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Precautionary motives for private firms' cash holdings☆

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ABSTRACT

In this paper, we focus on the precautionary motive for holding cash in private firms. We check novel implications of such motive that arise under conditions that are typical of private firms. Because of the incomplete separation of the finances of these firms from the finances of the owner, we also complement the traditional precautionary motive with a novel variant that considers stakeholders' risk attitudes. We find empirical evidence consistent with both versions of the precautionary motive though some of the implications of the traditional precautionary motive, in the form of the hedging motive, are unsupported by the data.

1. Introduction

The literature has devoted considerable attention to the precautionary motive for cash holdings, starting with Opler, Pinkowitz, Stulz, and Williamson (1999) and continuing, among others, with Dittmar, Mahrt-Smith, and Servaes (2003), Acharya, Almeida, and Campello (2007), Han and Qiu (2007), Gao, Harford, and Li (2013), Bonaimé, Hankins, and Harford (2014), Durán, Lozano, and Yaman (2016). A common trait of this literature is the emphasis on the possibility that firms hold cash as a precaution against not being able, in the future, to cheaply raise finance to cover funding needs. While cash holdings of listed firms have traditionally attracted the most attention, research on cash balances of private firms is gathering momentum, as in the work of Bigelli and Sánchez-Vidal (2012), Akguc and Choi (2013), Martínez-Sola, García-Teruel, and Martínez-Solano (2013), Mortal and Reisel (2014) and Mortal, Nanda, and Reisel (2016).

In our study, we seek to contribute to this growing literature. We consider both the traditional precautionary motive and, motivated by the peculiarity of private firms, a new precautionary motive. The new precautionary motive is closely related to the precautionary motive in the literature on household savings (e.g., Kimball, 1992). It is based on the risk attitudes of a class of stakeholders, who are both influential and committed, and whose preferences, as in Kimball (1993), exhibit prudence and temperance. We introduce this

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additional motive because of the increasing evidence (e.g., Gao et al., 2013; Mortal & Reisel, 2014) that the determinants of private firms' cash holding decisions cannot be easily reduced to those of public firms. To avoid confusion, we shall henceforth follow Opler et al. (1999) and Acharya et al. (2007) and refer to the traditional precautionary motive as the *hedging motive*, whereas we label the novel variant as the *attitudinal motive.* The hedging motive, as argued by Acharya et al. (2007), predicts that firms hold more cash when cash flows are negatively correlated with investment funding needs. The attitudinal motive predicts instead high cash holdings when the statistical distribution of the firm's earnings is negatively skewed, hence when the firm earnings volatility is negatively correlated with earnings.

These two versions of the precautionary motive are not mutually exclusive: each can separately explain a portion of the firm cash holding. In fact, the explanatory variable under the two motives are empirically correlated. Therefore, considering one without the other would lead to omitted variable bias. For this reason, in our empirical application we take both motives into account, even though the traditional hedging motive has been already extensively researched, and our focus is on our novel variant of the precautionary motive.

In our empirical analysis, we focus on European firms. We do so primarily to take advantage of the stricter financial data disclosure requirements placed on private firms by European law.[1] We find that, consistent with both motives (hedging and attitudinal), the cash holdings ratio (i.e., cash holdings to total assets) is negatively related to the skewness of the distribution of the firm returns as well as to the correlation between cash flows and investment needs. From this point of view, our results confirm that, as found by Gao et al. (2013) for US firms, the precautionary motive helps explain cash holdings in private firms. We also find, however, that some implications of the hedging motive, some of which are novel and hitherto untested, are not supported by our data.

The remainder of this paper is organized as follows. Section 2 more formally illustrates the precautionary motive, in both its variants (traditional and novel), and present our research hypotheses. Section 3 provides details on the dataset and outlines our empirical strategy. Section 4 presents our results. Section 5 provides some final remarks and draws together our conclusions.

2. Hypothesis development

We collectively refer to stakeholders who can influence the firm's decisions as the *insider*. We refer to the other stakeholders, without control over the firm financial policies, but with the ability to impose agency costs upon the firm, as the *outsiders*. Consistent with Durán et al. (2016), who focus on cash holding policies in family firms, which constitute a large fraction of private firms, we model the insider as the controlling shareholder, due to the special role played by this class of stakeholders in private firms. To reflect the fact that controlling shareholders of private firms typically are heavily committed (Kerins, Smith, & Smith, 2004; Mueller, 2011), we assume the insider's shares to be her only risky asset. We now discuss, first, the possible determinants of the cash the insider wishes to hold and, second, the possible determinants of the fraction of this cash she decides to hold inside the firm rather than in private means of storage, i.e. of corporate cash holdings.

2.1. *Cash held by the insider*

As previously explained, we take the hedging motive described by Acharya et al. (2007) as the prototype traditional precautionary motive. Therefore, we rely on their work for the identification of the circumstances under which it arises and its empirical implications, which we summarize in the following proposition.

PROPOSITION I. The lower the (expected) correlation of the firm cash flows with the firm investment funding needs and the higher the (expected) volatility of the firm cash flows and the funding constraints, the more the representative insider accumulates both cash and debt.

In the remainder of this section, we focus on the attitudinal motive. To this end, we assume that the insider's preferences exhibit standard risk aversion, as defined by Kimball (1993). Therefore, they can be described by a monotonically increasing and concave utility function defined over wealth, implying non-satiation and risk aversion, and exhibiting decreasing absolute risk aversion (DARA) and decreasing absolute prudence (DAP). DARA, as demonstrated by Kimball (1990), implies an increasing propensity to save in the face of uncertainty because of its link with prudence. Specifically, prudence implies greater savings in response to an expected increase in the volatility of consumption. As shown in Appendix A, this implies that the insider will save more if she expects the return on the firm equity (ROE) to become more volatile. It does not actually determine, however, whether the additional savings are channeled towards risky or safe assets. An increasing propensity to allocate savings to safe assets, and hence to cash, arises only if the insider's prudence is decreasing in wealth (Gollier, 1996), as per our DAP assumption. This point, in a different context, was made clear by Kimball (1992; 1993), who emphasize that DARA and prudence, per se, "cause an agent to respond to a risk by accumulating more wealth" whereas it is DAP, and hence temperance, that induces the decision-maker to allocate a greater fraction of savings to safe assets, and thus to cash holdings, if facing more asymmetric risk. The latter, in our context, takes the form of negative skewness (downside risk) of the distribution of ROE, as shown in Appendix A. The following proposition summarizes this discussion.

PROPOSITION II. Assume that the insider's preferences can be represented by a time and state-separable utility function and exhibit standard risk aversion. Assume further that she is a shareholder whose stake in the firm represents her only risky asset. Then, her cash holdings are positively related to the variance of the distribution of ROE and negatively related to its skewness.

[1] In the US, privately owned companies are not required by law to disclose detailed financial information in most instances (Mortal & Reisel, 2014).

PROPOSITION II is formulated in terms of moments of the distribution of ROE. From an econometric modeling point of view, this poses a problem. In the absence of long time series of ROE, it would be necessary to estimate the moments of the return on the firm assets (ROA) at the industry-level and then translate them into moments of the ROE distribution by considering the firm capital structure, similarly to what it is normally done to estimate the equity beta by re-levering an industry-level estimate of the asset beta. The problem is that such re-levering should be based on the market values of equity and debt which are unobservable for private firms. For this reason, we reformulate the implications of PROPOSITION II in terms of the moments of the distribution of ROA.

We follow Merton (1974) and note that shareholders enjoy an asymmetric exposure to the volatility of the firm operating earnings because equity is equivalent to a call option on the firm assets. Hence, *ceteris paribus*, the volatility of operating earnings implies positive skewness of the distribution of the owner's earnings. This is so for the same reason why the equity value is a positive function of the volatility of the firm assets, a well-known prediction of the application of real options theory to equity valuation. So, ROA volatility implies positive skewness of the distribution of ROE. Consequently, while the effects of skewness remain the same as in PROPOSITION II, those of volatility are now more nuanced. To the extent that firm cash flow volatility implies investment funding risk, it commands more cash holdings. However, since it translates into positive earnings skewness, it requires less cash holdings. The net effect is difficult to establish, both theoretically and empirically. As the two motives are not mutually exclusive, the sign of the relation between cash holdings and cash flow volatility is indeterminate. Therefore, as formally proven in Appendix B, the testable implications of PROPOSITION II for the relation between cash holdings and the ROA distribution can be stated as follows.

PROPOSITION III. Under the assumptions of PROPOSITION II, the attitudinal motive implies that the insider's optimal cash holdings are negatively related to the skewness of the distribution of ROA.

COROLLARY: The sign of the relation between cash holdings and the standard deviation of ROA can be positive or negative depending on factors that include the relative magnitude of prudence and temperance, financial leverage, and the duration of the liabilities. It is positive for firms with low financial leverage and high duration (long maturity) of debt liabilities, and negative otherwise.

2.2. *Fraction of cash held inside the firm*

The implications of both precautionary motives for the firm cash holdings depend on whether, for the insider, it is optimal to hold cash within the firm rather than in personal means of storage, such as the personal bank account. One reason considered by the literature is taxation. For example, Dittmar et al. (2003) argue that controlling families use their companies to store wealth because taking the funds out through dividends is too costly in terms of tax. The implications of taxation for cash holdings are difficult to model because they depend on the tax rules (both *de jure* and *de facto*) in each country. At a minimum, however, we can argue that the fraction of cash held inside the firm for the attitudinal precautionary motive depends on the progressivity of taxation. This is the case for two reasons. Firstly, in several jurisdictions (e.g., the UK), retained earnings are essentially exempt from personal taxation unless and until they are distributed. Secondly, firms can use discretionary financial reporting flexibility to temporarily disguise retained earnings as prudential provisions or charges for unrealized losses during good times and pay them out during bad times. Either way, the presence of progressivity of personal taxation increases the marginal benefit of storing cash inside the firm during good times (high earnings) and distributes (and spends) it during bad times (low and volatile earnings). Hence, it motivates prudent and temperant insiders to accumulate more cash inside the firm for any given level of earnings volatility and negative skewness they expect. Hence, the attitudinal precautionary motive is stronger when taxation is more progressive, as stated in the following proposition:

PROPOSITION IV. Let the assumptions of PROPOSITION II hold. Assume further either (a) that retained earnings are exempt from personal taxation unless and until they are distributed or (b) that firms can use discretionary financial reporting flexibility to temporarily disguise retained earnings as prudential provisions and/or charges for unrealized losses. Then, the strength of the attitudinal precautionary motive increases with the progressivity of the taxation to which the owner's earnings are subject.

Another possible set of reasons for storing inside the firm the cash held for precautionary reasons are agency problems, especially moral hazard due to incomplete contracting and information asymmetry between stakeholders. In the presence of this problem, payout decisions can play a signaling role. Withdrawing excess-cash can be in fact costly for the insider because it sends a signal to the outsiders of her limited commitment or, worse, insider information about poor firm prospects. In the terminology of Mayer (2013), accumulation of cash inside the firm is then a form of bonding device that reduces agency costs arising from moral hazard and information asymmetry between the insider and the outsiders. The following proposition summarizes the foregoing discussion.

PROPOSITION V. The fraction of cash held for precautionary motives inside the firm increases with the insider's informational advantage perceived by the outsiders.

3. Data and variables

We gathered all firm-level data for our analysis from the Bureau Van Dijk Amadeus database. Our initial sample comprised all private firms of the EU-15 area[2] over the period 2004–2011, for a total of 51,354 firms. Following Bigelli and Sánchez-Vidal (2012), we

[2] At the time of writing, the EU-15 area comprises the following countries: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, and the UK.

excluded firms belonging to the financial industry and utilities because they are subject to stringent regulatory provisions on cash holdings. We also excluded firms in which the majority owner is a public company and/or a financial company, because such owner does not match the description of the insider in our framework. Excluding also firms reporting either no value for cash holdings or negative values for sales, assets, or equity, the final sample is composed of up to 8 yearly observations on 34,646 firms for a total of 245,647 firm-year observations. A full breakdown of our dataset by year, country, and industry is provided in Table 1. We also collected Datastream data on stock market returns and Eurostat data on GDP growth and inflation rates, as well as KPMG data on personal and corporate tax rates, for all the countries and time periods in the sample.

We use these datasets to construct the dependent variable and the covariates of our empirical models. The variables are listed in Table 2, which also provides some descriptive statistics. The construction of all the variables is detailed next, along with a discussion on their inclusion in our analysis. In this discussion, the covariates are classified as determinants of cash holdings and control variables.

3.1. Dependent variable

Our dependent variable, *choa*, is the ratio of cash and cash equivalents to total assets. Fig. 1 presents a boxplot that visually represents the heterogeneity of *choa* over time. Fig. 2 plots the spatial distribution of the number of firms and cash holdings by country. While the countries with the greatest number of firms are concentrated in southern Europe, the countries with the greatest average cash holdings are concentrated in northern Europe.

3.2. Determinants of cash holdings

The primary determinant of cash holdings under the hedging motive is the correlation between cash flows and future investment funding needs that we measure in terms of the correlation between cash flow on total assets (*cfoa*) and capital expenditures on total assets (*coa*). We denote this variable with *cor*(*cfoa,coa*) and complement it with a second variable, given by the correlation between *cfoa* and the square of *coa*, *cor*(*cfoa,*coa^2). These correlations are estimated by computing the sample correlation of *cfoa* with *coa* and with coa^2 across groups of firms formed by industry, country, and year. *cor*(*cfoa,coa*) captures the hedging motive and is the same as the one used by Acharya et al. (2007), whereas *cor*(*cfoa,*coa^2) allows taking into account the special challenge that might be posed by the financing of larger investments. Together, they are meant to capture investment funding risk, which drives cash holdings accumulation under the hedging motive.

For each firm and time-period, we estimated the variance and skewness of the distribution of ROA, defined as the ratio of EBIT minus tax to total assets and denoted by *roa*. The variance and skewness of ROA, *sd(roa)* and *skew(roa)*, are estimated across clusters of firms by industry, country, and year in the same way as *cor*(*cfoa, coa*) and *cor*(*cfoa,* coa^2) and are our measures of earnings risk.

We use *roa* also as a measure of firm profitability, complemented by the ratio of sales to total assets, *soa*, which is a proxy for profitability less sensitive to earnings management (as well as a measure of operational efficiency). As a proxy for financial leverage, we use *bol*, the ratio of short-term bank debt to total assets, and *ltdol*, the ratio of long-term financial debt to total assets. To proxy for the liquidity of the firm assets, we use the variable *doa*, the ratio of trade receivables from clients and customers to total assets. To proxy for trade credit, we use the variable *col*, defined as debts to suppliers and contractors to total assets.

A further variable which might affect cash holding decisions is the cost of capital, *ciara*, as it represents a measure of how binding are funding constraints. We estimated it as the industry-country average of the firm opportunity cost of capital, according to the CAPM, using the method in Pattitoni, Petracci, Potì, and Spisni (2013). In applying this method, first we clustered firms by country and industry and used Datastream market data on listed comparable firms in the same country-industry cluster to estimate the CAPM unlevered opportunity cost of capital for each firm within the cluster.

Apart from using *coa* to construct our investment funding risk variables, we also use it, together with the ratio of intangible assets to total assets, *ioa*, to proxy for the firm investment and growth opportunities.

To proxy for the essential characteristics of the tax system, we consider the corporate tax rate, *ctax*, the average personal tax rate, *ptax*, and the highest personal tax rate, *maxptax*, reported for each country by the KPMG's Corporate and Indirect Tax Survey 2010 (KPMG, 2010). We then construct *diffptax*, which represents our measure of how progressive the tax system is, as the difference between *maxptax* and *ptax*.

As a measure of ownership concentration, we use a dummy variable, *comm*, indicating the presence of a single shareholder owning more than 50% of the equity. We use this variable as a proxy for the strength, at the margin, of the perceived insider-outsider information asymmetries and agency problems.

Most of the papers in the literature include the logarithm of total assets to consider size effects, which might proxy also for how financially constrained firms are. Since we have already rescaled by total assets all variables measuring firm cash flows and financial statement items, we use the logarithm of the number of employees, *ln*(*e*), to control for any residual effect of size.

3.3. Control variables

In our empirical models, we control for the general state of the economy by including each country market return, *rm*, annual inflation rate, *inf*, and annual growth rate of GDP at current market prices, *ggdp*. Data for *rm* are from Datastream; data for *inf* and *ggdp* are from Eurostat. All models include country and year dummies.

Table 1
Sample breakdown by year, country, and industry.

Year	N. of observations	%
2004	28,471	11.60
2005	29,400	11.98
2006	30,082	12.26
2007	31,532	12.85
2008	32,185	13.11
2009	32,783	13.36
2010	32,413	13.20
2011	28,601	11.65
Total	245,467	100.00
Country	**N. of firms**	**%**
Austria	217	0.63
Belgium	4982	14.38
Denmark	1515	4.37
Finland	1	0.00
France	3809	10.99
Germany	841	2.43
Greece	1351	3.90
Ireland	52	0.15
Italy	10,032	28.96
Luxembourg	592	1.71
Netherlands	86	0.25
Portugal	22,16	6.40
Spain	7548	21.79
Sweden	28	0.08
United Kingdom	1376	3.97
Total	34,646	100.00
Industry	**N. of firms**	**%**
Agriculture, Forestry and Fishing	313	0.90
Mining and Quarrying	176	0.51
Manufacturing	10,820	31.23
Construction	2889	8.34
Wholesale and Retail Trade	9576	27.64
Transportation and Storage	1798	5.19
Accommodation and Food Service Activities	612	1.77
Information and Communication	1200	3.46
Real Estate Activities	1733	5.00
Professional, Scientific and Technical Activities	2390	6.90
Administrative and Support Service Activities	1422	4.10
Public Administration and Defense	34	0.10
Education	465	1.34
Human Health and Social Work Activities	641	1.85
Arts, Entertainment and Recreation	320	0.92
Other Service Activities	248	0.72
Activities of Households as Employers	1	0.00
Activities of Extraterritorial Organizations and Bodies	8	0.02
Total	34,646	100.00

4. Empirical model

We consider specifications of the following general reduced-form model

$$y_{i,t} = \boldsymbol{x}_{i,t}^{'}\boldsymbol{\beta} + v_i + u_{i,t} \quad i = 1,\ 2,\ \ldots,\ N; t = 1,\ 2, \ldots,\ T \tag{1}$$

Here, $y_{i,t}$, the dependent variable, is our measure of cash holdings for firm i at time t; $\boldsymbol{x}_{i,t}$ is a vector of covariates; v_i denotes an unobservable time-constant firm effect; $u_{i,t}$ is an idiosyncratic error term, and $\boldsymbol{\beta}$ is a vector of regression coefficients.

We consider both static and dynamic specifications of (1). In static specifications, lagged values of the dependent variable are not included in $\boldsymbol{x}_{it}$ whereas, in dynamic models, $\boldsymbol{x}_{it}$ is extended to include such lags. The key difference is that, in static specifications, the estimated $\boldsymbol{\beta}$ coefficients can be interpreted as long-run effects whereas, in the dynamic models, the estimated coefficients are interpreted as short-run effects (Greene, 2011; Verbeek, 2012). In the dynamic models, partitioning $\boldsymbol{\beta}$ into a vector $\boldsymbol{\theta}$ of coefficients on the lags of $y_{i,t}$ and a vector $\boldsymbol{\gamma}$ of coefficients on the other elements of $\boldsymbol{x}_{it}$ as $\boldsymbol{\beta}' = [\boldsymbol{\theta}'\ \boldsymbol{\gamma}']$, the vector of long-run effects is given by $\boldsymbol{\lambda} = \frac{1}{1-\boldsymbol{\theta}'\boldsymbol{e}}\boldsymbol{\gamma}$, where $\boldsymbol{e}$ is a conformable vector of ones. This effect is related to the speed of adjustment of cash holdings considered by Dittmar and Duchin (2011) and Uyar and Kuzey (2014).

Table 2
Descriptive statistics.

Variables	Short description	Mean	Median	Std. dev.
Dependent variable				
Choa	Ratio of cash and cash equivalents to total assets.	0.09	0.03	0.14
Funding risk				
cor(*cfoa*,*coa*)	Correlation between the ratio of cash flow to total assets and *coa*.	−0.03	−0.02	0.16
cor(*cfoa*,coa^2)	Correlation between the ratio of cash flow to total assets and the square of *coa*.	−0.00	−0.00	0.18
Earnings risk				
sd(*roa*)	Standard deviation of *roa* by industry, country, and year.	0.07	0.07	0.04
skew(*roa*)	Skewness of *roa* by industry, country, and year.	0.21	0.40	1.98
Profitability				
roa	Return on assets, defined as the ratio of EBIT minus tax to total assets.	0.04	0.03	0.07
soa	Ratio of sales to total assets.	1.72	1.31	19.27
Cost of capital				
ciara	Industry-country average opportunity cost of capital.	0.05	0.04	0.02
Investment/growth				
coa	Ratio of capital expenditures to total assets.	−0.06	0.00	24.21
ioa	Ratio of intangible assets to total assets.	0.03	0.00	0.08
Leverage				
bol	Ratio of short-term bank debts to total assets.	0.11	0.05	0.15
ltdol	Ratio of long-term financial debt to total assets.	0.10	0.03	0.16
Liquidity/trade credit				
doa	Ratio of trade receivables from clients and customers (trade debtors) to total assets.	0.31	0.29	0.23
col	Ratio of debts to suppliers and contractors (trade creditors) to total assets.	0.21	0.17	0.18
Taxation				
difftax	Difference for each country between the highest personal tax rate and the average personal tax rate as reported by the KPMG's Corporate and Indirect Tax Survey 2010 (KPMG, 2010).	0.03	0.01	0.05
ctax	Average corporate tax rate for each country as reported by the KPMG's Corporate and Indirect Tax Survey 2010 (KPMG, 2010).	0.30	0.31	0.03
Ownership concentration				
comm	Dummy variable equal to 1 if a shareholder has a total ownership over 50%, 0 otherwise.	0.75		
Size				
ln(*e*)	Natural logarithm of the number of employees.	4.18	4.19	1.36
Economic cycle				
rm	Rate of return on country-specific market portfolios. The data are from Datastream.	0.04	0.15	0.29
inf	Annual inflation rate for each country. The data are from Eurostat.	0.02	0.02	0.01
ggdp	Annual growth rate of GDP at current market prices for each country. Data from Eurostat.	0.03	0.04	0.04

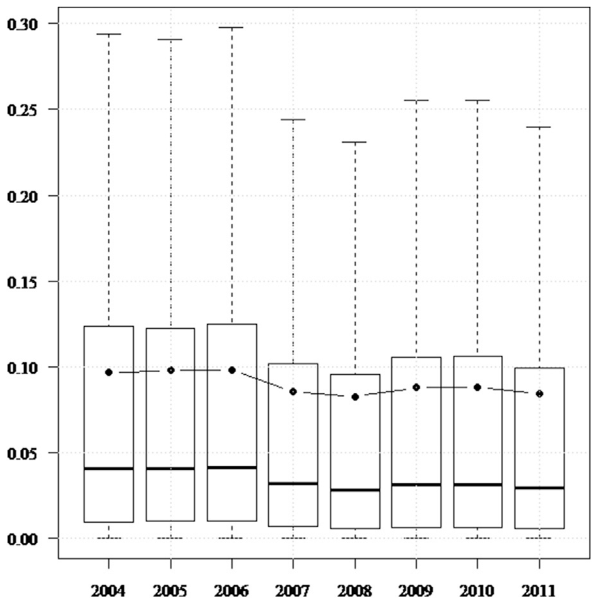

Fig. 1. Time series of cash holdings.

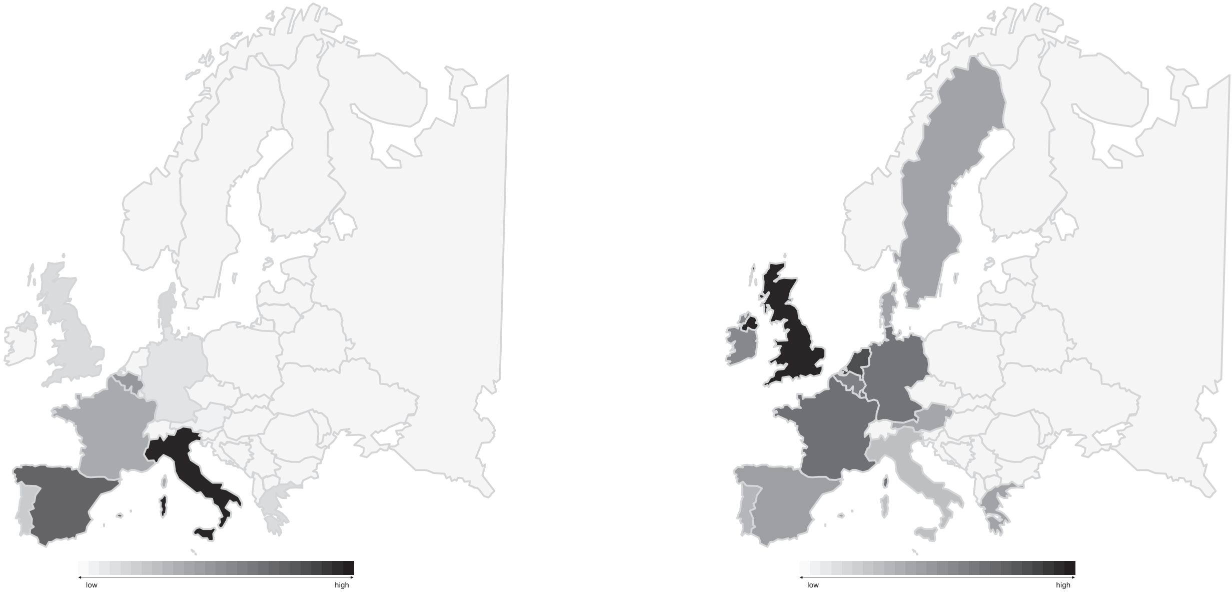

Fig. 2. Distribution of the number of firms (left) and cash holdings (right) by country.

Like Wintoki, Babajide, Linck, and Netter (2012), our key motivation for dynamic models is the possible endogeneity of determinants of cash holdings under either motive, along the lines of Magill, Quinzii, and Rochet (2015). A dynamic model is necessary if the past realizations of the dependent variable are correlated with the current explanatory variables. In our case, the lagged value of cash holdings is correlated with current investment funding risk and current earnings risk because the two types of risk are, at least in principle, endogenous. If the firm does not have the desired amount of cash, one way of achieving the desired level is to reduce risk rather than to increase cash holdings. The firm can do so by adjusting its business model. In this setup, the risk measures (investment funding risk and earnings risk) are both endogenous in the sense that, just like cash holdings, they are decision variables the insider can choose optimally to maximize her expected utility.

5. Results

5.1. Baseline results

We estimate the specifications of the model in (1) using several classes of panel data models. The static specifications include Pooled OLS (P-OLS), Fixed Effect (FE-OLS), Random Effect (RE-GLS). The dynamic specifications include two-step Arellano and Bond (1991) DIFF-GMM and two-step Blundell and Bond (1998) SYS-GMM estimators. In static models, all covariates are assumed to be strictly exogenous. In this case, if the individual effects are independent of the explanatory variables, then all estimators are consistent, and the RE estimator is the most efficient. If the individual effects are not independent of some of the covariates, however, the FE estimator is the only one to be consistent. In dynamic models, the covariates, treated as endogenous, are instrumented by their own lags. To reduce the problem of instrument proliferation (Roodman, 2009), in these models we limit the number of lags used as instruments.

In the first column of Table 3, we report estimates of a static specification of (1) whereas, in the second column, we report estimates of a dynamic specification including all explanatory variables described in the previous section and summarized in Table 2.[3] FE-OLS is used for the static model, whereas SYS-GMM is used for the dynamic model. The dynamic model includes, among the covariates, two lags of the dependent variable. We treat all covariates as endogenous, thus instrumenting them by their own lag, except for time-invariant and economic cycle variables.[4] We do not allow for interaction effects in the regressions considered in Table 3, leaving their analysis to the next Section. We do so for the sake of parsimony, to avoid losing efficiency, reassured by the fact that such effects are picked up, at least to some extent, by the fixed effects and, in the dynamic models, by lags of the dependent variable.

[3] Some of our independent variables are time-invariant, namely *comm*, *ctax*, *difftax* and *ciara*, and, therefore, do not appear in the FE specification as they are treated as fixed effects. More specifically, *comm* and *ciara* are measured in 2011 and *ctax* and *difftax* are measured in 2010. Given that ownership structure, cost of capital and tax rates of firms in a country are relatively stable over time, we do not expect that this might lead to any significant bias in our results (see LaPorta, López de Silanes, Shleifer, & Vishny, 2002; Ozkan & Ozkan, 2004).

[4] The Arellano-Bond tests do not reject our models. The Sargan's tests of over-identifying restrictions, however, do. These rejections, while suggesting some caution in interpreting our results, might also be due to heteroscedasticity in the data, since in this case the Sargan test tends to be unreliable (Arellano & Bond, 1991). The presence of heteroscedasticity is indeed likely to characterize our heterogeneous dataset of firms. This motivates our choice of using Windmeijer's finite-sample correction for the standard errors (Windmeijer, 2005). To save space, we did not tabulate the results on the Arellano-Bond and Sargan specification tests, but they are available upon request.

Table 3
Linear static and dynamic panel-data models.

	[1] - FE-OLS			[2] - SYS-GMM		
Variables	Coef	SE	Sign	Coef	SE	Sign
constant	11.13	0.74	***	−1.98	1.61	
choa lag 1				54.57	1.51	***
choa lag 2				6.59	1.02	***
Funding risk						
cor(*cfoa,coa*)	−1.55	0.31	***	−0.61	0.35	*
cor(*cfoa,coa*^{2})	−1.02	0.27	***	−0.40	0.33	
Earnings risk						
sd(*roa*)	14.14	6.06	**	−8.01	4.53	*
skew(*roa*)	−0.19	0.02	***	−0.17	0.02	***
Profitability						
roa	10.65	1.01	***	6.62	1.22	***
soa	0.26	0.16		0.43	0.12	***
Cost of capital						
ciara				3.01	11.50	
Investment and growth						
coa	−3.92	0.86	***	−5.17	1.09	***
ioa	−10.01	1.00	***	−3.49	0.96	***
Leverage						
bol	−6.38	0.42	***	−3.15	0.48	***
ltdol	−6.59	0.48	***	−2.76	0.51	***
Liquidity						
col	1.57	0.49	***	1.12	0.62	*
doa	−21.57	0.62	***	−11.71	0.74	***
Taxation						
ctax				13.54	4.56	***
difftax				13.21	3.41	***
Ownership concentration						
comm				2.77	0.94	***
Size						
ln(e)	0.06	0.13		0.48	0.11	***
Economic cycle						
rm	−3.48	0.31	***	−0.67	0.37	*
inf	58.73	5.79	***	−2.29	5.98	
ggdp	45.88	2.59	***	13.00	2.88	***
Year dummies χ^2	11316		***	24079		***
$\mathbf{R^2}$	77.84			NA		
$\mathbf{R^2}$ **Adj.**	73.13			NA		

Notes: ***, ** and * denote significance at the 1, 5 and 10 per cent levels. Inference is based on robust standard errors. All coefficient estimates are in percentage. The estimates in columns [1] and [2] differ by estimation method, which is specified in the column header. The estimates in [2] are obtained including as instruments all the variables that are not time-invariant, with the exclusion of the economic cycle variables.

In the static model, the coefficients of the two variables most directly related to the hedging motive, namely *cor*(*cfoa,coa*) and *cor*(*cfoa,coa*^{2}), are negative and significant, consistent with Acharya et al. (2007) but, in the dynamic model, the coefficient of *cor*(*cfoa, coa*) is only marginally significant, and the coefficient of *cor*(*cfoa,coa*^{2}) is insignificant.

Regarding the coefficient of *sd(roa)*, it is positive and significant in the static model. Hence, it agrees with the implications of the hedging motive, as summarized by PROPOSITION I and it is not incompatible with the attitudinal motive, since PROPOSITION III admits this possibility. In the dynamic GMM model, however, the estimate of the coefficient of *sd(roa)* is negative. This is important because a non-positive sign of the coefficient of *sd(roa)* cannot be admitted under the hedging motive alone but can be rationalized if we posit that both precautionary motives are present, since the Corollary of PROPOSITION III admits this possibility if financial leverage is sufficiently high and debt duration sufficiently low (hence for heavily financially constrained firms).

This helps us overcome the near observational equivalence of the two effects and makes a more conclusive inference on the presence of the attitudinal motive, alongside the hedging one or by itself. In other words, the negative dynamic GMM estimate of the coefficient of *sd(roa)* is the smoking gun of the presence of the attitudinal motive, possibly alongside the hedging motive, rather than the hedging motive alone.

Evidence partially in contrast with the hedging motive is provided by the estimates, in both models (static and dynamic), of the effect of the "investment and growth" and "leverage" variables. The coefficients of the ratios capital expenditures to total assets (*coa*) and

Table 4
Robustness checks I.

	[3] - FE-OLS			[4] - FE-OLS			[5] - SYS-GMM			[6] - SYS-GMM		
Variables	Coef	SE	Sign	Coef	SE	Sign	Coef	SE	Sign	Coef	SE	Sign
constant	11.37	0.74	***	11.93	0.66	***	−1.51	1.73		−3.48	3.52	
choa lag 1							54.49	1.50	***	54.16	1.48	***
choa lag 2							6.64	1.02	***	6.28	1.01	
Funding risk												
cor(cfoa,coa)				−1.29	0.30	***				−0.18	0.35	
cor(cfoa,coa^2)				−0.90	0.26	***				0.39	0.32	
Earnings risk												
sd(roa)	13.78	5.94	**				−10.61	4.95	**			
skew(roa)	−0.18	0.02	***				−0.17	0.02	***			
Profitability												
roa	10.67	1.01	***	10.54	1.01	***	6.47	1.23	***	6.01	1.26	***
soa	0.26	0.16		0.26	0.16		0.42	0.12	***	0.42	0.12	***
Cost of capital												
ciara							33.78	14.62	**	−28.03	17.03	*
Investment and growth												
coa	−3.88	0.85	***	−3.94	0.87	***	−5.30	1.09	***	−5.50	1.22	***
ioa	−9.95	1.00	***	−10.01	1.00	***	−3.52	0.96	***	−4.27	1.00	***
Leverage												
bol	−6.39	0.42	***	−6.33	0.42	***	−3.12	0.49	***	−2.87	0.49	***
ltdol	−6.61	0.48	***	−6.51	0.49	***	−2.76	0.51	***	−2.61	0.51	***
Liquidity												
col	1.58	0.49	***	1.51	0.49	***	1.31	0.62	**	1.39	0.62	**
doa	−21.55	0.62	***	−21.57	0.62	***	−12.36	0.75	***	−11.95	0.75	***
Taxation												
ctax							5.52	5.15		24.14	12.23	**
difftax							19.34	3.93	***	18.38	5.67	***
Ownership concentration												
comm							3.30	1.00	***	1.70	1.15	
Size												
ln(e)	0.05	0.13		0.03	0.13		0.46	0.13	***	0.45	0.13	***
Economic cycle												
rm	−3.49	0.31	***	−3.71	0.31	***	−0.43	0.37		−0.71	0.38	*
inf	51.63	5.63	***	68.70	5.86	***	−4.10	6.04		2.34	6.21	
ggdp	46.32	2.60	***	44.99	2.55	***	17.29	3.12	***	14.11	3.18	***
Year dummies χ^2	11146		***	11239		***	24417		***	21764		***
R^2	77.83			77.80			NA			NA		
R^2 Adj.	73.11			73.06			NA			NA		

Notes: ***, ** and * denote significance at the 1, 5 and 10 per cent levels. Inference is based on robust standard errors. All coefficient estimates are in percentage. The estimates in [5] and [6] are obtained including as instruments all the variables that are not time-invariant, with the exclusion of economic cycle variables.

intangible assets to total assets (*ioa*) are negative in both models (static and dynamic), and therefore in contrast with the hedging motive if these variables proxy for the availability of investment opportunities. Intangibles are typically a large fraction of assets in firms with greater growth opportunities. For these firms, there is a greater chance of facing a costly funding shortfall in the future and, therefore, they should find the hedging motive stronger and hold more cash. Besides, a large fraction of intangibles over total assets should negatively affect the firm ability to raise external capital, due to the limited extent to which intangibles may be pledged as collateral, and therefore should render the firm more capital constrained. Under the hedging motive, this should lead the firm to a greater accumulation of cash. It is even more remarkable that the coefficients of short-term and long-term debt (*bol* and *ltdol* respectively) are negative. Unless we make the arguably unrealistic assumption that the typical private firm is financially unconstrained, this finding is consistent with the view that cash acts indeed as a substitute for debt capacity and thus as "negative debt", in contrast with the hedging motive put forth by Acharya et al. (2007). In defense of the hedging motive, however, it should be noted that it is possible that funding constraints are so severe that firms run down cash holdings to fund present investment opportunities. This would happen if free cash flows were low. The strong relationship between profitability and cash holdings suggests this is a concrete possibility, which future research should explore.

Overall, the static estimates are largely consistent with the main testable implication of both precautionary motives, but the dynamic GMM estimates are less supportive of the hedging motive. The static FE model does not allow for the endogeneity of the funding and earnings risk variables whereas the dynamic GMM specification does. Therefore, in the dynamic specification, the lags of the dependent

Table 5
Robustness checks II (**other estimators**).

Panel A Static models	FE-OLS				P-OLS				RE-GLS			
	(a)		(b)		(a)		(b)		(a)		(b)	
Funding risk												
cor(cfoa,coa)	−1.29	***	−1.55	***	−2.24	***	−1.64	***	−1.40	***	−1.70	***
cor(cfoa,coa^2)	−0.90	***	−1.02	***	−1.45	***	−0.68		−1.00	***	−0.84	***
Earnings risk												
sd(roa)			14.14	**			57.01	***			39.29	***
skew(roa)			−0.19	***			−0.07	**			−0.13	***
Panel B **Dynamic models** (Instruments include lags of earnings risk variables and funding risk variables)												
	SYS-GMM (**two lags**)				**SYS-GMM** (**one lag**)				**DIFF-GMM** (**one lag**)			
	(a)		**(b)**		**(a)**		**(b)**		**(a)**		**(b)**	
Funding risk												
cor(cfoa,coa)	−0.18		−0.61	*	−0.19		−0.52	*	0.15		−0.43	**
cor(cfoa,coa^2)	0.39		−0.40		0.34		−0.30		−0.01		−0.30	*
Earnings risk												
sd(roa)			−8.01	*			−7.24				−7.97	***
skew(roa)			−0.17	***			−0.16	***			−0.12	***
Panel C **Dynamic models** (Instruments exclude lags of earnings risk variables and funding risk variables)												
	SYS-GMM (**two lags**)				**SYS-GMM** (**one lag**)				**DIFF-GMM** (**one lag**)			
	(a)		**(b)**		**(a)**		**(b)**		**(a)**		**(b)**	
Funding risk												
cor(cfoa,coa)	0.12		−0.74	**	−0.01		−6.09	***	0.29		−0.20	
cor(cfoa,coa^2)	0.49		−0.59	*	0.42		−3.77		−0.03		−0.31	*
Earnings risk												
sd(roa)			−22.65	***			−19.00	***			−7.87	***
skew(roa)			−0.21	***			−0.19	***			−0.12	***

Notes: ***, ** and * denote significance at the 1, 5 and 10 per cent levels. Inference is based on robust standard errors. Columns (a) report results for models that don't include earnings risk variables, whereas columns (b) report results for the models that include them. Regressors include an intercept and all the control variables. All coefficient estimates are in percentage. Panel A and Panel B differ in the set of instruments used in estimating the dynamic models.

variable pick up effects, such as endogeneity of funding and earnings risk variables as well as delayed adjustments of cash holdings, which are omitted in the static specification and are correlated with *sd(roa)*. Hence, we should view the (positive) estimate of the coefficient of *sd(roa)* in the static model as inconsistent and the (marginally significantly negative) dynamic GMM estimate thereof as the consistent one. In fact, the dynamic component of our model to estimate cash holding appears important, implying a half-life of cash flow shocks of approximately $h \cong \frac{\ln(0.5)}{\ln(0.5513)} = 1.16$ years (from the estimate of the coefficient of the first lag of *choa* in model [2] in Table 3). This horizon is compatible with the reason we conjectured for adopting the dynamic specification, namely the endogeneity of earnings risk variables due to reverse causality.

Table 4, as a robustness check, reports estimates either without the earnings risk variables or without the funding risk variables, for both specifications (static and dynamic). The estimated coefficients of many of the included variables are largely unchanged relative to the estimates reported in Table 3. The estimated coefficient of *cor(cfoa, coa)* in the dynamic specification, however, is no longer significant when the earnings risk variables are excluded, and the coefficient of *cor(cfoa, coa^2)* changes sign, but it is not significant. In contrast, the estimates of the earnings risk variables, in both specifications (static and dynamic), are robust to the exclusion of the funding risk variables. If anything, the estimates become more significant. As can be seen by comparing model [1] in Table 3 with models [3] and [4] in Table 4, the coefficient of determination of the static model is almost unchanged when either the earnings risk variables or the funding risk variables are removed, despite their statistical significance. A first obvious explanation is that, because the two pairs of risk variables are not orthogonal, they proxy for each other when one pair is omitted. This might explain why the presence of the attitudinal motive has gone unnoticed so far. A second and related explanation is that the year dummies and firm-level fixed effects too pick omitted variation up over time and across firms.

Table 5 succinctly reports results concerning the other estimators for the model that includes all explanatory variables except the earnings risk ones and for the model that includes all explanatory variables with no exception, in the columns labeled with "(a)" and "(b)", respectively. We report estimates only for the coefficients that are more closely related to both precautionary motives, namely the

Table 6A
Cross-sectional variation in the hedging motive.

	(a)		(b)		(a) - (b)	
High vs. low profitability	**High *roa***		**Low *roa***			
	−2.12	***	−0.88	**	−1.24	**
High vs. low efficiency	**High *soa***		**Low *soa***			
	−2.23	***	−0.68		−1.55	**
High vs. low cost of capital	**High ciara**		**Low ciara**			
	−0.86	**	−1.71	***	0.85	
High vs. low growth	**High *coa***		**Low *coa***			
	−1.10	***	−2.32	***	1.23	**
High vs. low intangibles	**High *ioa***		**Low *ioa***			
	−1.42	***	−1.62	***	0.20	
High vs. low bank debt	**High *bol***		**Low *bol***			
	−0.72	**	−1.99	***	1.27	**
High vs. low long-term debt	**High *ltdol***		**Low *ltdol***			
	−0.90	**	−1.99	***	1.09	*
High vs. low liquidity	**High *doa***		**Low *doa***			
	−2.29	***	−1.10	**	−1.19	**
High vs. low corporate taxation	**High c*tax***		**Low c*tax***			
	−0.26		−2.02	***	1.76	**
High vs. low tax progressivity	**High *difftax***		**Low *difftax***			
	−0.43		−4.34	***	3.91	***
Concentrated vs. dispersed ownership	**Concentrated**		**Dispersed**			
	−1.74	***	−0.96		−0.78	
Small vs. big firms	**Small**		**Big**			
	−1.28	***	−1.80	***	0.52	
Anti-cyclical vs. pro-cyclical	**Anti-cyclical**		**Pro-cyclical**			
	−1.86	***	−1.45	***	−0.41	

earnings risk variables and the funding risk variables. In Panel A, the estimators are P-OLS and RE-GLS and, in Panel B and Panel C, SYS-GMM with one lag of the dependent variable included among the regressors and DIFF-GMM. To facilitate comparisons, we also reproduce results already reported in Table 3 concerning FE-OLS and SYS-GMM with two lags of the dependent variable. The results reported in Panel B are based on a set of instruments that includes the earnings risk variables and funding risk variables, whereas Panel C refers to the results obtained excluding these variables from the instruments. The sign, magnitude and significance of the estimated coefficients in the static models are largely consistent with the corresponding results reported in Table 3. In the dynamic models, however, the sign and statistical significance of the coefficients of *sd(roa)* and of the funding risk variables change depending on the estimator and whether the earnings risk variables are included, becoming significant only when these variables are indeed included, whereas the coefficient of *skew(roa)* is always negative and significant. These findings, like the previous ones, lend support to the attitudinal motive but are problematic from the point of view of the hedging motive.

5.2. Interaction effects

The analysis in Section 2 suggests that the strength of each motive varies with several variables. For the sake of parsimony, we did not explicitly allow for these effects in the regressions considered so far, but we explore them here. We estimate the joint effect on cash holding of several firm characteristics and each one of the two precautionary motives. The firm characteristics we consider include all our independent variables and an additional one indicating whether the industry in which the firm is active is cyclical or anti-cyclical.[5]

We classify firms into subsamples according to each characteristic and estimate, for each subsample, separate static panel regressions like the ones considered in Table 3. Then, we test for the difference across subsamples of the coefficients most directly associated with each of the two precautionary motives. We perform these "poolability" tests only on estimates of the static models because doing so using estimates of the dynamic models would be too complex.

In Table 6A and Table 6B, for each sorting characteristic, we report the estimated coefficients of *cor*(*cfoa,coa*) and *skew(roa)*, respectively, in each subsample as well as their differences across subsamples. For each characteristic, the second and third column of each table report the estimated coefficients in each subsample. The more negative the sign of these coefficients, the stronger the hedging motive and the attitudinal motive, respectively, in the subsample which the estimate refers to. The fourth column reports the difference

[5] Cyclicality is proxied by the correlation between final demand for the industry output and GDP of the country where the firm is based. The firm might hold cash to ensure a smooth payout profile for influential stakeholders rather than the shareholder.

Table 6B
Cross-sectional variation in the attitudinal motive.

	(a)		(b)		(a) - (b)	
High vs. low profitability	**High roa**		**Low roa**			
	−0.21	***	−0.14	***	−0.07	*
High vs. low efficiency	**High *soa***		**Low *soa***			
	−0.25	***	−0.14	***	−0.11	***
High vs. low cost of capital	**High ciara**		**Low ciara**			
	−0.20	***	−0.14	***	−0.06	
High vs. low growth	**High *coa***		**Low *coa***			
	−0.13	***	−0.24	***	0.12	***
High vs. low intangibles	**High *ioa***		**Low *ioa***			
	−0.15	***	−0.24	***	0.09	**
High vs. low bank debt	**High *bol***		**Low *bol***			
	−0.12	***	−0.25	***	0.13	***
High vs. low long-term debt	**High *ltdol***		**Low *ltdol***			
	−0.13	***	−0.24	***	0.11	***
High vs. low liquidity	**High *doa***		**Low *doa***			
	−0.15	***	−0.23	***	0.08	**
High vs. low corporate taxation	**High *ctax***		**Low *ctax***			
	0.02		−0.23	***	0.24	***
High vs. low tax progressivity	**High *difftax***		**Low *difftax***			
	0.00		−0.35	***	0.35	***
Concentrated vs. dispersed ownership	**Concentrated**		**Dispersed**			
	−0.22	***	−0.12	***	−0.10	**
Small vs. big firms	**Small**		**Big**			
	−0.19	***	−0.19	***	−0.01	
Anti-cyclical vs. pro-cyclical	**Anti-cyclical**		**Pro-cyclical**			
	0.00		−0.18	***	0.18	***

Notes: ***, ** and * denote significance at the 1, 5 and 10 per cent levels. Inference is based on robust standard errors. Panel A and Panel B report the fixed effect model coefficients of *cor*(*cfoa*,*coa*) and *skew*(*roa*), respectively estimated over subsamples. Regressors include an intercept and all the control variables. All figures are in percentage.

between the values reported in the previous two columns, which represents an estimate of the effect of the sorting characteristic on the strength of the associated precautionary motive, akin to the coefficients of the regression of *choa* on "interaction" variables represented by the product of the sorting characteristic and either *cor*(*cfoa, coa*), for the hedging motive, or *skew*(*roa*), for the attitudinal motive.

As far as the hedging motive is concerned, the coefficient estimates imply that it is counter-intuitively stronger for more profitable and efficient firms. Also, the sign of the estimated coefficient of the funding risk variable is the wrong one for both high and low values of *coa*, *ioa*, *bol,* and *ltdol*. These coefficients are all negative whereas, under the hedging motive, they should be positive. In contrast, the estimates are generally supportive of the attitudinal motive. The sign of the coefficients of *skew(roa)* is more negative when firms are more profitable. This can be rationalized in a manner consistent with the attitudinal motive because, for the representative insider, the marginal value of consumption is lower when profits are high. The attitudinal motive is also significantly stronger in low growth firms and firms with low rates of intangibles to total assets. This fact is consistent with a long-run endogeneity of firm growth, in that stakeholders will choose low growth strategies if growth is associated with a negative skewness of the earnings distribution (i.e., if it is risky) and they cannot accumulate cash they wish to hold. The analysis also supports the testable implications of the attitudinal motive in the presence of progressive personal taxation (as per PROPOSITION IV). The sign of the coefficients of *skew(roa)* is also more negative in firms where ownership is concentrated. This too is consistent with the attitudinal motive (as per PROPOSITION V) because the concentration of ownership implies stronger influence, at the margin, of insider-outsider agency problems. As such, it is also consistent with the view that cash is accumulated, especially when, from the perspective of the insider, it is less likely that it will be used inefficiently. This is consistent with arguments emphasized by the empirical literature on corporate governance and cash holdings (e.g., Harford, Mansi, & Maxwell, 2008).

Overall, this analysis confirms our previous conclusions: the attitudinal motive is, at the very least, an essential complement to the hedging motive emphasized by the precautionary motive literature.

6. Conclusions

In this study, we explored the role of precautionary motives in explaining cash holdings in private firms. Due to the peculiarities of private firms, we considered a novel variant of the precautionary motive, driven by insider risk attitudes, alongside the traditional motive à la Opler et al. (1999) and Acharya et al. (2007).

Our findings, based on a large sample of European private firms, are multi-faceted. First, we find that some of the implications of the precautionary motive, especially in the case of the hedging motive, lack empirical support. For example, the relationship between cash holdings and debt is negative in our sample, whereas it should be positive according to the hedging motive. We also find that some of the patterns traditionally explained using the hedging motive are more easily explained if the attitudinal motive is also present. This might depend on our sample: it is composed of private firms, and these firms are from Europe rather than the US.

In our sample, cash holdings are lower than in the samples considered by previous studies, which have prevalently focused on US public firms. They are 9% of assets, which is less than half than, for example, the average cash ratio (23%) in the sample of US firms considered by Bates, Kahle, and Stulz (2009). They seem too low if the purpose is to hedge funding risk of future investment opportunities, which would require the more sizeable balances typical of US firms, whereas they seem to be large enough to hedge the risk of fluctuations of the insider's consumption possibilities. In this respect, our results are consistent with the findings by Mortal and Reisel (2014) and Mortal et al. (2016), who use a European dataset and report that cash holdings are lower and the hedging motive is weaker in private firms than in public ones. It is, however, at least in part in contrast with the importance of the hedging motive in US private firms found by Gao et al. (2013).

A parallel implication of our findings is that the assumption of exponential utility with a constant absolute risk aversion (CARA), which is analytically convenient and thus ubiquitous in corporate finance models, should be scrutinized. This is because the exponential utility function rules out prudence and temperance, which are instead crucial in explaining the role of ROA skewness as a determinant of cash holdings under our motive. Alternative utility functions featuring DARA should be considered instead. The well-known power utility and its limiting case, namely logarithmic utility, are among the utility functions that exhibit DARA, alongside less-known ones belonging to the family of HARA (hyperbolic absolute risk aversion) utility functions. In this regard, a useful extension would be to investigate the possible influence of variation of risk attitudes across cultural settings (countries, regions, etc.).

From a policy point of view, an important implication of our results is that financially constrained insiders will reduce the riskiness of their business if unable to attain the desired level of cash holdings. More precisely, in economies affected by cash shortages, entrepreneurs will be more cautious, with possibly socially suboptimal effects on the allocation of resources and economic activity. It would be important to quantify such effects. For example, since strategies that more aggressively pursue innovation are often risky, the inability to build up cash holdings may have adverse implications for the propensity of firms to innovate (Magill et al., 2015). We leave the investigation of these important possibilities for future research.

CRediT authorship contribution statement

Valerio Potì: Conceptualization, Methodology, Writing - review & editing. **Pierpaolo Pattitoni:** Data curation, Methodology, Formal analysis. **Barbara Petracci:** Writing - original draft, Data curation, Formal analysis.

Appendix A

PROPOSITION II: Assume that the insider's preferences can be represented by a time and state-separable utility function and exhibit standard risk aversion. Assume further that she is a shareholder whose stake in the firm represents her only risky asset. Then, her cash holdings are positively related to the variance of the distribution of ROE and negatively related to its skewness.

Proof: To prove this proposition, we present a simple model of the insider's consumption-savings and cash holding decisions under uncertainty, based on the two-period model of Kimball (1990). It is essentially a restatement of the analysis offered by Kimball (1990), adapted to our context.

Let the assumptions in PROPOSITION II hold. Then, the insider is an undiversified shareholder whose only risky asset is her share of equity and whose preferences can be represented by a time and state-separable utility function, $U(c_1, \tilde{c}_2)$, defined over present, c_1, and future, $\tilde{c}_2$, consumption, that takes the form

$$U(c_1, \tilde{c}_2) = u(c_1) + \beta u(\tilde{c}_2) \tag{A1}$$

Here, $\beta \in (0,1)$ is the subjective discount factor and, from the point of view of the insider who makes a choice in period 1, $\tilde{c}_2$ is a random variable. The assumption that the insider's preferences exhibit standard risk aversion, as formalized by Kimball (1993), implies that her marginal utility is positive, $u'(.) > 0$, decreases with consumption, $u''(.) < 0$, is convex, $u'''(.) > 0$, and also that the fourth derivative of utility is negative, $u^{(4)}(.) < 0$. The positivity of marginal utility implies greed or, equivalently, non-satiation (NS). The latter and the requirement that marginal utility be decreasing imply risk aversion (RA). RA and the convexity of marginal utility, i.e. $u'''(.) > 0$, imply DARA. In the formalization put forth by Kimball (1990), NS, RA, and DARA together define *prudence*, which is at the heart of the so-called precautionary savings motive in the household literature. For a utility function that exhibits this property $u^{(4)}(.) < 0$, implies that absolute risk aversion (ARA) decreases at a decreasing rate and defines DAP or *temperance*. Given the monotonicity and concavity of the utility function, the combination of DARA and DAP is necessary and sufficient for "standard risk aversion" as defined by Kimball (1993).

Because, by assumption, equity is the insider's only risky asset and assuming (for simplicity and with no loss of generality) no initial cash holdings and a zero-interest rate, the life-time budget constraint is

$$\tilde{c}_2 = k_0 + \pi_1 - c_1 + \tilde{\pi}_2 \tag{A2}$$

where k_0 is the stakeholder's share of equity accumulated by the firm by the start of period 1 and π_1 and $\tilde{\pi}_2$ are her share of the firm's first and second (end of) period earnings, respectively. The second-period earnings are stochastic, and, for convenience, we can divide them into their expectation, $\overline{\pi}_2$, and a zero-mean stochastic term, $\tilde{\varepsilon}_2$, that is $\tilde{\pi}_2 = \overline{\pi}_2 + \tilde{\varepsilon}_2$. In (A2), the difference $s_1 = \pi_1 - c_1$ is the amount of savings in the first period that is either channeled towards risky (internal financing) or safe (cash holdings) assets, held either directly (in the bank account) or indirectly (within the firm) by the stakeholder. In other words, the life-time budget constraint simply says that all residual wealth in period 2 is consumed, i.e. distributed. The problem of the insider who wants to maximize her expected utility under the life-time budget constraint can then be written as

$$\max_{c_1} u(c_1) + \beta E_1(u(k_0 + \pi_1 - c_1 + \overline{\pi}_2 + \tilde{\varepsilon}_2)) \tag{A3}$$

where the expectation, $E_1(.)$, is taken conditional on the information set available in the first period. Then, the optimality condition of the problem in (A3) is given by the familiar Euler equation[6]

$$u'(c_1) = \beta E_1(u'(\tilde{c}_2)) \tag{A4}$$

The Euler equation says that the insider must be indifferent between consuming one more unit in the first period or saving and consuming it in the second period. For the Euler equation to hold, if $E_1(u'(\tilde{c}_2))$ rises, so does $u'(c_1)$. Thus, because $u'(c_1)$ decreases with c_1, due to the RA assumption, an increase in $E_1(u'(\tilde{c}_2))$ implies a decrease in c_1 and, consequently, an increase in savings (s_1). To understand how the cash holding decisions depend on the (conditional) distribution of future earnings, we need to consider the other two properties of the insider's utility function, namely $u'''(.) > 0$ and $u^4(.) < 0$ or prudence and temperance, respectively, and use them to link variation in $E_1(u'(\tilde{c}_2))$ to variation in the conditional moments of the earnings distribution. To this end, we consider a third-order Taylor expansion of $u'(\tilde{c}_2)$ about the expected value $\overline{c}_2$ of the second-period consumption,

$$u'(\tilde{c}_2) \equiv u'(\overline{c}_2 + \tilde{\varepsilon}_2) \cong u'(\overline{c}_2) + u''(\overline{c}_2)\tilde{\varepsilon}_2 + \frac{1}{2}u'''(\overline{c}_2)\tilde{\varepsilon}_2^2 + \frac{1}{6}u^4(\overline{c}_2)\tilde{\varepsilon}_2^3 \tag{A5}$$

Taking expected values leads to

$$\begin{aligned} E_1(u'(\tilde{c}_2)) &\cong u'(\overline{c}_2) + u''(\overline{c}_2)E_1(\tilde{\varepsilon}_2) + \frac{1}{2}u'''(\overline{c}_2)E_1(\tilde{\varepsilon}_2^2) + \frac{1}{6}u^4(\overline{c}_2)E_1(\tilde{\varepsilon}_2^3) \\ &= u'(\overline{c}_2) + \frac{1}{2}u'''(\overline{c}_2)var_1(\tilde{\varepsilon}_2) + \frac{1}{6}u^4(\overline{c}_2)skew_1(\tilde{\varepsilon}_2) \end{aligned} \tag{A6}$$

where $var_1(.)$ and $skew_1(.)$ denote the variance and skewness operators, respectively.[7] When prudence and temperance are present, if the variance of earnings increases or their skewness decreases, then $E_1(u'(\tilde{c}_2))$ increases and, for the equality in (A4) to hold, current consumption c_1 must decrease (since marginal utility decreases in wealth, due to the risk aversion assumption). Hence, because of the budget constraint in (A2), the amount of savings (s_1) must increase. In other words, if the insider is prudent and temperant, then she saves more if she expects a higher earnings volatility and less skewness in their distribution. Moreover, as shown by Kimball (1993), temperance determines the fraction of savings allocated to safe investments. Hence, in our context, a more temperant insider will allocate a greater fraction of savings to cash. Ultimately, this is because, as explained by Kimball (1993), temperance reflects the desire to moderate the exposure to total risk and thus, in the context of firm-level consumption-savings decisions, the fraction of savings that is conveyed to cash holdings and away from risky reinvestment. Prudence and temperance, and therefore DARA and DAP, are necessary for an increase in risk (wealth volatility) and downside risk (negative skewness) to lead to a greater allocation to savings and the safe asset. Risk aversion, per se, would not warrant this. In the presence of constant absolute risk aversion (exponential utility), the allocation to the safe asset is independent of the moments of the return distribution, as it depends entirely on the risk aversion coefficient. Finally, it is convenient to express the moments in (A6) as functions of the moments of ROE. We denote the ROE of the firm at the end of time $t = 2$ by $\widetilde{ROE}_2$. By definition, $\tilde{\pi}_2 := S_1 \times \widetilde{ROE}_2$, where S_1 is the insider's share of the firm equity. Hence, $\widetilde{ROE}_2 = \frac{\tilde{\pi}_2}{S_1}$ and, therefore, [8]

[6] The multi-period optimality condition of the consumption-savings problem is $u'(c_t) = \beta E_t(u'(\tilde{c}_{t+1}))$. One of the approaches to obtain this solution is writing the problem in Bellman equation form and using the envelope theorem to derive the Euler equation. The multi-period Euler equation is analogous to that in (A4). Thus, considering a simple two-period setup simplifies the analysis without substantially affecting the generality of the conclusions.

[7] While in the statistical literature skewness is typically defined as the third standardized moment, in the corporate finance literature it is often defined, as in (A5), as the third central (but not scaled) moment. The two definitions are related by a proportionality relationship.

[8] Here, we can bring the term in S_1 outside of the variance and skewness operators because it is known at time $t = 1$. Also, it should be recalled that, as remarked in the previous footnote, we are using the properties of unscaled skewness.

$var_1(\widetilde{ROE}_2) = \frac{var_1(\tilde{\pi}_2)}{S_1^2} = \frac{var_1(\overline{\pi}_2 + \tilde{\varepsilon}_2)}{S_1^2} = \frac{var_1(\tilde{\varepsilon}_2)}{S_1^2}$ and $skew_1(\widetilde{ROE}_2) = \frac{skew_1(\tilde{\pi}_2)}{S_1^3} = \frac{skew_1(\overline{\pi}_2 + \tilde{\varepsilon}_2)}{S_1^3} = \frac{skew_1(\tilde{\varepsilon}_2)}{S_1^3}$. Then, solving for the moments of the distribution of the earnings innovations, we have

$$var_1(\tilde{\varepsilon}_2) = S_1^2 var_1(\widetilde{ROE}_2) \tag{A7}$$

$$skew_1(\tilde{\varepsilon}_2) = S_1^3 skew_1(\widetilde{ROE}_2) \tag{A8}$$

Hence, the previously obtained relations of savings and cash holdings with $var_1(\tilde{\varepsilon}_t)$ and $skew_1(\tilde{\varepsilon}_t)$ imply that, under the insider's own beliefs, cash holdings increase in the variance and decrease in the skewness of the firm ROE distribution.

Appendix B

PROPOSITION III: Under the assumptions of PROPOSITION II, the attitudinal motive implies that the insider's optimal cash holdings are negatively related to the skewness of the distribution of ROA.

Proof: Let $var\left(\ln\frac{S_{t+1}}{S_t}\middle|I_t\right) := \sigma_{S,t}^2$ and $skew\left(\ln\frac{S_{t+1}}{S_t}\middle|I_t\right) := \gamma_{S,t}$, where I_t denotes the information set available to the decision-maker at time t, var and skew denote the variance and skewness of the log-growth of the value of equity S_{t+1} inclusive of the value of any end-of-period payout (e.g., dividends or, equivalently, assuming for simplicity that the firm does not pay any dividend), based on the representative insider's information set I_t. We then have that $\sigma_{S,t}^2 \cong var(ROE_{t+1}|I_t)$ and $\gamma_{S,t} \cong skew(ROE_{t+1}|I_t)$. PROPOSITION II states that the insider's optimal cash holdings are positively related to the variance of the distribution of ROE and negatively related to its skewness. Hence, denoting the cash holding as $cash_t$, PROPOSITION II implies that

$$cash_t = \beta_0 + \beta_1\sigma_{S,t}^2 + \beta_2\gamma_{S,t} + u_t \tag{B1}$$

Here, under the attitudinal motive, $\beta_1 > 0$ and $\beta_2 < 0$ are regression coefficients and u_t is a regression error that, together with the constant, β_0, captures other influences on the cash holding balance orthogonal to the skewness and variance of the firm ROE.

To rewrite the moments of the firm ROE as functions of the more easily measurable moments of the firm ROA, we follow Merton (1974) and view the firm equity as a call on the firm assets. We use the model proposed by Merton (1974) to obtain the value for the firm equity as a function of the distribution of the value of the firm assets. If log-returns on the firm assets are not normally distributed, this value is only an approximation. For our purposes, however, it is a useful one as it can be used to derive a first-order approximation of the variance and skewness of the firm equity as a function of the corresponding moments of the firm assets. As shown by Galai and Masulis (1976), the model put forth by Merton (1974) implies that

$$\sigma_{S,t}^2 = \left(\frac{\frac{\partial S_t}{S_t}}{\frac{\partial A_t}{A_t}}\right)^2 \sigma_{A,t}^2$$

Here, $A_t = S_t + D_t$ is the value of the firm assets, where D_t is the value of its debt. Therefore,

$$\sigma_{S,t}^2 = \left(\frac{A_t}{S_t}\right)^2\left(\frac{\partial S_t}{\partial A_t}\right)^2\sigma_{A,t}^2 = \left(\frac{A_t}{S_t}\right)^2 N(d_{1,t})^2\sigma_{A,t}^2 = \left(1+\frac{D_t}{S_t}\right)^2 N(d_{1,t})^2\sigma_{A,t}^2 \tag{B2}$$

Here, $d_{1,t} = \frac{1}{\sigma_{A,t}\sqrt{T-t}}\ln\left(\frac{A_t}{D_t}\right) + \left(r + \frac{\sigma_{A,t}^2}{2}\right)(T-t)$, where T is the maturity of the firm debt.

To derive the relation between the firm ROE and ROA, we start by defining $\tilde{r}_{S,t} := \ln\left(\frac{S_t}{S_{t-1}}\right) - E\left(\ln\left(\frac{S_t}{S_{t-1}}\right)\middle|I_{t-1}\right)$ and assume rational valuation on the part of the representative insider. Then, using the law of iterated expectations, we have that the skewness of the ROE distribution is proportional to the covariance between the variance of ROE and ROE itself,

$$\gamma_{S,t} \propto E\left(\tilde{r}_{S,t}^3|I_{t-1}\right) = E\left(\tilde{r}_{S,t} \times E\left(\tilde{r}_{S,t}{}^2|I_{t-1}\right)|I_{t-1}\right) \cong E\left(\tilde{r}_{S,t} \times \sigma_{S,t}^2\middle|I_{t-1}\right)$$

$$\cong Cov\left(\ln\left(\frac{S_t}{S_{t-1}}\right), \sigma_{S,t}^2\middle|I_{t-1}\right) \tag{B3}$$

Using (B2) in (B3) and the approximation $\ln\left(\frac{S_t}{S_{t-1}}\right) \cong \left(1+\frac{D_t}{S_t}\right)\ln\left(\frac{A_t}{A_{t-1}}\right)$, we then have

$$\gamma_{S,t} \cong Cov\left(\left(1+\frac{D_t}{S_t}\right)\ln\left(\frac{A_t}{A_{t-1}}\right), \left(1+\frac{D_t}{S_t}\right)^2 N(d_{1,t})^2\sigma_{A,t}^2\middle|I_{t-1}\right)$$

Ignoring possible covariation between $\left(1+\frac{D_t}{S_t}\right)^3$ and $\ln\left(\frac{A_t}{A_{t-1}}\right) \times N(d_{1,t})^2\sigma^2_{A,t}\Big|I_{t-1}$ because of higher-order, we then have

$$\gamma_{S,t} \cong \left(1+\frac{D_t}{S_t}\right)^3 Cov\left(\ln\left(\frac{A_t}{A_{t-1}}\right), N(d_{1,t})^2\sigma^2_{A,t}\Big|I_{t-1}\right) = \left(1+\frac{D_t}{S_t}\right)^3\left[N(d_{1,t})^2 Cov\left(\ln\left(\frac{A_t}{A_{t-1}}\right), \sigma^2_{A,t}\Big|I_{t-1}\right) + \sigma^2_{A,t} Cov\left(\ln\left(\frac{A_t}{A_{t-1}}\right), N(d_{1,t})^2\Big|I_{t-1}\right)\right]$$

To first order, this gives

$$\gamma_{S,t} \cong \left(1+\frac{D_t}{S_t}\right)^3\left[N(d_{1,t})^2\gamma_{A,t} + \sigma^2_{A,t}\Gamma_{S,t}\right] \tag{B4}$$

Here, $\Gamma_{S,t} \cong \frac{\partial N(d_{1,t})^2}{\partial \ln\left(\frac{A_t}{A_{t-1}}\right)} \cong \frac{\partial N(d_{1,t})^2}{\partial d_{1,t}} \times \frac{\partial d_{1,t}}{\partial \ln(A_t)} = 2\frac{N(d_{1,t})\varphi(d_{1,t})}{\sigma_{A,t}\sqrt{T-t}}$, where $\varphi(.)$ is the density function of a normal standard variate, is the convexity of the value of the call representing the firm equity, and is strictly positive for a firm that is not in default. So, using (B2) and (B4) in (B1), we have

$$cash_t = \beta_0 + \underbrace{\beta_1}_{>0}\left[\left(1+\frac{D_t}{S_t}\right)^2 N(d_{1,t})^2\sigma^2_{A,t}\right]$$

$$+\underbrace{\beta_2}_{<0}\left\{\left(1+\frac{D_t}{S_t}\right)^3\left[N(d_{1,t})^2\gamma_{A,t} + \sigma^2_{A,t}\Gamma_{S,t}\right]\right\} + u_t \tag{B6}$$

Then, grouping terms in $\gamma_{A,t}$ and $\sigma^2_{A,t}$,

$$cash_t = \beta_0 + \underbrace{\underbrace{\beta_1}_{>0}\left[\underbrace{N(d_{1,t})^2}_{>0} + \underbrace{\underbrace{\frac{\beta_2}{\beta_1}}_{<0}\underbrace{\left(1+\frac{D_t}{S_t}\right)}_{>0}\underbrace{\Gamma_{S,t}}_{>0}}_{<0}\right]}_{?} \times \left(\left(1+\frac{D_t}{S_t}\right)^2\sigma^2_{A,t}\right)$$

$$+\underbrace{\underbrace{\beta_2}_{<0}\underbrace{N(d_{1,t})^2}_{>0}}_{<0} \times \left(\left(1+\frac{D_t}{S_t}\right)^3\gamma_{A,t}\right) + u_t \tag{B7}$$

This shows that the sign of the coefficient of $\left(\left(1+\frac{D_t}{S_t}\right)^3\gamma_{A,t}\right)$ is negative since $\beta_2 < 0$ and $N(d_{1,t})^2 > 0$.

COROLLARY: The sign of the relation between cash holdings and the standard deviation of ROA can be positive or negative depending on factors that include the relative magnitude of prudence and temperance, financial leverage, and the duration of the liabilities.

PROOF: From (B7), we see that the sign of $\left[N(d_{1,t})^2 + \frac{\beta_2}{\beta_1}\left(1+\frac{D_t}{S_t}\right)\Gamma_{S,t}\right]$, which is the coefficient of $\left(\left(1+\frac{D_t}{S_t}\right)^2\sigma^2_{A,t}\right)$, depends on $N(d_{1,t})$ and $\Gamma_{S,t}$ as well as on the ratio $\frac{\beta_2}{\beta_1}$. We know that, under the attitudinal precautionary motive, $\frac{\beta_2}{\beta_1} < 0$. Therefore, the sign of

$$\underbrace{N(d_{1,t})^2}_{>0} + \underbrace{\underbrace{\frac{\beta_2}{\beta_1}}_{<0}\underbrace{\left(1+\frac{D_t}{S_t}\right)}_{>0}\underbrace{\Gamma_{S,t}}_{>0}}_{<0}$$

depends on the relative magnitude of the first and second term. It is positive if $N(d_{1,t})$ is large and both the absolute value of $\frac{\beta_2}{\beta_1}$ and $\Gamma_{S,t}$ are sufficiently small. The requirement that the absolute value of $\frac{\beta_2}{\beta_1}$ be small amounts to requiring the representative insider to be more prudent than temperant. The requirement that $N(d_{1,t})$ and $\Gamma_{S,t}$ be large can be interpreted recalling that the equity of the firm can be seen as a call option on the firm assets with a strike price given by the firm debt, and that $N(d_{1,t})$ and $\Gamma_{S,t}$ are the delta and gamma (convexity) of this option. A large delta and a small gamma are typical of long-dated deep-in-the-money options. Hence, $N(d_{1,t})$ and $\Gamma_{S,t}$ are large if the liabilities of the firm are sufficiently small relative to the assets of the firm and of relatively long-maturity (so that the curvature, $\Gamma_{S,t}$, of the equity value is modest).

Appendix C. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.iref.2020.03.003.

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