Corporate Life-Cycle Dynamics of Cash Holdings

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First version: March 2015

Abstract

This paper shows that the corporate life-cycle is an important dimension for the dynamics and valuations of cash holdings. Our results indicate that firms' cash policies are markedly interacted with their strategy choices. While firms in early stages and post-maturity stages hold large amounts of cash, cash ratios decrease when firms move towards maturity. Much of this variation in cash holdings is attributable to a changing demand function for cash over the different life-cycle stages. Trade-off and pecking order motives are of different importance for cash policies dependent on a firm's life-cycle stage. An additional dollar in cash is highly valuable for introduction and growth firms, while a dollar in cash adds, on average, less than a dollar in market value for firms in later life-cycle stages, most likely due to increasing agency problems. Most of the dynamics in cash holdings are observed at life-cycle transition points rather than during the different life-cycle stages. Finally, the secular trend in cash holdings seems strongly attributable to increases in cash in the introduction and the decline stage.

Keywords: Life-cycle, cash holdings, value of cash

JEL Classification Codes: G30, G32, M10

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I. Introduction

The dynamics and valuations of corporate cash holdings have received a lot of attention in the corporate finance literature. Motives, such as precautionary saving, competitive pressure or refinancing risk, are suggested to rationalize observed cash levels. Agency costs and tax issues are important costs associated with holding cash. However, little consensus has been reached about the relative importance of and the interplay between these concepts. We argue in this paper that an important dimension has been missing from the discussion, namely the corporate life-cycle.[1] The goal of our paper is to close this gap.

The notion of a corporate life-cycle is a highly complex and multi-dimensional concept. Among other things, the economics literature connects production and investment behavior (Jovanovic and MacDonald (1994)), experience and learning (Spence (1981)), and competition as well as market share (Wernerfelt (1985)) to the corporate life-cycle. Broadly speaking, when we refer to the corporate life-cycle, we think about firms following different strategies in different stages to deal with varying constraints and challenges. Therefore, our paper also relates to the strand of the literature that links firms' strategic decisions to financing choices (see Parsons and Titman (2008) for an overview). In particular, the focus of our study is to evaluate empirically and in the context for firms' cash management whether the corporate life-cycle matters.

The key challenge for the econometrician is to determine from observable data which life-cycle stage a firm is in during a particular period of time. For this purpose, we follow Dickinson (2011), who developed and evaluated a mechanism to match firms to life-cycle stages using the signs of cash-flows from various sources (i.e., operations, investments and financing). Specifically, we distinguish five stages – introduction, growth, maturity, shake-out and decline (see Gort and Keppler (1982)) – in this paper. An important conceptual advantage of this classification is that it does not imply a strict sequence across the stages of the life-cycle and, in contrast, allows firms to dynamically move back and forth between stages. This setup allows us to

[1] The only exception we know of is a working paper, Dittmar and Duchin (2011), which looks at the interaction between firm age (time since IPO), as a proxy for the life-cycle, and cash holdings. Our analysis differs substantially in terms of methodology to identity life-cycle stages and empirical tests regarding the cash management of firms.

study and distinguish a rich cross-section of transitions between life-cycle stages in our empirical analysis.

Surprisingly, the literature is relatively silent regarding the importance of the corporate life-cycle for corporate finance questions. Notable exceptions are DeAngelo, DeAngelo and Stulz (2006), using retained earnings as proxy for the life-cycle stage, and DeAngelo, DeAngelo and Stulz (2010), using years listed as proxy for the life-cycle stage. They find that firms' payout policies are consistent with a life-cycle theory of the firm (see also Banyi and Kahle (2014)). Bulan and Yan (2010) study the link between the pecking order theory and the corporate life-cycle. They consider only two stages – the "growth" stage is defined as the first 6 years post-IPO and the "maturity" stage is defined as the consecutive six-year period following a dividend initiation. Finally and most closely related to our paper, Dittmar and Duchin (2011) study the dynamics of cash using firm age (years since the IPO) as a measure of the corporate life-cycle.

Our main results are as follows. Levels of observed and target cash, determinants of target cash, adjustment speeds, and the value of cash vary substantially across life-cycle stages. These results suggest that firms in different life-cycle stages follow different motives in their cash policies. For example, we find that firms in life-cycle stage 1 and 5 actively manage their cash holdings towards target levels and, given their pronounced levels of financial constraints and low correlations between operating income and investment opportunities (Acharya, Almeida, and Campello (2007)), use cash as a hedging instrument. In contrast, firms in the "maturity" life-cycle stage put less weight on target cash holdings but adjust cash holdings in response to the fortunes of the company (i.e., they follow the financing hierarchy model).

We also study secular trends in the dynamics of aggregate cash holdings per life-cycle stage. Bates, Kahle and Stulz (2009) document a steady increase in cash holdings over time. We find that average/median cash holdings have increased over time for all life-cycle stages but to varying degrees. The strongest increases in cash holdings are observed for firms in the "introduction" and the "decline" stage.

Life-cycle stages also play an important role in determining the valuation of cash. As one would expect, we find that an additional dollar in cash is highly valuable in the "growth" stage. However, a dollar in cash adds, on average, less than a dollar in market value for firms in life-cycle

stages 4 and 5, most likely due to pronounced agency costs. Interestingly, the value of an additional dollar of cash is much lower for firms in LC-5 than in LC-1. This is surprising given that our analysis of target cash levels (and speeds of adjustment) suggests that firms in life-cycle stage 1 and 5 follow relatively similar cash policies; nevertheless, it seems that the market evaluates the motives to hold cash very differently depending on the stage of the life-cycle that a firm is in.

Finally, and most importantly, we find that transitions between life-cycle stages matter a lot. In particular, we find substantial variation in median cash levels in the final year of a given life-cycle stage depending on the target life-cycle stage in the subsequent year. Similarly, we observe pronounced differences in relative changes of cash holdings during transition years. For example, the median firm in the "introduction" stage has cash holdings of 6.7% in the year before progressing to the "growth" stage and increases its cash holdings by 11.3% in the following year. In contrast, the median firm in the "introduction" stage that moves on to the "decline" stage shows cash holdings of 40.8% and marginally reduces them by 0.5% in the following year. We also find that the market takes future life-cycle stages into consideration when evaluating additional dollars in cash. For example, the value of an additional dollar in cash is 1.43 (0.56) for firms in the "maturity" stage that are transiting to the "introduction" ("shake-out") stage in the following year.

An important caveat, however, applies to the current set of results. While our analysis suggests an important role for the corporate life-cycle on top of standard firm characteristics in explaining cash management policies, we are not able to establish causality, i.e., we do not know whether strategic decisions drive financing decisions or vice versa. In the end, it seems not unlikely that both are determined contemporaneously.

The paper is organized as follows. In section 2 we explain the methodology to assign firms to life-cycle stages and provide some motivation for why we expect the corporate-life-cycle to matter for cash management. Section 3 describes the data, and section 4 summarizes our empirical results. Section 5 concludes.

II. Measuring the Corporate Life-Cycle

Although the life-cycle theory of the firm has been of enduring interest to researchers in theoretical and empirical economics, there exists neither a unique life-cycle model nor a consensus on the definition of corporate life-cycle stages. Proposed models differ in terms of their aggregation level and the number of life-cycle stages. The theoretical literature proposes three-stage, four-stage, or five-stage models that focus primarily on a description of the product life-cycle, while viewing the firm as an aggregation of the single product cycles. Overall, most models agree about the stages introduction, growth, and maturity. In addition, higher order models also include post-maturity stages.

From the empirical perspective, current research further lacks a consensus on how to identify each life-cycle stage. Empirical applications in financial research, so far, have been dominated by univariate approaches to map the life-cycle of the firm. Both size and age, but also the earned/contributed capital mix, are common proxies for a firm's current life-cycle stage. However, the implicit assumption when using these measures is that a firm moves monotonically from its introduction to maturity, staying there until 'death'. This again implies that such measures fail to cover corporate reinvention and restructuring scenarios, since they do not allow firms to enter back into the introduction or growth stage once they have reached maturity. An important advantage of the classification of life-cycle stages employed in this study is that firms do not have to run through the individual stages sequentially. Instead, they can basically jump back and forth in any arbitrary way. The following sections describe the applied measure and its implementation in detail.

A. Formulation of the Life-Cycle Measure

To incorporate post-maturity stages, we adapt a five-stage life-cycle measure recently developed by Dickinson (2011). Following Gort and Klepper (1982), Dickinson (2011) defines (1) introduction, (2) growth, (3) maturity, (4) shake-out, and (5) decline as relevant life-cycle stages. Her life-cycle identification strategy is based on the proposition that corporate cash flows capture the financial outcome of the distinct life-cycle stages, so that each stage has a characteristic pattern of net cash flows, i.e., a stage-specific combination of operating cash flow, investing cash flow, and financing cash flow. The idea behind is that the combination of

cash flow patterns represents a firm's resource allocation and operational capability interacted with its strategy choices. Abstracting from the actual level, each of the three types of cash flows can take a positive or negative sign. Combining the three cash flow signs, results in eight possible combinations of potentially observable cash flow patterns, which are mapped into life-cycle theory in order to derive an empirically applicable life-cycle classification. In contrast to univariate metrics, this 'cash flow pattern proxy' is based on the entire financial information set available at each financial statement date. Following Dickinson (2011), Table I provides an overview of the eight possible cash flow combinations and the resulting life-cycle classification scheme.

[Insert Table I here]

Introduction: As a consequence of lacking established customers, unexploited economies of scale, and a deficit of knowledge about potential costs and revenues (Jovanovic (1982)), introduction firms typically suffer from negative net cash flows from operating activities. On the other hand, they are expected to make large investments to provide or renew the basis for its operating activities and to exploit existing growth opportunities, leading to negative investing cash flows. Given that introduction firms arguably do not possess sufficient capital resources to continuously finance outflows from operations and investment, they need to rely on external financing, i.e., financing cash flows are expected to be positive.

Growth: In contrast to introduction firms, growth-stage firms maximize their profit margins by optimizing their investment activity and increasing operational efficiency (Spence (1977, 1979, 1981), Wernerfelt (1985)), so that operating cash flows are expected to become positive. Similar to the preceding life-cycle stage, investment cash flows are still expected to be significantly negative. Although cash inflows from operations may be used cover the continuing investment activity, growth firms typically require further external financing to maintain high investment capacity.

Maturity: Entering maturity, firms are expected to further increase efficiency. Both maximized profit margins and the large customer base of mature firms provide high operating cash flows. By their definition, mature firms have exhausted their positive net present value projects, so

that they have fewer investment opportunities. Therefore, investments are reduced relative to the preceding stages. However, mature firms are expected to maintain capital, still resulting in negative cash flows from investing during the maturity stage. Both the high operational profitability and the lack of investment opportunities minimize the need for external financing. Given the expected financial surplus, mature firms start to service debt and/or distribute cash to shareholders leading to negative financing cash flows.

Shake-out: Firms entering the shake-out stage exhibit declining or negative growth rates. Arguably, this leads to declining prices (Wernerfelt (1985)), while re-increasing inefficiencies attributable to larger firm size or distress related phenomena lead to an extended cost structure over the life-cycle. Both effects result in decreasing (or negative) operating cash flows. Similar to mature firms, shake-out firms may continue to invest for maintenance reasons. On the other hand, they may liquidate assets to service existing debt obligations and to support operations, i.e., investing cash flows may either be positive or negative. The same holds for financing cash flows. Although shake-out firms may still be able to distribute cash to shareholders, they may also rely on external financing to cover capital maintenance or deficits from operations.

Decline: Decline firms suffer from a deteriorating dilution of earning relative to the shake-out stage. Increased costs of financial distress are expected to further depress corporate results, so that most likely decline firms exhibit negative operating cash flows. In contrast, investment cash flows are expected to be positive. By definition decline firms lack appropriate investment opportunities, but are likely to liquidate assets to support operations rather than expanding their capital budgets. Depending on the deficit (surplus) after investments, decline firms will have positive (negative) financing cash flows.

B. Implementation of the Life-Cycle Proxy

Following Table I, the combination of a firm's net operating, investing, and financing cash flows provide the firm's life-cycle classification at each financial statement date. In order to reduce the impact of single-year effects, we use three-year moving averages of each cash flow type rather than fiscal year-end values to obtain the final life-cycle classification. At this point we deviate from Dickinson (2011), who uses fiscal year-end cash flow data as reported by the firm to implement her life-cycle proxy. The applied correction of the measure controls for non-

fundamental life-cycle classification changes of firms with cash flows around zero. In such cases, cash flows may change signs due to single-year effects that are not related to the operational capability or strategy choice of the firm, resulting in a life-cycle classification possibly providing misleading information on the actual life-cycle stage of the firm. Though the choice of using a three-year moving average is ad hoc to a certain extent, it seems to be a reasonable way to deal with single-year effects. Eventually, using a moving average-based classification does not substantially affect the distributional characteristics of the life-cycle proxy. However, it slightly increases the average dwelling time per life-cycle stage relative to the Dickinson (2011) classification. Section IV.B provides a brief comparison of transition probabilities implied by both implementations.

One might worry that there is a mechanical link between this cash-flow based procedure to separate life-cycle stages and our variable of interest, cash holdings. While there is obviously an important difference between flow and stock variables, it is also important to reemphasize that we only condition on the signs of cash-flows (and their specific patterns across the three sources) rather than their magnitudes. Importantly, all stages of the life-cycle are identified by a combination of positive and negative cash-flows, and thus no stage is unambiguously associated with a positive or negative total cash-flow shock.

III. Data

For our empirical analyses, we obtain annual accounting data of U.S. incorporated industrial firms (active and inactive) from the WRDS merged CRSP/Compustat files for the period 1989 through 2013.[2] We explicitly exclude firms with SIC codes inside the ranges 4900–4999 (utilities) and 6000–6999 (financial firms) that operate in regulated markets and whose cash holding behavior may be driven by special factors. We initially require that firms have non-missing data on total asset (*AT*) and sales (*SALE*) to be included in the sample and we exclude firms with book assets below 1 million USD.

[2] Consistent statement of cash flow data for all U.S. companies in Compustat is only available subsequent to the adoption of the Statement of Financial Accounting Standards #95 (effective for fiscal years ending July 15, 1988 onwards).

Our central figure of interest is the cash balance of the firm measured as cash and equivalents (*CHE*) scaled by total assets (*AT*). To construct the lifecycle proxy for each firm-year, we follow the classification scheme in Table I. Specifically, we use the past three-year moving average of (i) net cash flow from operating activities (*OANCF*), (ii) net cash flow from investing activities (*IVNCF*), and (iii) net cash flow from financing activities (*FINCF*) instead of the plain fiscal year-end values. Detailed information on the construction principles of other variables used in this study are provided in Appendix A. Our final sample comprises 77,377 firm-years with non-missing data for cash and the life-cycle classification (introduction: 12,963; growth: 26,338; maturity: 27,814, shake-out: 4,849; decline: 5,413).

IV. Empirical Results

In this section, we summarize the empirical results. First, we discuss summary statistics focusing on the patterns of firm characteristics over the corporate life-cycle. We also discuss transition probabilities between life-cycle stages and look at the dynamics of aggregate cash levels per life-cycle over time. Second, we report detailed results for the drivers of cash holdings of firms and run a horse race between the trade-off theory and the pecking order theory to understand how firms manage their cash holdings. Third, we analyze the marginal value of an additional dollar in cash. In all these discussions, the focus is on a comparison of results across firms in different life-cycle stages, as this is the key contribution of the paper. Full sample estimates are usually included to ensure comparability to the existing literature.

A. Descriptive Statistics

First, we examine the variation in corporate characteristics over the life-cycle. Table II reports summary statistics for our full sample and for firms in individual life-cycle stages.[3] Most importantly, cash holdings exhibit a U-shaped pattern, with the largest (lowest) average level of cash holdings observed for firms in life-cycle stages 5 and 3, amounting to 38.2% and 13.7% respectively. While leverage measured at book or market values does not show a distinct pattern across the corporate life-cycle, short-term debt mimics the U-shape of cash holdings, albeit

[3] In the following discussion, we focus on average values. Note, however, that all patterns described also hold for median values.

to a less extreme extent. These patterns are consistent with Acharya, Davydenko, and Strebulaev (2012), who show that a conservative cash policy (i.e., higher cash levels) is more likely to be pursued by a firm that finds itself close to distress. As a result, larger cash holdings are empirically associated with higher, not lower, levels of credit risk.

[Insert Table II here]

If we analyze variables that have been used in the prior literature as univariate proxies for a firm's life-cycle, we observe similarities, but also notable differences. Age, for example, shows a hump-shaped pattern indicating that, on average, firms in later life-cycle stages (i.e., "decline" and "shakeout" or LC-4 and LC-5) are younger and not older than mature firms (i.e., firms in LC-3). Not surprisingly, this suggests that age as a "linear" indicator of firm life-cycle is not very sensible.

Somewhat similar patterns are observed for size, retained earnings, and payout measures. They do not increase monotonically across life-cycle stages, but follow hump shapes. Overall, it seems that our classification of life-cycles cannot be easily replicated by using any of the standard, univariate measures employed in the literature before.

In terms of other firm characteristics, we observe intuitive patterns across the board. Many variables such as tangibility, operating income, net working capital and capital expenditures feature hump shapes, reaching their maximum values either for firms in LC-2 or LC-3 and decreasing towards the earlier and later life-cycle stages. In contrast, variables such as market-to-book ratios, R&D expenses, equity issuances, and financing deficits exhibit U-shaped patterns. Measures of financial constraints feature both patterns depending on how they are defined; however, they all suggest that firms in earlier and later life-cycle stages are more constrained than mature firms.

Finally, we take a look at secular trends in the dynamics of aggregate cash holdings for each life-cycle stage. Bates, Kahle and Stulz (2009) document that cash holdings have increased substantially over the last thirty years. They relate this pattern to an increase in the riskiness of firms' cash-flows and similar trends in other firm characteristics, concluding that the precau-

tionary saving motive plays an important role in explaining these dynamics. Figure I plots average and median cash holdings over time for firms in different life-cycle stages. Most importantly, we find that this increase in cash holdings is driven to a large extent by firms in LC-1 and LC-5. These firms raised their cash levels three to four times during our sample period. In contrast, average/median cash holdings have increased much less for firms in other life-cycle stages.

[Insert Figure I here]

Another interesting and surprising result is that cash holdings were very similar across life-cycle stages early on in our sample. During the late 80ties and early 90ties median cash holdings, for example, varied between 5% and 10% across life-cycle stages. In contrast, at the end of our sample period this variation covers the range of 10% to 50%. This suggests that the interaction between the corporate life-cycle and cash management has changed dramatically.

A somewhat related question is whether there have been any long-term trends in the distribution of firms across life-cycle stages. Figure II shows the proportions of firms in each life-cycle stage over time using equal and value weighting. As one would expect, firms tend to concentrate in LC-2 and LC-3. Interestingly, however, there has been a persistent shift towards firms in the "maturity" life-cycle stage after 2000, at least if we use value weighting. Another interesting observation is that the frequency of firms in the "introduction" phase has declined over time reaching its minimum of less than 10% during the recent financial crisis.

[Insert Figure II here]

B. Dynamics of Cash Around Life-Cycle Transitions

An important advantage of the classification of life-cycle stages employed in our study is that firms do not have to run through the individual stages sequentially. Instead, they can basically jump back and forth in any arbitrary way. Overall, the average period a firm stays in a specific life-cycle stage is 2.8 years, but it slightly differs across life-cycle stages (introduction: 2.3

years; growth: 2.9 years; maturity: 3.4 years; shake-out: 2.0 years; decline: 2.2 years).[4] Table III reports the corresponding transition probabilities across life-cycle stages. Most importantly, it shows that firms have a tendency to stay in a life-cycle stage for a few years. For example, the "maturity" life-cycle stage seems to be the stickiest stage, as one would expect: 52% of the firms that are in this stage at time *t* continue to stay in this stage for five years. In contrast, the "shake-out" stage is the one from which firms exit most quickly – only 12.6% stay in this stage for five years. Importantly, our classification does not imply that firms change their life-cycle stage every year, which would not have been very realistic.

[Insert Table III here]

In terms of transitions across life-cycle stages, we find that transition probabilities are highest for neighboring life-cycle stages, i.e., if firms switch, they tend to either progress to the next life-cycle stage or drop back to the previous one. Again, this seems intuitive and provides some comfort regarding our classification. Nevertheless, in some cases larger jumps across various life-cycle stages are also observed. For example, a firm that is in LC-4 this year has a 10% chance of being in LC-2 next year (i.e., moving back from the "shake-out" stage to the "growth" stage).

The focus of our study is on cash holdings and their dynamics for firms in different life-cycle stages. While we have already noted that average cash levels follow a hump shape according to Table II, Table IV provides a more detailed analysis focusing on median cash holdings around transitions. In this table, we focus on medians rather than averages, as changes in cash levels during life-cycle stages and around transitions suffer from extreme, positive outliers.

[Insert Table IV here]

[4] The lifecycle classification applied throughout this study deviates from the original classification proposed by Dickinson (2011) in that we use three-year moving averages instead of fiscal year-end values of the cash flow types to obtain these lifecycle proxies. Using the Dickinson (2011) classification, the average period that a firm stays in a specific stage decreases to 1.8 years (introduction: 1.65 years; growth: 1.86 years; maturity: 1.98 years; shake-out: 1.77 years; decline: 1.63 years).

Most importantly, we observe that firms have different levels of cash in the first year of each stage depending on where they are coming from (column labeled (t) in the table). For example, depending on where a firm is coming from the median level of cash holdings in the first year in LC-1 varies between 2.6% (firms coming from LC-3) and 37.9% (firms coming from LC-5). Similarly, firms have very different levels of cash in the final period of a certain life-cycle stage, depending on where the firm is moving to (column labeled (T) in the table). For example, for firms in LC-1, the average level of cash holdings varies between 2.7% (firms moving to LC-3 next year) and 40.8% (firms moving to LC-5 next year). While similar patterns exist for each life-cycle stage, the magnitudes vary quite a bit. In the case of LC-4, for example, the variation in cash holdings in the first year in stage LC-4 only ranges from 17.0% (firms coming from LC-3) to 20.4% (firms coming from LC-1).

One issue with the above analysis is that it could be driven by composition effects, i.e., by the selection of firms in each cell of Table IV, rather than firms actively adjusting their cash levels before or after transitions. To address this concern, we also include the median relative cash changes immediately before and after transition and during life-cycle phases in Table IV. Interestingly, but maybe not unexpectedly, the median changes in cash levels during each life-cycle stage are zero. This picture, however, changes if we focus on time periods immediately before or after transitions. For example, irrespective of its current life-cycle stage (with the exception of firms in LC-5) the median firm that switches to LC-1 next year reduces its cash holdings in the year of the transition. We observe the largest (smallest) reduction for firms in LC-3 (LC-4) amounting to 19.4% (2.8%). In contrast, the median firm emerging from LC-1 increases its cash holdings in the year of the transition except if it moves directly into life-cycle stage LC-5.

If we follow the median firm through the corporate life-cycle sequentially, we observe the following changes in cash levels around transitions: a firm in LC-1 increases its cash level by 11.3% in the year of switching into the growth phase; it then only marginally raises the cash level even further when moving on to LC-3, by 0.6%; surprisingly, it keeps increasing the cash level by 8.3% when transitioning to LC-4 but then reduces it substantially, by 8.5%, when changing into the decline phase. In general, the largest decreases in cash levels are observed

for firms switching back to earlier life-cycle stages, especially into the introduction stage. Similarly, most pronounced increases are observed for transitions of firms into later stages, especially the maturity and the shake-out stage.[5]

These results suggest that the corporate life-cycle and cash holdings are closely intertwined. In a given life-cycle stage, firms are keeping their cash holdings rather stable, suggesting that benefits and costs of cash do not vary that much within a specific stage. However, around transitions into later or earlier life-cycle stages, cash holdings change notably. As expected, cash holdings increase when firms move through the life-cycle stages sequentially, i.e., become more mature, until they enter the final, decline, stage. In contrast, firms tend to use up cash if they 'reinvent' themselves and move back to earlier stages, such as introduction and growth.

C. Determinants of Cash over the Life-Cycle

The results up to this point already suggest that cash holdings and dynamics vary across the corporate life-cycle. However, so far we have not controlled for other firm characteristics that have been shown to affect cash policies. In a next step, we thus follow the literature (Opler et al. (1999), Bates, Kahle and Stulz (2009), Harford, Klasa and Maxwell (2014), among others) and estimate target cash level regressions controlling for the standard set of firm characteristics.

We model the cash-to-assets ratio as a function of net working capital scaled by total assets, leverage (split into short-term debt scaled by total assets and long-term-debt scaled by total assets,) firm size (measured as the natural logarithm of total assets in constant USD), market-to-book assets, R&D expenses scaled by sales, capital expenditures scaled by total assets, a dividend payer dummy variable (indicating whether a firm paid a dividend in a given year), operating income scaled by total assets, median industry cash flow volatility, and acquisition expenses scaled by total assets (see Appendix A for further details on the construction of these variables). Table V shows the corresponding results. While column 2 (labeled "Full") shows results for the entire sample, the remaining five columns show the results if these regressions

[5] One might think that these dynamics are inconsistent with the U-shaped patterns described in Table II. This, however, is not the case, as these results cannot be directly compared. Note that the dynamics in Table IV are focusing on individual years within each stage (i.e., the first and the last year) and are conditioning on the target life-cycle stage as well as the stage of origin.

are estimated separately for each life-cycle stage. All regression specifications include firm-fixed and year-fixed effects to control for unobserved heterogeneity across firms and over time. All ratios are winsorized at the upper and lower one percentile to eradicate errors and to mitigate the impact of outliers.

[Insert Table V here]

Looking at the results for the full sample, we find that they are consistent with the literature (Opler et al. (1999), Bates, Kahle, and Stulz (2009), Harford, Klasa, and Maxwell (2014)). In particular, coefficient signs and magnitudes fit well to previously reported values, indicating that our sample is comparable to previously analyzed samples.

As a next step, we compare coefficients across columns 2 to 6 to investigate whether the corporate life-cycle has any noticeable impact on these relations. We find strong evidence that this is the case, as coefficients of several variables vary dramatically across firms in different life-cycle stages. In what follows, we will discuss some of these life-cycle patterns in more detail.

The link between short-term debt and cash holdings is a particularly interesting case. We find negative coefficient estimates across the board, but the link is much less pronounced for firms in LC-1 and LC-5. In the latter case, we do not even find any statistically significant link. In contrast, in LC-2, LC-3, and to some extent LC-4, we find statistically highly significant and, in absolute terms, large coefficient estimates. One interpretation of these results is that short-term debt and cash levels seem to be substitutes for firms in LC-2, LC-3, and LC-4, while they seem to be rather independent from each other in LC-1 and LC-5. Both cash holdings and short-term debt show a U-shaped pattern across life-cycle stages in Table II, thus indicating that they both are important sources of funding for firms in LC-1 and LC-5.

This result seems to be consistent with Acharya, Almeida, and Campello (2007), who show theoretically and empirically that cash is different from negative debt for firms facing financing frictions and having hedging needs, i.e., firms in life-cycle stages LC-1 and LC-5. In fact, Table II confirms that standard measures of financial constraints peak for firms in LC-1 and LC-5. Moreover, it shows that operating income is lowest and market-to-book ratios are highest for

these firms.[6] Therefore, it seems reasonable to assume that these firms face low correlations between operating income and investment opportunities.

Firm size is often used as a proxy for information asymmetries (i.e., large firms being less exposed to information asymmetries), and the negative coefficient usually estimated in such regressions is consistent with this interpretation. Nevertheless, we do not find any link between size and cash holdings for firms in LC-1, LC-4 and LC-5, which are precisely those life-cycle stages for which one expects information asymmetries to matter most. One explanation of this pattern could be that these firms, in general, suffer from large information asymmetries, and, therefore, size differences within each group matter much less. Table II also shows that firms in LC-1 and LC-5 are, on average, much smaller.

Similar to firm size, research and development expenses proxy for information asymmetries between a firm and market participants concerning the firm's prospects. Underinvestment is more costly for firms with larger growth opportunities, and consequently, these firms are predicted to hold more cash. However, we find that such a positive relation only exists for firms in LC-3, and to a much weaker extent firms in LC-2. For all other life-cycle stages, the coefficient of R&D is insignificant and small in absolute terms.

Controlling for operating income in the cash regressions addresses the issue that more profitable firms are less likely to be financially constrained and to need high cash balances for precautionary purposes. Additionally, it controls for the possibility that more profitable firms suffer from greater agency costs related to managerial discretion. In the prior literature, the link between free cash-flows and levels of cash holdings has attracted some attention without reaching a consensus regarding the sign of the coefficient. For example, Dittmar and Duchin (2011) find negative coefficients while Opler et al. (1999) document a positive relation. In our empirical analysis, operating income shows a very pronounced pattern across the corporate life-cycle. Firms in LC-3 and, to a lesser extent, in LC-4 have a positive coefficient. Cash levels of firms in LC-1 depend negatively on operating income; and for firms in LC-2 and LC-5 cash levels and operating income seem to be independent from each other. One interpretation of these results is that the precautionary savings motive plays a more important role for firms in

[6] Opler et al. (1999) suggest using the market-to-book ratio as a proxy for investment opportunities.

LC-1 (negative coefficient), while agency costs (in the sense of Jensen's (1986) free cash flow hypothesis) or the financing hierarchy model (see the next section for a more detailed discussion) dominate for firms in LC-3 and LC-4 (positive coefficients).

Another variable which is often associated with the precautionary savings motive is industry cash-flow volatility, implying a positive coefficient in the target cash level regression. While this conjecture seems to hold strongly for firms in LC-2 and LC-3, it does not apply to firms in LC-1, LC-4, and LC-5. Especially in the introduction and decline phases of the life-cycle, we do not find any link between industry cash flow volatility and cash holdings.

Finally, it is also surprising that the dividend dummy does not play an important role in our regressions, consistently across all life-cycle stages. It only receives a positive and marginally significant coefficient for firms in LC-5, suggesting that these firms, on average, show some tendency to use cash for dividends.

To summarize the empirical results, we find that links between firm characteristics and cash holdings vary considerably across the corporate life-cycle. This confirms our ex-ante expectation that the life-cycle matters for firms' cash policies. In many cases, firms in LC-1 and LC-5 show somewhat different patterns than firms in LC-2, LC-3, and LC-4. Put differently, results presented in the literature so far seem to be driven by firms in LC-2 and LC-3, but are less representative for firms in other life-cycle stages.

D. Target Cash Levels vs. Pecking Order

Another important question that must be addressed in the context of corporate cash policies is whether firms care about target cash levels and adjust their actual cash holdings towards these targets. Such a behavior would be consistent with a generalized tradeoff model of cash, where firms weigh costs and benefits to determine a target cash ratio. Alternatively, the variation of corporate cash holdings may also follow the financing hierarchy theory, which implies that there is no optimal level of cash holdings, but changes in cash ratios are rather driven by the firms financing needs. As proposed by Myers and Majluf (1984), information asymmetries make equity financing costly. Therefore, firms use debt when they do not have sufficient internal resources, and when they do have enough resources, they repay debt that becomes due, and

accumulate cash otherwise. This behavior, in turn, implies that cash rises and falls with the fortunes of the firm.

Following Opler et al. (1999), we disentangle the tradeoff from the financing hierarchy model by estimating a regression in which we run a horse race between two variables in explaining yearly changes in actual cash levels: (1) a variable capturing the estimated target cash deviation, and (2) a measure of the financing deficit. The target cash deviation is estimated as the difference between observed cash and the predicted cash level from our model in Section IV.C, i.e. target cash levels are based on the life-cycle stage specific regressions in Table V. In order not to estimate an accounting identity, the financing deficit is measured as the flow of funds deficit before financing, defined as cash dividends plus capital expenditures, plus the change in net working capital (less cash), plus the current portion of long-term debt due, minus the operating cash flow. Table VI reports the corresponding results.

[Insert Table VI here]

Table VI shows that both coefficients are statistically significant over the entire life-cycle. This result implies that both theories seem to matter, and none is of exclusive relevance in one of the life-cycle stages. However, both coefficients exhibit strong patterns over the life-cycle suggesting that the relative importance varies quite substantially. We find that the cash policies of firms in LC-1, LC-4, and LC-5 are driven by trade-off motives rather than by the variation of the financing deficit – the speed of adjustment estimates towards target cash levels are largest and the sensitivity of cash changes to the financing deficit are smallest in absolute terms for these firms. In contrast, firms in stage 2 and stage 3 show the opposite pattern. For these firms, the financing hierarchy model seems to gain importance, while the adjustment towards targets slows down quite a bit.

These observations are also consistent with some patterns we identified in Table V. In particular, firms in LC-2 and LC-3 do not seem to follow optimal target levels for cash and leverage, but instead seem to replace one source of funding by the other depending on its availability (as shown by the strongly negative relation between cash levels and measures of debt). Similarly, Opler et al. (1999) argue that, based on the financing hierarchy model, firms with high cash

flows should hold more cash. Consistent with their argument, we find a positive coefficient of operating income for firms in LC-3, and a negative (insignificant) one for firms in LC-1 in Table V.[7]

To conclude, our results are consistent with Opler et al. (1999) in the sense that we also find that both effects, deviations from a target and the financing deficit, can explain changes in cash holdings. Most importantly, we add a new aspect to this discussion by showing that the relative importance of these two theories varies substantially across firms in different life-cycle stages – as before, firms in LC-1 and LC-5 seem to behave very differently from firms in LC-2, LC-3 and LC-4.

E. The Value of Cash over the Corporate Life-Cycle

As the final step of our empirical analysis, we follow Faulkender and Wang (2006) to study the valuation of cash over the corporate life-cycle. Similar to before, we expect the value of cash to vary across the life-cycle. Under the assumption that firms in early and late life-cycle stages are more constrained in their access to capital markets, we expect the valuation of an additional dollar of cash to be highest for those firms (LC-1 and LC-5). In contrast, it should be lowest for firms in the middle life-cycle stages (LC-2, LC-3, and LC-4). Arguably, agency costs, investment opportunities, and existing cash and leverage levels also matter for the valuation of cash and vary themselves over the corporate life-cycle.

Adapting the approach suggested by Faulkender and Wang (2006), we estimate the sensitivity of firms' market values to changes in corporate cash holdings controlling for further value-driving factors. Specifically, we regress excess stock returns over the fiscal year on the change in earnings, the change in net assets, the change in R&D expenses, the change in interest expenses, the change in dividends, the beginning-of-the-year cash level, market leverage, and the amount of net financing over the corresponding time period. We further add two interaction terms involving the change in cash and the beginning-of-the year levels of cash and market leverage, respectively. All explanatory variables (except leverage) are scaled by the beginning-

[7] Note that for several other variables our results are not consistent with the arguments of Opler et al. (1999), e.g., size (all negative coefficients suggesting the trade-off theory), R&D all positive coefficients (suggesting the trade-off theory) and capital expenditures (all negative coefficients suggesting the pecking order theory).

of-the-year market value of equity (see Appendix A for further details on the construction of the variables). We end up with a reduced sample of 57,582 firm-year observations for this analysis. Table VII summarizes the empirical results.

[Insert Table VII here]

The marginal value of cash (i.e., the combined effect of changes in cash including the effect of average cash and leverage levels) varies considerably across life-cycle stages and indicates the largest values of an extra dollar of cash for firms in LC-2. Also firms in LC1 and LC3 exhibit marginal cash values distinctly above unity. In the case of firms in LC-4, we find a marginal value of cash well below 1 suggesting that for these firms the costs of adding a dollar in cash dominate the benefits; potentially, due to agency conflicts.[8] For LC 5 firms, the value of an additional dollar in cash is statistically indifferent from unity.

Intuitively, this pattern of marginal values of cash across life-cycle stages seems quite plausible, as investors value cash rather positively in earlier life-cycle stages but would like firms in later life-cycle stages to either payout cash or invest it such that the firm starts over again in an earlier life-cycle stage. However, the wedge between the valuation of cash for firms in LC-1 and LC-5 is quite surprising. When discussing the results in Table V (i.e., the models to predict target cash levels), we concluded that the results for firms in LC-1 and LC-5 are consistent with the interpretation that cash does not simply seem to be viewed as negative debt (Acharya, Almeida, Campello (2007)). While this interpretation might still be valid, the market seems to distinguish very carefully between these two groups of firms in its valuation. The relative discount which we find for the latter set of firms would be consistent with the market's anticipation of substantial agency conflicts.

[8] The value of 0.794 for firms in LC-4 is calculated as follows: (0.906*1) + (–0.255*0.220) + (–0.33*0.169) = 0.794. The value of 0.220 (0.169) correspond to the average cash holding (market leverage) for firms in LC-4. Note that our full sample estimate of the marginal value of cash differs from the estimate of Faulkender and Wang (2006) in terms of magnitude – they report a marginal value of cash of 0.94, while we find one of 1.210. This difference is largely driven by a pronounced difference in average market leverage if we compare their sample with ours. In terms of coefficient estimates, the models are nearly identical.

If we zoom into the determinants of the marginal value of cash, we find some interesting interaction effects. The marginal value of cash is most sensitive to existing levels of cash (interaction effect labelled $\Delta Cash*Cash_{t-1}$ in the table) and leverage (interaction effect labelled $\Delta Cash*Leverage_{t-1}$ in the table) for firms in LC-1 and LC-2, i.e., the value of an additional dollar of cash drops quickly for these firms if they have already built up cash buffers or leverage beyond the average levels observed in the sample. Finally, it is worth pointing out that the adjusted R-squares of these regressions are largest for firms in LC-1 and LC-2. For firms in other stages of the life-cycle, these models seem to work somewhat less accurately.

Similar to Table IV, Table VIII focuses on transitions between life-cycle stages and reports marginal values around these breakpoints. Value of cash estimates are obtained by applying the Faulkender and Wang (2006) approach separately to subsets of firm-year observations that are surrounding transitions from one stage to another. Sample sizes at transition points vary life-cycle substantially, and thus we only consider cases for which we have at least 200 observations; otherwise values are reported as missing in Table VIII.

[Insert Table VIII here]

In general, we observe substantial changes in the valuations of cash, depending on where firms are coming from and where they are moving to. Again, the results reconfirm our intuition that life-cycle stages and strategic choices of firms do matter – and in particular, for the valuation of cash. Importantly and consistent with our argument above, we find that for firms in LC-4 and LC-5 the marginal value of cash is positive (1.436 and 1.262, respectively) in the year before they switch back to the introduction stage. Therefore, while marginal values of cash in these stages are below 1, on average, they are notably above 1 for firms that use cash to start over again.

Focusing on the standard sequence through individual life-cycle stages, we observe the following pattern in marginal values of cash. The marginal value of cash seems to be around 1 or slightly below one early in the introduction phase. Around the transition into the growth phase, we find valuations of roughly 1.3, and these values drop somewhat during the growth phase

and reach levels around 1.1 when firms move on into the maturity stage. Finally, they deteriorate substantially to levels below 1 when firms continue their path into the later stages LC-4 and LC-5. While it is hard to pin down the reasonability of specific values, we believe that the overall pattern is very intuitive.

V. Conclusions

The dynamics and valuations of corporate cash holdings have been analyzed in both the theoretical and empirical literature from many different perspectives (such as precautionary savings, information asymmetries and agency problems, competitive pressure, or refinancing risk). A natural dimension of corporate cash policies that has not received attention so far is the corporate life-cycle. The main reason for this lack of research is that it is notoriously difficult to define and measures life-cycle stages.

Our main premise is that corporate cash policies are markedly interacted with firms' strategy choices. In order to implement empirical tests, we use a life-cycle measure from Dickinson (2011) which is based on the idea that the different combinations of cash flow patterns represent a firm's resource allocation and operational capability interacted with its strategy choices. Specifically, corporate cash flows capture the financial outcome of the distinct life-cycle stages, so that each stage has a characteristic pattern of net cash flows, i.e., a stage-specific combination of operating cash flow, investing cash flow, and financing cash flow. Rather than looking at the actual levels of the three cash flows (which, in aggregation, are mechanically related to cash holdings), we combine the signs of the three cash flows and map them into life-cycle theory. Our approach results in five life-cycle stages: introduction, growth, maturity, shake-out, and decline. An important advantage of our classification of life-cycle stages is that firms do not have to run through the individual stages sequentially, but can jump back and forth in any arbitrary way (i.e., it is not a "linear" measure such as firm age).

We observe that levels of observed and target cash, determinants of target cash, adjustment speeds, and the value of cash vary significantly across life-cycle stages. A recurring finding is that firms in early and post-maturity stages show somewhat different patters than firms in the other stages. For example, firms in early stages and post-maturity stages hold large amounts of

cash, but cash ratios decrease when firms move towards maturity. Analyzing the standard factors which are assumed to determine cash holdings, we find that much of this variation in cash holdings is attributable to a changing demand function for cash over the different life-cycle stages. We further document that the relative importance of trade-off and pecking order motives varies substantially when comparing the early and post-maturity stages with the other stages. Analyzing the valuation of cash holdings, we find that an additional dollar in cash is highly valuable for introduction and growth firms, while a dollar in cash adds, on average, less than a dollar in market value for firms in later life-cycle stages, most likely due to increasing agency problems. Finally, the secular trend in cash holdings seems strongly attributable to increases in cash in the introduction and the decline stage.

Finally, the analysis of cash holding dynamics provides comforting result for our life-cycle measure. Transitions between life-cycle stages are important. In fact, most of the dynamics in cash holdings are observed at life-cycle transition points rather than during the different life-cycle stages. We find variation in cash levels in the final year of a given life-cycle stage depending on the target life-cycle stage in the subsequent year, and we further observe differences in relative changes of cash holdings during transition years. Cash holdings increase when firms move through the life-cycle stages sequentially, i.e., as they become more mature and finally enter into the decline stage. In contrast, firms tend to use up cash if they 'reinvent' themselves and move back to earlier stages, such as introduction and growth.

Appendix

Find Table A1 including all variable definitions on the next page.

Table A1
Variable Definitions

Variable	Description	Compustat Items
Key Variables (Cash Regressions - Table V*):*		
Cash holdings	Corporate cash holdings and equivalents scaled by total assets	CHE/AT
Short-term debt	Short-term debt scaled by total assets	DLC/AT
Net working capital	Working capital net of cash and short-term debt scaled by total assets	(WCAP-CHE+DLC)/AT
Firm size	Natural logarithm of total assets in constant year-2000 USD	Ln (AT)
Market-to-book	Ratio of the quasi-market value of assets divided by total book assets	(AT-CEQ+MKVALT)/AT
R&D	Research and development expenses scaled by sales	XRD/SALE
Capex	Capital expenditures scaled by total assets	CAPX/AT
Dividend dummy	Dividend paying indicator which equals 1 if a firm paid a dividend in a given	=1 if DV>0
Operating income	Operating income after depreciation scaled by total assets	OIADP/AT
Long-term debt	Long-term debt scaled by total assets	DLTT/AT
Acquisitions	Acquisition expenses scaled by total assets	AQC/AT
Industry cash flow volatility	Industry median (2-digit SIC) of the standard deviation of cash flow to assets over the past ten years (we require at least three years of historical data for the single firm to be included in the industry median in a given year).	-
Faulkender and Wang (2006) variable deifinitions (Value of cash regressions - *Table VII*):		
Excess stock return	Excess return of the firm's stock during the fiscal year over the return of a benchmark portfolio assigned according to the firm's book-to-market ratio and the market value of assets (see Faulkender and Wang (2006) for details)	-
ΔCash	Change in cash holdings from year t-1 to t scaled by the beginning-of-the-year market value of equity	$(CHE_t - CHE_{t-1})/MKVALT_{t-1}$
ΔEarnings	Change in earnings (income before extraordinary items plus interest expenses plus deferred taxes plus investment tax credits) from year t-1 to t scaled by the beginning-of-the-year market value of equity	$((IB_t+XINT_t+TXDC_t+ITCB_t)-(IB_{t-1}+XINT_{t-1}+TXDC_{t-1}+ITCB_{t-1}))/MKVALT_{t-1}$
ΔNet assets	Change in total assets net of cash from year t-1 to t scaled by the beginning-of-the-year market value of equity	$(AT_t-CHE_t)-(AT_{t-1}-CHE_{t-1})/MKVALT_{t-1}$
ΔR&D expenses	Change in R&D expenses from year t-1 to t scaled by the beginning-of-the-year market value of equity	$(XRD_t-XRD_{t-1})/MKVALT_{t-1}$
ΔInterest expenses	Change in interest expenses from year t-1 to t scaled by the beginning-of-the-year market value of equity	$(XINT_t-XINT_{t-1})/MKVALT_{t-1}$

(continued)

Table A1 - continued

ΔDividends	Change in dividends paid from year t-1 to t scaled by the beginning-of-the-year market value of equity	$(DVC_t-DVC_{t-1})/MKVALT_{t-1}$
Leverage	Market leverage defined as interest-bearing debt scaled by the beginning-of-the-year market value of equity	$(DLTT+DLC)/MKVALT_{t-1}$
Net financing	Equity issuances minus share repurchases plus long-term debt issuance less long-term debt redemption scaled by the beginning-of-the-year market value of equity	$(SSTK-PRSTKC+DLTIS-DLTR)/MKVALT_{t-1}$
Other variables:		
Book leverage	Short-term and long-term interest-bearing debt scaled by total assets	(DLC+DLTT)/AT
Market leverage	Short-term and long-term interest-bearing debt scaled by the quasi-market value of assets	(DLC+DLTT)/(AT-CEQ+MKVALT)
Equity ratio	Common equity scaled by total assets	CEQ/AT
Retained earnings	Retained earnings scaled by common equity	RE/CEQ
Proportion of short-term debt	Short-term debt net of the current portion of long-term debt scaled by total debt	(DLC-DD1)/DLC+DLTT)
Proportion of long-term debt	Long-term debt plus the current portion of long-term debt scaled by total debt	(DLTT+DD1)/DLC+DLTT)
Firm age	Years of coverage in Compustat	-
Industry market share	Sales of firm i divided by the sum of industry sales according to the Fama-French (1997) industry classification in a given year	-
Tangibility	Property, plants, and equipment scaled by total assets	PPENT/AT
Depreciation	Depreciation scaled by total assets	DP/AT
Payout ratio	Cash dividends paid to common and preferred stock plus share repurchases	DVP+DVC+PRSTKC
Long-term debt issuances	Long-term debt issuances scaled by total assets	DLTIS/AT
Equity issuances	Equity issuances scaled by total assets	SSTK/AT
Share repurchases	Share repurchases scaled by total assets	PRSTKC/AT
Financing Deficit	Cash dividends plus investments plus change in net working capital – internal cash flow (see Frank and Goyal (2003))	DV+(CAPX+IVCH+AQC-SPPE-SIV-IVSTCH-IVACO)+(-RECCH-INVCH-APALCH-TXACH-AOLOCH+CHECH+FIAO-DLCCH)-(IBC+XIDOC+DPC+TXDC+ESUBC+SPPIV+FOPO+EXRE)
Rating probability	Estimated rating probability calculated using the coefficient estimates from Lemmon and Zender (2010).	-
Debt constraints	A firm is classified as debt constraint if ist rating probability is in the lowest quintile in a given year-	

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Tables

Table I
Construction of the Life-Cycle Proxy

The table presents the cash flow pattern-based classification scheme of life-cycle stages according to Dickinson (2011). Considered life-cycle stages (i.e. introduction, growth, maturity, shake-out, and decline) follow the corporate life-cycle definition introduced by Gort and Klepper (1982). The table provides the final classification as in Dickinson (2011). Positive/negative net cash flows are indicated by +/–. The life-cycle measure in this study is based on three-year moving average of the net cash flows rather than on the accounting value reported for each year.

	(1) Intro	(2) Growth	(3) Maturity	(4) Shake-Out	(5) Shake-Out	(6) Shake-Out	(7) Decline	(8) Decline
Operating CF	–	+	+	–	+	+	–	–
Investing CF	–	–	–	–	+	+	+	+
Financing CF	+	+	–	–	+	–	+	–

Table II

Firm Characteristics by Life-Cycle Stage

The table shows mean values of firm characteristics for the full sample and separately for each life-cycle stage. The sample period is 1989 through 2013. All firm fundamentals except for retained earnings (relative to total equity), market-to-book, all debt maturity items, R&D expenses (relative to sales) and industry cash flow volatility are scaled by total assets. ***, **, and * indicate statistical difference of the mean values with respect to the preceding lifecycle stage. Variables definitions are given in Appendix A.

	(Total)	(LC-1)	(LC-2)	(LC-3)	(LC-4)	(LC-5)
Capital structure:						
Cash holdings	0.187	0.275***	0.148***	0.137***	0.232***	0.382***
Book leverage	0.215	0.230***	0.249***	0.186***	0.195***	0.183***
Market leverage	0.161	0.152***	0.198***	0.140***	0.161***	0.114***
Short-term debt	0.050	0.086***	0.045***	0.037***	0.044***	0.059***
Long-term debt	0.163	0.141***	0.203***	0.148***	0.149	0.120***
Equity ratio	0.497	0.468	0.495***	0.516***	0.497***	0.475***
Retained earnings	-0.698	-2.876***	-0.014***	0.359***	-0.676***	-4.170***
Debt maturity:						
Proportion of short-term debt	0.145	0.236***	0.115***	0.126***	0.133	0.204***
Proportion of long-term debt	0.855	0.764***	0.885***	0.874***	0.867	0.796***
Due in ≤ 3 Years	0.460	0.577***	0.408***	0.434***	0.488***	0.599***
Due in > 3 Years	0.540	0.423***	0.592***	0.566***	0.512***	0.401***
Other company variables:						
Age	15.83	9.23***	14.23***	20.60***	18.97***	12.03***
Size	5.187	3.694***	5.608***	5.829***	5.022***	3.564***
Industry market share	0.009	0.001	0.009***	0.015***	0.008***	0.001***
Market-to-book	2.028	2.811***	1.840***	1.796***	1.580***	2.663***
Tangibility	0.261	0.187***	0.307***	0.285***	0.199***	0.143***
Operating income	-0.001	-0.235***	0.065***	0.101***	0.022***	-0.308***
Industry cash flow volatility	0.051	0.059***	0.049***	0.047***	0.049***	0.064***
Net working capital	0.090	0.036***	0.100***	0.126***	0.088***	-0.021***
Capital expenditures	0.056	0.047***	0.075***	0.053***	0.031***	0.028***
R&D expenses	0.280	0.948***	0.049***	0.030***	0.072***	1.279***
Depreciation	0.048	0.048	0.049*	0.049	0.041***	0.048***
Payout ratio	0.025	0.012***	0.011	0.043***	0.041*	0.017***
Acquisition expenses	0.021	0.013***	0.038***	0.014***	0.009***	0.006***
Capital market activities:						
Long-term debt issuances	0.008	0.034***	0.031**	-0.013***	-0.044***	-0.011***
Equity issuances	0.059	0.194***	0.033***	0.009***	0.014***	0.159***
Share repurchases	0.016	0.004***	0.007***	0.029***	0.032**	0.009***
Financing deficit	0.052	0.224***	0.057***	-0.032***	-0.061***	0.140***

(continued)

Table II - continued

	(Total)	(LC-1)	(LC-2)	(LC-3)	(LC-4)	(LC-5)
Financial Constraint Measures:						
SA-Index	-3.117	-2.399	-3.209***	-3.477***	-3.204***	-2.460***
WW-Index	-10.169	1.146***	-5.963***	-20.791***	-8.014***	2.924***
Rating Probability	0.252	0.081*	0.300***	0.319***	0.221***	0.063***
Debt Constraints	0.200	0.457***	0.099***	0.114***	0.226***	0.570***

Table III

Life-Cycle Transition Matrix

The table presents transition rates of firm-observations from one life-cycle stage to another for five subsequent periods beyond the life-cycle identification at year t. This requires that at least five years of data subsequent to initial life-cycle classification are available for a firm to be included in the sample. The reduced sample period is from 1989 to 2008. Underlined values indicate the proportion of firms that remain in their initial stage during subsequent years. The table basically replicates Table 3 (Panel B) in Dickinson (2011).

Formation Period	Future Period	(t+1)	(t+2)	(t+3)	(t+4)	(t+5)
Introduction	Introduction	62.52%	50.47%	37.87%	35.60%	31.94%
	Growth	15.84%	21.21%	23.84%	26.06%	27.95%
	Maturity	4.33%	7.85%	14.13%	15.74%	18.35%
	Shake-Out	3.02%	4.07%	5.68%	5.11%	5.27%
	Decline	14.29%	16.42%	18.49%	17.50%	16.49%
Growth	Introduction	7.46%	8.87%	9.09%	8.05%	7.42%
	Growth	69.87%	58.37%	44.30%	42.11%	40.86%
	Maturity	19.08%	26.40%	36.60%	38.95%	39.97%
	Shake-Out	2.49%	4.23%	6.32%	6.83%	7.25%
	Decline	1.09%	2.13%	3.70%	4.06%	4.50%
Maturity	Introduction	1.82%	3.34%	5.37%	5.60%	5.90%
	Growth	18.46%	24.60%	32.05%	32.96%	31.18%
	Maturity	72.10%	61.91%	51.87%	51.16%	51.99%
	Shake-Out	6.73%	8.36%	7.68%	7.40%	7.98%
	Decline	0.89%	1.79%	3.04%	2.88%	2.95%
Shake-Out	Introduction	4.96%	7.14%	9.64%	9.32%	9.50%
	Growth	9.92%	16.54%	24.54%	27.47%	26.54%
	Maturity	23.94%	31.51%	40.82%	40.05%	42.32%
	Shake-Out	49.62%	33.04%	16.34%	13.45%	12.57%
	Decline	11.57%	11.76%	8.66%	9.70%	9.08%
Decline	Introduction	20.86%	28.28%	37.13%	34.65%	31.91%
	Growth	3.64%	7.31%	16.08%	17.52%	21.75%
	Maturity	2.51%	5.91%	11.75%	13.89%	14.71%
	Shake-Out	10.30%	11.40%	7.34%	8.52%	6.95%
	Decline	62.69%	47.11%	27.69%	25.41%	24.69%

Table IV

Cash over the Life-Cycle and during Life-Cycle Periods

This table presents median cash balances as a fraction of total assets for the year prior to a life-cycle change (t-1, T) and the year of the life-cycle change (t, T+1). We further report median percentage changes in cash to assets from t-1 to t, from T to T+1, and during a specific life-cycle stage dependent on whether a firm comes from or moves to this stages (from/to).

			Life-Cycle Stage					
				From	To			
	(t-1)	← Δ% →	(t)	← Δ% →	← Δ% →	T	← Δ% →	(T+1)
Introduction	-	-	-	-	-	-	-	-
Growth	0.089	-13.4%	0.060	0.0%	0.0%	0.067	11.3%	0.096
Maturity	0.045	-19.4%	0.026	0.0%	0.0%	0.027	15.6%	0.041
Shake-Out	0.186	-2.8%	0.173	0.0%	0.0%	0.177	4.4%	0.204
Decline	0.403	0.0%	0.379	0.0%	0.0%	0.408	-0.5%	0.420
Introduction	0.067	11.3%	0.096	0.0%	0.0%	0.089	-13.4%	0.060
Growth	-	-	-	-	-	-	-	-
Maturity	0.060	-0.7%	0.054	0.0%	0.0%	0.062	0.6%	0.065
Shake-Out	0.179	-10.5%	0.142	0.0%	0.0%	0.124	10.4%	0.180
Decline	0.267	6.0%	0.251	0.0%	0.0%	0.227	0.8%	0.237
Introduction	0.027	15.6%	0.041	0.0%	0.0%	0.045	-19.4%	0.026
Growth	0.062	0.6%	0.065	0.0%	0.0%	0.060	-0.7%	0.054
Maturity	-	-	-	-	-	-	-	-
Shake-Out	0.150	-3.3%	0.135	0.0%	0.0%	0.132	8.3%	0.170
Decline	0.119	13.0%	0.130	0.0%	0.0%	0.139	-8.4%	0.151
Introduction	0.177	4.4%	0.204	0.0%	0.0%	0.186	-2.8%	0.173
Growth	0.124	10.4%	0.180	0.0%	0.0%	0.179	-10.5%	0.142
Maturity	0.132	8.3%	0.170	0.0%	0.0%	0.150	-3.3%	0.135
Shake-Out	-	-	-	-	-	-	-	-
Decline	0.183	3.4%	0.194	0.0%	0.0%	0.211	-8.5%	0.189
Introduction	0.408	-0.5%	0.420	0.0%	0.0%	0.403	0.0%	0.379
Growth	0.227	0.8%	0.237	0.0%	0.0%	0.267	6.0%	0.251
Maturity	0.139	-8.4%	0.151	0.0%	0.0%	0.119	13.0%	0.130
Shake-Out	0.211	-8.5%	0.189	0.0%	0.0%	0.183	3.4%	0.194
Decline	-	-	-	-	-	-	-	-

Table V

Determinants of Corporate Cash Holdings over the Life-Cycle

The table presents regressions estimates for the determinants of corporate cash holdings for the full sample and separately for each life-cycle stage.. The sample period is from 1989 through 2013. The dependent variable is cash to assets. Cash is modeled as a function of short-term debt to assets (excluding long-term due within the next year), net working capital (excluding cash and short-term debt) to assets, firm size as the natural logarithm of inflation adjusted real assets, market-to-book ratio, R&D expenses to sales, capital expenditures to assets, a dividend payer dummy, operating income to assets, industry cash flow volatility, long-term debt to assets, and acquisition expenses to assets. All explanatory variables except for industry cash flow volatility are lagged by one period. All specifications include firm- and year-fixed effects to account for unobserved heterogeneity in the cross-section and through time. All ratios are winsorized at the upper and lower one percentile. Reported standard errors account for clustering at the firm level firms and over time. Corresponding p-values are reported in parentheses. ***, **, and * denote statistical significance of differences in coefficients with respect to the preceding life-cycle stage at the 1%, the 5% and the 10% level, respectively. Summary statistics include the mean absolute prediction error (MAE), the mean squared prediction error (MSE), and the number of observations.

	(Full)	(LC 1)	(LC 2)	(LC 3)	(LC 4)	(LC 5)
Short-term debt	-0.179	-0.075	-0.246***	-0.373***	-0.139***	-0.016*
	(0.000)	(0.020)	(0.000)	(0.000)	(0.019)	(0.565)
Net working capital	-0.167	-0.055	-0.173***	-0.211*	-0.133	-0.064
	(0.000)	(0.018)	(0.000)	(0.000)	(0.004)	(0.047)
Firm size	-0.016	-0.006	-0.020**	-0.011**	-0.008	0.002
	(0.000)	(0.268)	(0.000)	(0.001)	(0.399)	(0.790)
Market-to-book	0.010	0.010	0.011	0.005***	-0.002	0.007
	(0.000)	(0.000)	(0.000)	(0.004)	(0.778)	(0.003)
R&D	0.004	0.002	0.016*	0.194***	-0.002***	0.002
	(0.000)	(0.246)	(0.036)	(0.000)	(0.817)	(0.119)
Capex	-0.291	-0.248	-0.194	-0.411***	-0.119**	-0.294
	(0.000)	(0.000)	(0.000)	(0.000)	(0.333)	(0.003)
Dividend dummy	0.004	-0.005	-0.003	0.001	0.003	0.027
	(0.160)	(0.666)	(0.388)	(0.763)	(0.776)	(0.115)
Operating Income	0.014	-0.030**	-0.000	0.118***	0.082	0.027
	(0.088)	(0.021)	(0.993)	(0.000)	(0.054)	(0.165)
Long-term debt	-0.067	-0.057	-0.064	-0.122***	-0.020***	-0.026
	(0.001)	(0.000)	(0.000)	(0.000)	(0.100)	(0.384)
Ind. cash flow volatility	0.424	0.057	0.588	0.536	0.675	-0.090
	(0.001)	(0.885)	(0.002)	(0.000)	(0.260)	(0.846)
Acquisitions	-0.181	-0.259	-0.100***	-0.218***	-0.048*	-0.276*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.613)	(0.002)
Intercept	0.283***	0.272***	0.290***	0.236***	0.284***	0.339***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
MAE	0.065	0.069	0.047	0.045	0.048	0.071
MSE	0.010	0.012	0.005	0.004	0.006	0.012
Observations	63,437	9,298	21,066	24,254	4,112	4,707

Table VI

Adjustment Speed of Cash over the Life-Cycle

The table presents regressions examining whether firms have target cash levels. The dependent variable is change in cash to assets. The analysis closely follows Opler et al. (1999). The model is kind of a standard partial adjustment model including the firms deviation from its cash target at the beginning of period t as a target adjustment indicator and the financing deficit (flow of funds deficit before financing) as a pecking order term

$$(C_{i,t} - C_{i,t-1} = \lambda_1\left(C^*_{i,t} - C_{i,t-1}\right) + \lambda_2 FinDef_t + \varepsilon_{i,t}).$$

Target cash is approximated as a function of short-term debt to assets (excluding long-term due within the next year), net working capital (excluding cash and short-term debt) to assets, firm size as the natural logarithm of inflation adjusted real assets, market-to-book ratio, R&D expenses to sales, capital expenditures to assets, a dividend payer dummy, operating income to assets, industry cash flow volatility, long-term debt to assets, and acquisition expenses to assets. All these explanatory variables except for industry cash flow volatility are lagged by one period. Target cash for the full sample is estimated using all sample firms providing non-missing data on cash to assets and the set of explanatory variables. For Columns (2) to (6) we estimate life-cycle specific target using observations from the respective life-cycle stage. Cash targets are estimated based on the entire sample period. All target cash regressions include firm- and year-fixed effects to account for unobserved heterogeneity in the cross-section and through time. All ratios are winsorized at the upper and lower one percentile to mitigate the impact of outliers. The sample period is 1989 through 2013. Reported standard errors account for clustering at the firm level firms and over time. Corresponding p-values are reported in parentheses. ***, **, and * denote statistical significance of differences in coefficients with respect to the preceding life-cycle stage at the 1%, the 5% and the 10% level, respectively. Summary statistics include the adjusted R-squared and the number of observations.

	(Full)	(LC-1)	(LC-2)	(LC-3)	(LC-4	(LC-5)
Intercept	-0.000	0.003	-0.007	-0.002	0.001	0.000
	(0.016)	(0.000)	(0.000)	(0.000)	(0.025)	(0.593)
Financing deficit	-0.131	-0.136***	-0.460***	-0.494	-0.102***	-0.033
	(0.000)	(0.000)	(0.000)	(0.000)	(0.095)	(0.032)
Target deviation	0.511	0.691***	0.556***	0.359***	0.790***	0.824
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	63,424	9,297	21,062	24,247	4,111	4,707
Adj. R^2	0.369	0.545	0.604	0.545	0.654	0.583

Table VII

The Value of Cash over the Life-Cycle

This table presents the results of regressing the firm's excess stock return on changes in firm characteristics over the fiscal year. All variables except market leverage and excess stock return are deflated by the lagged market value of equity. Firm characteristics include the change in cash, change in earnings, change in total assets (excluding cash), change in R&D expenses, change in interest expenses, change in dividend payments. We further control for lagged cash holdings, market leverage and net cash flows from financing. Standard errors are heteroscedasticity-consistent and corrected for correlation across observations of a given firm (White (1980)). Corresponding p-values are given in parentheses. . ***, **, and * denote statistical significance of differences in coefficients with respect to the preceding life-cycle stage at the 1%, the 5% and the 10% level, respectively. Summary statistics include the adjusted R-squared and the number of observations. Variables definitions are given in Appendix A.

	(Full	(LC-1)	(LC-2)	(LC-3)	(LC-4)	(LC-5)
ΔCash	1.531	1.718***	1.732	1.331***	0.906***	1.222**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ΔEarnings	0.314	0.301***	0.387**	0.339	0.245**	0.187
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ΔNet Assets	0.229	0.180	0.246***	0.249	0.200*	0.139**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ΔR&D Expenses	0.679	0.691	0.518	0.425	0.046	0.557
	(0.000)	(0.003)	(0.022)	(0.124)	(0.911)	(0.015)
ΔInterest Expenses	-1.868	-0.455**	-1.422***	-2.238**	-2.222	-1.538
	(0.000)	(0.115)	(0.000)	(0.000)	(0.000)	(0.000)
ΔDividends	1.982	-1.877	3.672**	1.822**	2.894	0.324
	(0.000)	(0.361)	(0.000)	(0.000)	(0.000)	(0.854)
Cash $_{t-1}$	0.249	0.364	0.243***	0.180**	0.209	0.362***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Leverage	-0.415	-0.664***	-0.617	-0.312***	-0.284	-0.377
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Net Financing	0.032	0.399	0.107***	-0.419***	-0.226***	0.311***
	(0.044)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ΔCash* Cash $_{t-1}$	-0.797	-0.975**	-0.917	-0.734	-0.255***	-0.512
	(0.000)	(0.000)	(0.000)	(0.000)	(0.023)	(0.000)
ΔCash*Leverage	-1.133	-1.555**	-1.586	-0.789***	-0.330	-0.757
	(0.000)	(0.000)	(0.000)	(0.000)	(0.175)	(0.005)
Marg. value of cash	1.204***	1.211***	1.281***	1.122**	0.794***	0.937
Adj. R^2	0.157	0.212	0.205	0.132	0.147	0.153
Observations	57,582	7,670	19,651	22,819	3,764	3,678

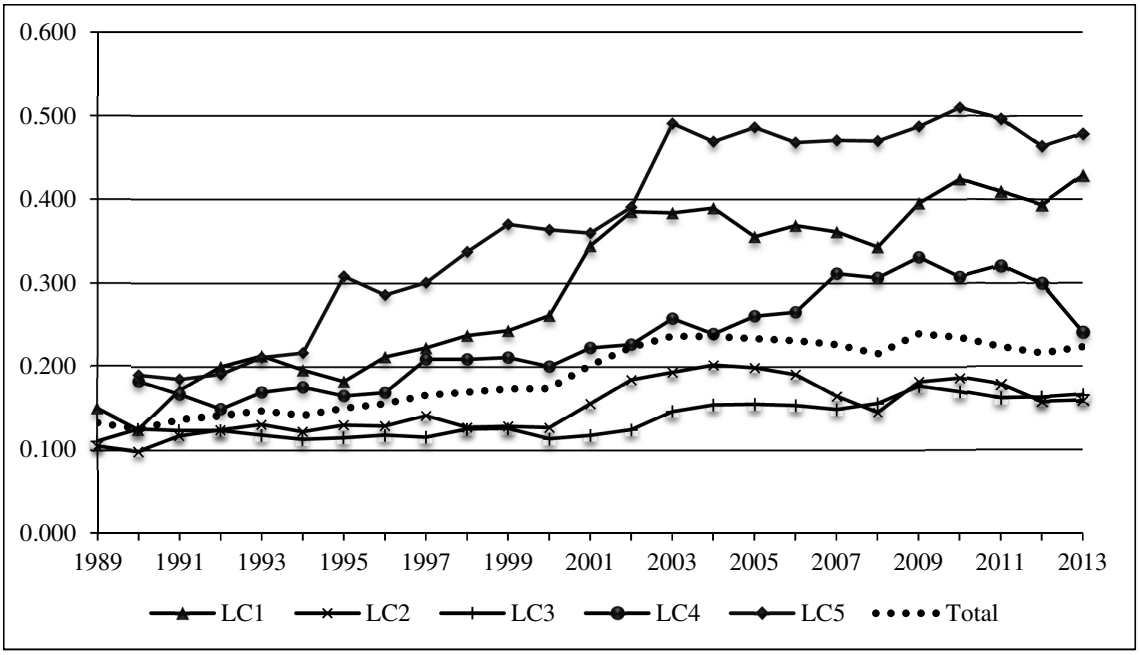
Table VIII

The Value of Cash at Life-Cycle Breakpoints

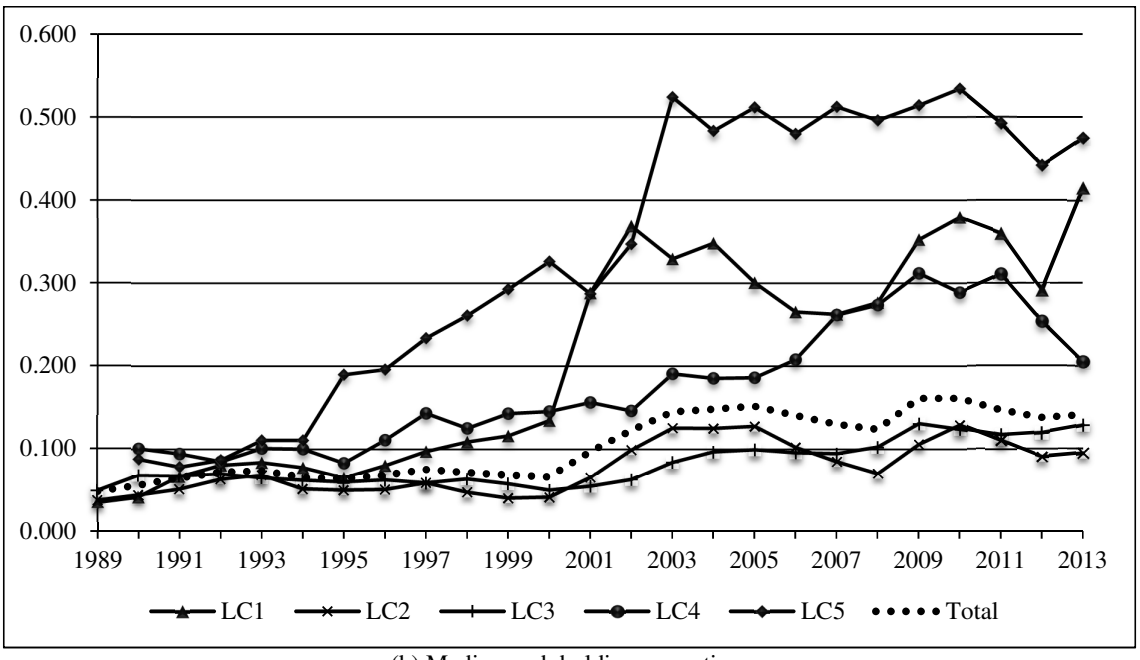
This table presents marginal values of cash at life-cycle breakpoints. We report estimates for the year prior to a lifecycle change (t-1, T), i.e. the last year in the preceding stage, and the year of the lifecycle change (t, T+1), i.e. the first year in the respective lifecycle stage.

	Lifecycle stage			
	From		To	
	(t-1)	(t)	T	(T+1)
Introduction	-	-	-	-
Growth	1.533	0.999	1.310	1.277
Maturity	1.427	0.945	1.850	1.011
Shake-Out	1.436	1.190	1.184	1.376
Decline	1.262	0.882	1.276	1.093
Introduction	1.310	1.277	1.533	0.999
Growth	-	-	-	-
Maturity	1.168	1.244	1.131	1.122
Shake-Out	0.898	1.310	0.708	0.602
Decline	NA	NA	NA	NA
Introduction	1.850	1.011	1.427	0.945
Growth	1.131	1.122	1.168	1.244
Maturity	-	-	-	-
Shake-Out	0.839	0.935	0.556	0.768
Decline	NA	NA	NA	NA
Introduction	1.184	1.376	1.436	1.190
Growth	0.708	0.602	0.898	1.310
Maturity	0.556	0.768	0.839	0.935
Shake-Out	-	-	-	-
Decline	0.970	1.053	0.863	0.840
Introduction	1.276	1.093	1.262	0.882
Growth	NA	NA	NA	NA
Maturity	NA	NA	NA	NA
Shake-Out	0.863	0.840	0.970	1.053
Decline	-	-	-	-

Figures

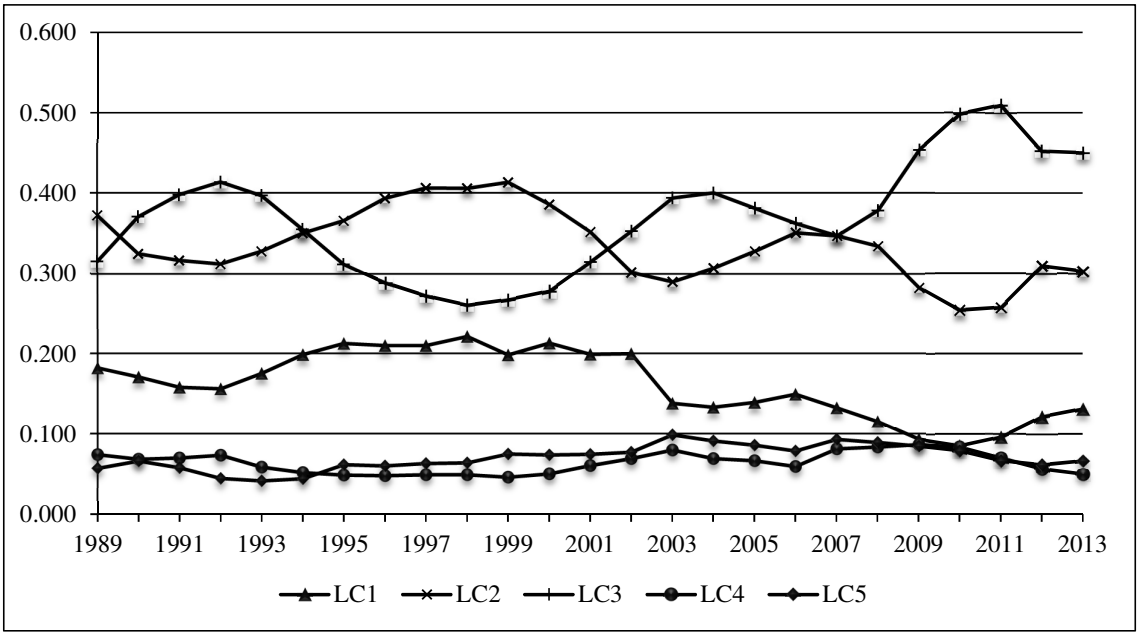


(a) Average cash holdings over time

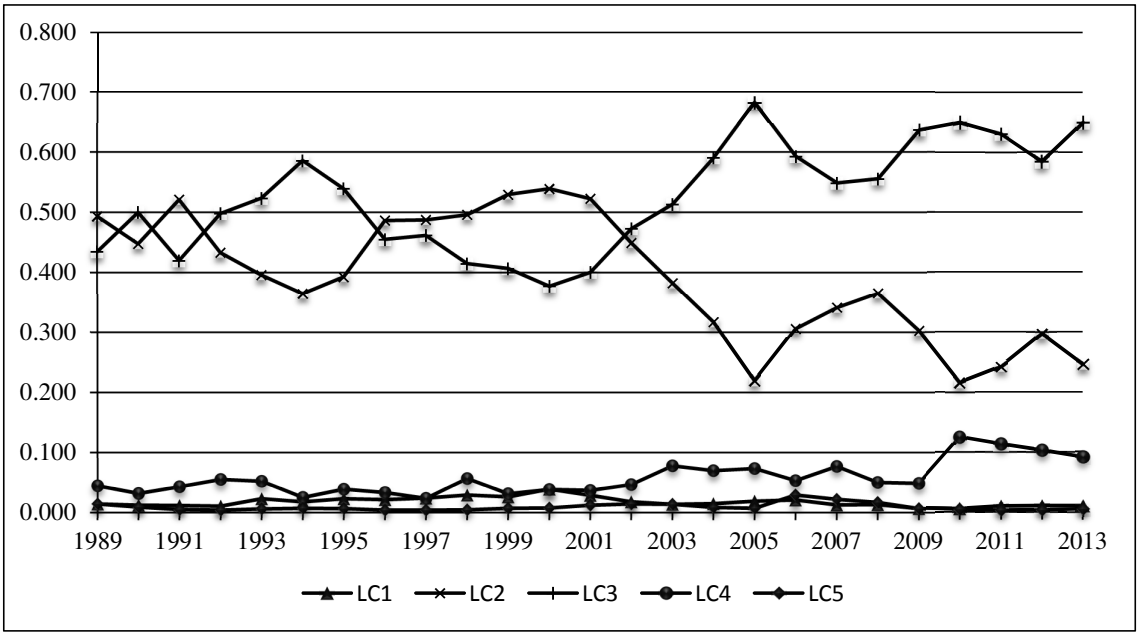


(b) Median cash holdings over time

Figure I. Evolution of cash holdings over time by life-cycle stage The figure shows average and median cash holdings relative to total assets over time for each lifecycle stage. The sample period is 1989 through 2013.



(a) Proportions of firms per life-cycle stage over time (equal-weighted)



(b) Proportions of firms per life-cycle stage over time (value-weighted)

Figure II. Proportions of firms per life-cycle stage over time. The figure shows equal-weighted and value weighted proportions of firms per lifecycle stage over time. The sample period is 1989 through 2013.