825		0.643914	
Adjusted R-squared	0.632589		0.606356		0.611235		0.606710		0.600489	
Obs.	633		633		598		633		633	
F-statistic	16.54489	***	14.90729	***	15.00943	***	20.49914	***	14.82815	***

Table 5 above presents the coefficient estimates of equation (4.4.1) with fixed effects. The dependent variable is CASH, measured as the ratio of cash and cash equivalents to total assets. C is the constant term. GROWOP is the ratio of book value of assets minus book value of equity plus market value of equity to book value of assets. FIRMSIZE is the natural logarithm of total assets. LEV is the ratio of total debt to total assets minus cash and cash equivalents. DEBTMAT is the ratio of long-term debt to total debt. DIVIDEND is a dummy variable that is set to one if the firm paid dividends in each year and zero otherwise. DIVIDEND_2 is the ratio of dividend paid over total assets. LIQ is the ratio of working capital minus cash to total assets. CFLOW is the ratio of pre-tax profits plus depreciation to total assets. ROA is the ratio of net income to total assets. ROA_2 is the ratio EBIT to total assets. Standard errors robust to heteroscedasticity are reported in parenthesis under each coefficient. Statistical significance is represented by * at 10%, ** at 5% and *** at 1%.

Concerning the basic empirical model, the change of the dependent variable (specification (1)) increases the adjusted R-square marginally, which suggests that the model is slightly more appropriate to explain the variable CASH_2. Additionally, there are no substantial changes regarding the variables' statistical significance nor about the estimated coefficients'. In contrast with the positive association between cash holdings and payment of dividends founded in section 5.1., the specification (2) suggests that there is no relation between cash levels and the amount of dividends paid. Moreover, the behavior of the remaining variables of the regression is in line with the original model. The specification (3) shows that sports firms do not significantly affect the comparability among the other firms. The estimation without sports firms has similar coefficients and significance levels. The specification (4) suggests that the exclusion of yearly dummy variables diminishes the precision of the model. At the same time, the GROWOP variable stops being significant and DEBTMAT variable loses statistical significance. The remaining variables maintain the same significance and similar coefficients. Hence, there may be unobserved macroeconomic or other effects, captured in the yearly dummies, that influence the cash levels. The specification (5) shows that the variables maintain similar coefficients and levels of significance. DEBTMAT and DIVIDEND variables even increase their significance level, while CFLOW and ROA obtain a smaller level of significance, although they are still significant at 5%. LIQ variable is significant, however only at the 10% level, thus we conclude that our previous inferences are not affected.

Regarding the robustness checks of the alternative model, as a general rule, the conclusions are in line with the robustness checks of the equation (4.4.1), which confirms the robustness of the models. In order to check that our variables are stationary we perform the Im Pesaran and Shin test (Im *et al.*, 2003, cited in Baltagi, 2005). The null hypothesis is rejected for the larger part of our variables, except for BSIZE and INED variables. Thus, excluding BSIZE and INED variables, the remaining variables are stationary in level. Then we test for first and second differences and we could conclude that BSIZE and INED variables are stationary at second differences. Afterwards, we perform the original model replacing the BSIZE and INED variables by the stationary variables and the majority of the variables maintaining their significance levels. Thus we may could conclude that, as general rule, our initial conclusions are not affected[18].

5.4. Pre and Post-Crisis Analyses

This section intends to understand if the relation between the cash ratio variable and its explanatory variables changed along the pre-crisis and post-crisis periods. In order to perform this analysis, we split the sample between two time periods, the pre-crisis and post-crisis periods. Campello *et al.* (2010), study the effects of financial constraints during the financial crisis, and they identify that the difference between a constrained firms and its unconstrained control firms becomes much more pronounced in the 2008Q4, the *"crisis peak period"* (Campello *et al.*, 2010, p. 478). Based on that, the pre-crisis period corresponds to the years between 1995 and 2008, and the post-crisis period starts in 2009 and goes until 2015.

Accordingly, we run the regressions for each subsample in order to identify whether there is a change in the regression coefficients. In order to test the robustness of the results we compute these regressions for all for all of the three regressions models. According to the panel tests the suitable models for the pre-crisis and post-crisis periods is the random effects and fixed effects models, respectively (Annex B, table 8). The following table presents the output of the regression models.

18- The estimates and tests are available upon request.

TABLE 5: ESTIMATION OUTPUT OF PRE-CRISIS AND POST-CRISIS REGRESSIONS

Independent variable	Pooled OLS Model		Fixed Effects Model		Random Effects Model	
	Pre-crisis	*Post-crisis*	*Pre-crisis*	*Post-crisis*	*Pre-crisis*	*Post-crisis*
constant	0.067441 *	0.019037	0.043438	0.032924	0.025105	-0.059123
	(0.035545)	(0.037768)	(0.105815)	(0.230379)	(0.059738)	(0.069830)
GROWOP	0.006312 *	0.029476	0.004728 **	-0.024960	0.004316 **	0.004864
	(0.003586)	(0.018669)	(0.001856)	(0.018874)	(0.001770)	(0.020244)
FIRMSIZE	-0.005902 *	-0.001823	-0.005210	0.002101	-0.003787	0.007106
	(0.003343)	(0.002948)	(0.008464)	(0.016472)	(0.005127)	(0.005421)
LEV	0.047368	0.040155	0.150196 ***	0.145855 ***	0.145135 **	0.092753 *
	(0.063308)	(0.048691)	(0.055694)	(0.046599)	(0.057049)	(0.052423)
DEBTMAT	0.028469 **	-0.015137	-0.014421	-0.048506	-0.004836	-0.030992
	(0.013706)	(0.022010)	(0.016607)	(0.032368)	(0.015756)	(0.025361)
DIVIDEND	0.022102 ***	0.060333 ***	0.025004 ***	0.010910	0.020304 ***	0.023955 **
	(0.010532)	(0.010082)	(0.007525)	(0.012842)	(0.006849)	(0.011125)
LIQ	-0.029702 *	-0.012194	-0.002578	0.042723	-0.013702	0.014403
	(0.018234)	(0.031239)	(0.024940)	(0.036144)	(0.021175)	(0.032657)
CFLOW	-0.011480	-0.217597 ***	0.024105	-0.120417 ***	0.016965	-0.142919 ***
	(0.060709)	(0.049096)	(0.064088)	(0.055736)	(0.056723)	(0.052089)
RoA	0.001368 *	0.003345 **	0.000681	0.001934 ***	0.000846	0.002266 ***
	(0.000684)	(0.001042)	(0.000697)	(0.000778)	(0.000602)	(0.000800)
R-squared	0.120311	0.201536	0.666413	0.744074	0.200729	0.104621
Adjusted R-squared	0.065656	0.158209	0.602134	0.677723	0.182512	0.077488
Obs.	360	273	360	273	360	273
F-Statistic	2.201280 **	4.651463 ***	10.36747 ***	11.21419 ***	11.01874 ***	3.855892 ***

Table 5 above presents the coefficient estimates of equation (4.4.1) with pooled OLS, fixed effects and random effects models. The dependent variable is CASH, measured as the ratio of cash and cash equivalents to total assets. C is the constant term. GROWOP is the ratio of book value of assets minus book value of equity plus market value of equity to book value of assets. FIRMSIZE is the natural logarithm of total assets. LEV is the ratio of total debt to total assets minus cash and cash equivalents. DEBTMAT is the ratio of long-term debt to total debt. DIVIDEND is a dummy variable that is set to one if the firm paid dividends in each year and zero otherwise. LIQ is the ratio of working capital minus cash to total assets. CFLOW is the ratio of pre-tax profits plus depreciation to total assets. ROA is the ratio of net income to total assets. Standard errors robust to heteroscedasticity are reported in parenthesis under each coefficient. Statistical significance is represented by * at 10%, ** at 5% and *** at 1%.

First of all, we can identify that the variable GROWOP is positive and statistically significant in all three models during the pre-crisis period. In contrast with the post-crisis period, the variable is not significant in any model. Based on the *trade-off* theory, this finding could suggest that in the post-crisis the benefits from the growth opportunities of the firm were reduced while the opportunity costs of large cash reserves increased. The result is also in agreement with the empirical work of Lins *et al.* (2010), which suggests that credit lines give firms the option to exploit future business opportunities and excess cash can protect them against future cash flow shocks. In addition, this finding is in accordance with the research by Campello *et al.* (2010), as they find that *"nearly 90% of constrained companies say that financial constraints restrict their pursuit of attractive projects, and more than half of these firms are forced to cancel valuable investments"* (Campello *et al.*, 2010, p. 486).

Regarding the firm size variable (FIRMSIZE), the pooled OLS model shows a negative and significant association with cash levels during the pre-crisis period. However, this variable is not statistically significant during the post-crisis period. Concerning the fixed effects and random effects models, and in spite of the opposite coefficient signs across the two periods, this variable is not statistically significant in any of these models.

The variable leverage (LEV) is statistically significant in both fixed effects and random effects models. The variable coefficient in the post-crisis period is in accordance with the hypothesis 11 (H11) which argues that in the post-crisis period high leveraged firms tend to accumulate high cash balances in order to avoid financial distress. In addition, if we assume that a high leverage ratio means a good relation with banks (Ferreira and Vilela, 2004; Guney *et al.*, 2007), hence in the post-crisis period the small coefficients suggest the existence of credit restrictions (Campello *et al.*, 2010).

The LIQ and DEBTMAT variables (non-cash liquid assets and the ratio of long term debt over total debt, respectively) are only significant in the pre-crisis period with the pooled OLS model.

Concerning the relation between dividend payments and cash levels, we identify positive and statistically significant coefficients using pooled OLS and random effects models along the two periods. Then, we identify a larger coefficient in the post-crisis periods. These results suggest that firms that pay dividends tend to accumulate higher levels of cash. This could mean that in the post-crisis period, firms tend to retain larger amounts of cash. This could be a symptom of the financial restrictions and the reduction in the willingness to lend by banks.

The cash flow generated by the firm variable (CFLOW) is not statistically significant in any

model during the pre-crisis period. However in the post-crisis period, the coefficient is negative and statistically significant over the three estimation models. This result is in line with hypothesis 12 (H12) and suggests that firms with larger cash flows tend to accumulate lower levels of cash, hence cash flows act as liquid assets substitutes. This finding also suggests that in the post-crisis there are fewer opportunities for firms to accumulate cash.

To conclude, the previous results suggest that the financial crisis of 2008 impacted on the relation between cash levels of Portuguese firms and their determining factors. In particular, regarding the growth opportunities and the cash flow generation variables. The first one ceased to be significant in the post-crisis period, which could be justified by the absence of growth opportunities or the delay of investments in a context of post-financial crisis. The variable cash flow generated by the firm is significant and with a negative sign in the post-crisis period, which could suggest that firms are recurring to internal funds. This could be related to the shortage of credit in the financial markets.

6. Conclusions

The present study investigates the determinants of corporate cash holdings for listed firms in Portugal, using panel data for the period of 1995 to 2015. The main results of the regression analysis suggest significant and positive associations between cash levels and growth opportunities, leverage and dividend payments. In contrast, cash flow and longer debt maturity impact negatively on the levels of cash holdings. These findings are mostly in line with the *trade-off* theory while the theory less supported by our results is the *free cash flow* theory. Concerning the analysis of corporate governance factors, we find that the presence of independent non-executive directors on the board has a positive association with cash levels, however the significance is weak.

Finally, we also examine the impact of the financial crisis of 2008 on the relation between cash levels and its characteristics, by computing regressions for pre and post-crisis samples. The results show a decrease in the significance of growth opportunities in the post-crisis period, which suggests the lack of growth opportunities or a delay in investment policies in the post-crisis period. In addition, the variable cash flow generated by the firms, which was not statistically significant until 2008, starts to be significant in the post-crisis period and with a negative coefficient. Thus, we can argue that in the post-crisis period, the firms' cash flow starts to act as a liquid assets substitute, which evidences the difficulties in getting loans from banks in this period.

Regarding future research suggestions, based on the significant association between the governance characteristics and the cash levels, a more detailed study of the relation between cash holdings and governance characteristics is suggested. The study of the implications of the EU/ECB/IMF financial assistance to Portugal in 2011 on cash holdings' behavior could also be a good exercise. Moreover, we think that a study concerning the financial crisis' impact on corporate cash levels across a sample of European Monetary Union's listed firms might prove fruitful.

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Annexes

Table 6: Wald test

	Statistic	Prob.
Wald test	36.1939	0.01

The table presents the output estimation of Wald test.

Table 7: Collinearity Statistics

Independent variable	VIF
GROWOP	1.17
FIRMSIZE	1.74
LEV	1.38
DEBTMAT	1.67
DIVIDEND	1.51
LIQ	1.79
CFLOW	4.03
RoA	4.19

The table presents the outputs of the estimation of the variance inflation factor.

Table 8: Panel tests

Pre-crisis period

	Statistic	Prob
F test	13.8846	0.00
LM test	349.265	0.00
Hausman test	7.25913	0.51

Post-crisis period

	Statistic	Prob
F-test	10.9564	0.00
LM test	57.0843	0.00
Hausman test	30.4839	0.00

The table presents the outputs estimation of F-test, Breush-Pagan Lagrande multiplier (LM) and Hausman test.