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The Liability of Volatility and How it Changes Over Time Among New Ventures

Erik Lundmark[1], Alex Coad[2,3], Julian S. Frankish[4], and David J. Storey[5]

Abstract

This article theorizes how short-term revenue volatility affects new venture viability and how such volatility develops over time. Tracking the bank accounts of 6,578 new ventures over a 10-year period, we find that, even after controlling for a range of other factors, short-term revenue volatility is a strong predictor of venture exit. Although short-term revenue volatility is associated with the depletion of buffer resources and financial default, surviving ventures do not, on average, decrease their short-term revenue volatility over time. However, short-term revenue volatility decreases at the cohort level due to higher exit rates of volatile ventures.

Keywords

liability of newness, adaptation, selection, evolutionary theory, liability of smallness

Introduction

Short-term volatility is recognized as a serious issue for new ventures because it is believed to lead to involuntary firm exits (Bruton & Bamford, 2016; Hisrich, Peters, & Shepherd, 2013; Wiklund, Baker, & Shepherd, 2010). However, our knowledge of these linkages is based largely on anecdotal evidence and untested assumptions. Such evidence can be misleading (Wiklund, 1999). We do not know whether short-term volatility is associated with higher mortality rates among new ventures, whether it is higher among newer than older ventures, or how it develops over time. Whereas constructs such as new venture size and growth have received considerable attention (e.g., Aldrich & Auster, 1986; Coad, 2018; Delmar, McKelvie, & Wennberg, 2013; McKelvie & Wiklund, 2010; McKelvie, Brattström, & Wennberg, 2017; Wennberg, Delmar, & McKelvie, 2016), the extant literature provides only scattered theorizing about the effect of

[1]Macquarie Business School, Macquarie University, NSW, Australia
[2]CENTRUM Católica Graduate Business School (CCGBS), Lima, Peru
[3]Pontificia Universidad Católica del Perú (PUCP), Lima, Peru
[4]Barclays Bank UK plc, Poole, UK
[5]School of Business Management and Economics, University of Sussex, Falmer, Brighton, UK

Corresponding Author:
Erik Lundmark, Macquarie Business School, Macquarie University, NSW 2109, Australia.
Email: erik.lundmark@mq.edu.au

short-term volatility. So, although short-term volatility is believed to be important, there remain both theoretical and empirical gaps in our understanding of how it impacts on new ventures and how it develops over time. To build a reliable body of knowledge, we need large-scale longitudinal studies that span levels of analysis (Davidsson & Wiklund, 2001; Low & MacMillan, 1988).

This study begins to address these research gaps by theorizing and empirically investigating how short-term revenue volatility, as measured by volatility in monthly revenue streams, affects new venture viability and how this type of volatility develops over time in a cohort of new ventures. Like studies of longer term volatility, commonly captured by venture growth and decline (i.e., negative growth) based on annual data, there are several potential measures that are subject to volatility such as revenue, assets, number of employees, and profit (Shepherd & Wiklund, 2009). We focus on revenue because this is the most commonly used measure in such studies (Shepherd & Wiklund, 2009) and, as we outline in this article, there are theoretical reasons to believe that it affects new venture viability. We study a cohort of 6,578 new ventures that all started trading in early 2004. We track these ventures' bank accounts over a 10-year period or until they go out of business. The study analyzes both firm-level developments and aggregated cohort effects (i.e., how the composition of ventures in the cohort changes over time).

The article makes important theoretical contributions. First, by setting out the theoretical links connecting short-term revenue volatility to new venture viability, we contribute to the liability-of-newness literature (Stinchcombe, 1965). Previous studies have shown that there is a liability of smallness, which is separate from, yet intertwined with, the liability of newness (Aldrich & Auster, 1986; Coad, 2018). A major contribution to this literature is to show that short-term revenue volatility is a separate liability in its own right and to outline how the liability of volatility is related to the liabilities of newness and smallness. Our findings are of particular relevance to entrepreneurship research using financial measures to theorize on new venture viability (e.g., Storey, Keasey, Watson, & Wynarczyk, 1987; Wiklund et al., 2010; Wennberg et al., 2016).

Second, we contribute to the literature on evolutionary theory in the domain of entrepreneurship and organization studies (Aldrich & Ruef, 2006; Hannan & Freeman, 1977). In seeking to explain changes in the composition of cohorts of organizations over time, this literature importantly distinguishes between adaptation and selection mechanisms. To date, however, studies addressing these mechanisms simultaneously have tended to rely on theoretical arguments or computer simulations (e.g., Bruderer & Singh, 1996; Levinthal & Marino, 2015). Empirical studies have examined relatively large ventures (compared to the typical start-up) and changes to salient attributes, such as types of services offered or the types of niches occupied (Baum & Singh, 1996; Delacroix & Swaminathan, 1991; Usher & Evans, 1996). Such studies are informative but limited in their ability to assess whether adaptation in salient traits is the outcome of strategic foresight rather than imitation of successful firms. Our study remedies this limitation by providing insights into changes to attributes that are not easily observable for outsiders. Our study also contributes important insights into the longitudinal effects of adaptation and selection in the early parts of the venture life cycle, which have been highlighted as important areas for research (Delmar et al., 2013).

The remainder of the article proceeds as follows. The section "Theoretical Background and Hypotheses" provides the theoretical background and develops our hypotheses. The section "Data and Methodology" sets out the data and methodologies used to test the hypotheses. The section "Results" provides results, with these being discussed in the section "Discussion"and summarized in the concluding section "Conclusions and Practical Implications."

Theoretical Background and Hypotheses

As long ago as 1955, Beesley (1955) observed that the mortality rate of young manufacturing firms in Birmingham, United Kingdom, was considerably higher than that of their older counterparts. A decade later, Stinchcombe (1965) theorized that this was a characteristic of organizations more broadly, particularly of those that broke with tradition and adopted new forms. He referred to this as the "liability of newness" and argued that it reflected challenges that were specific to new organizations: the designing of new roles and routines, learning and establishing such roles and routines, developing social relations and trust between strangers inside the organization, and developing stable relationships with external stakeholders. In this article, we focus on new ventures, rather than the more specific cases of the liability of new forms or the more general case of new organizations.

While subsequent research has firmly demonstrated that new ventures experience considerably higher mortality rates than their older counterparts (Box, 2008; Thornhill & Amit, 2003; Yang & Aldrich, 2017), the specific mechanisms that underpin this outcome are still not sufficiently understood. Existing research suggests that the survival chances of new ventures can be increased by access to buffer resources such as cash reserves and/or a willingness to work extensive hours with little or no compensation (Shane, 2008; Wiklund et al., 2010). The consequence is that, for ventures with such buffers, the liability of newness has been described as a liability of adolescence, where the mortality rate of new ventures starts at a lower rate, grows as the buffers become exhausted, and then falls as the ventures become established (Brüderl & Schüssler, 1990; Fichman & Levinthal, 1991; Le Mens, Hannan, & Pólos, 2011).[1] New ventures tend to be supported by some buffer resources that allow for the initial establishment of routines and provide protection against fluctuations in venture performance, so raising their short-run survival rates (Frid, Wyman, & Coffey, 2016; Storey, 2011; Wiklund et al., 2010).

Because larger firms tend to have more buffer resources than smaller ones, venture size has been identified as an important factor explaining mortality rates in its own right and is referred to as the liability of smallness (Aldrich & Auster, 1986; Freeman, Carroll, & Hannan, 1983). Since most new ventures are also small, age and size are correlated so that the liability of smallness is intertwined with the liability of newness (Coad, 2018). The links between smallness and newness are both empirical (observed correlation between age and size) and theoretical, since the perils of being small also apply to why it is perilous to be new—such as the difficulty of recruiting employees and raising capital (Aldrich & Auster, 1986).

Ultimately, however, small and large ventures alike must generate a positive cash flow to survive (Venkataraman, Van De Ven, Buckeye, & Hudson, 1990). Cash flow is the total amount of money going into, and coming out of, a business in a given time period. It is positive when cash revenue exceeds outgoing payments and negative in the reverse case. Yang and Aldrich (2017) showed that although a range of other factors matter in establishing a new venture, achieving a positive cash flow for a single month was the single most important factor. This reduced the mortality rate of new ventures by 65%, whereas 10 years of industry work experience reduced the hazard of failing by 20% and previous startup experience had no significant effect.

Cash flow is consequently an important aspect of new venture viability, but we know little about how either revenue streams or expenses develop over time and how this is linked to new venture viability. While there is some quantitative research on how accounting and financial measures, including revenue, influence new venture survival, such studies are limited to annual data that lack measures of short-term flows (Delmar et al., 2013; Storey et al., 1987; Wiklund et al., 2010). This is a key limitation because it is widely believed that short-term revenue volatility (i.e., volatility within a year, such as monthly fluctuations) creates cash flow problems and that such volatility, therefore, constitutes one of the most important threats to new ventures (Hisrich et al., 2013; Bruton & Bamford, 2016). Unfortunately, these beliefs have yet to be tested in large-scale longitudinal research.

Knowledge of how short-term revenue volatility develops over time is therefore crucial for our understanding of the liability of newness. Without it we do not know whether such volatility differs between new ventures and more established ventures. To better understand the differences between new and established ventures, we must move beyond the firm as the unit of analysis and also assess developments at the cohort level. For example, if there are differences in volatility between new and older firms, is this difference due to changes in individual firms or to selection/retention mechanisms that influence the composition of firms in a cohort, or some combination of the two? In the following sections, we home in on short-term revenue volatility, its effect on new venture performance, and how it develops over time.

Short-Term Revenue Volatility and Venture Exits

New ventures close for a variety of reasons (Gimeno, Folta, Cooper, & Woo, 1997; Jenkins & McKelvie, 2016; Wennberg & DeTienne, 2014). In some cases, this is because the venture is unable to meet its financial obligations, forcing the owner(s) to close the business. Some such exits reflect insolvency and, in a minority of cases, lead to bankruptcy for the owner(s). "Voluntary exits" are more typical. These take place when business ownership compares unfavorably to other options open to the founder(s), such as an alternative job, an alternative investment, retirement, or unemployment. Consequently, anything that lowers the perceived value of the venture in comparison to alternatives for the founder(s) will lower the venture's relative viability (Coad, 2014). In this subsection, we theorize how short-term revenue volatility, *ceteris paribus*, is related, first to new venture viability and then to financial buffer resources.

Short-term revenue volatility and relative venture viability. We now identify four possible reasons why short-term revenue volatility might be expected to decrease a venture's relative viability. The first is that *volatility makes it harder to plan ahead*: A volatile revenue stream makes it harder for a firm to evaluate its "average" size or "steady-state" scale of operations, because this changes from one month to the next. *A fortiori*, revenue volatility makes it more difficult to predict future demand for a firm's products or services, thus making planning more difficult (cf., Bloom, 2014; Bo, 2001; Tuli, Bharadwaj, & Kohli, 2010). A firm that cannot accurately judge its needs in the short term will have difficulties planning for the longer term. A firm whose revenue streams fluctuate in the short term may also be distracted by flickering indicators and attempts at interpreting inconstant "micro-trends," straining the entrepreneur's cognitive abilities, and thereby devoting excessive attention to short-term issues. Consequently, less attention is directed toward the longer term strategic aspects of the venture's operations, reducing the venture's viability.

The second reason is that *volatility adds psychological stress*: Higher demand uncertainty leads to uncertainty over the amount and type of work that is required. While it is commonly known that high workloads can lead to high levels of stress, low workloads, especially in ambiguous circumstances, can also be stressful (Bruursema, Kessler, & Spector, 2011; Crawford, Lepine, & Rich, 2010). Demand uncertainty may also lead to unreliable remuneration or ultimately uncertainty about the existence of the job itself. Qualitative research suggests that variable and uncertain demand is a source of stress for entrepreneurs (Stephan, 2018) and a range of studies show that uncertainty is positively related to stress and negatively related to job satisfaction and commitment (e.g., Ashford, Lee, & Bobko, 1989; Paulsen et al., 2005; Pollard, 2001). For all these reasons, increased short-term revenue volatility will, *ceteris paribus*, reduce the entrepreneurs' perceived value of the job provided by the venture in terms of their psychic utility and mental health, which in turn will reduce their commitment to the venture.

Third, *volatility adds a risk premium*: For two otherwise equal investments, the risk premium for a more volatile one will be higher (Bloom, 2014). Consequently, the valuation of a venture by its founder(s) will, *ceteris paribus*, be negatively influenced by short-term revenue volatility (Rountree, Weston, & Allayannis, 2008), which in turn reduces the venture's relative viability. Such volatility also leads to higher risk premia among any existing or potential external investors and may increase the cost of borrowing as lenders too may charge a risk premium.

Fourth, *volatility raises average costs*: In addition to the increased cost of credit, volatility in revenue streams may lead to higher average costs because the firm must continually adapt its scale of operations (e.g., paying employees overtime rates in some months and paying them to stay on with less work in leaner months; disrupting work and reassigning tasks while fluctuating between overuse and underuse of machines). Irrespective of any induced uncertainty, each time a firm changes its scale of operations, it incurs adjustment costs (e.g., costs of hiring new employees, costs of firing, costs of paying overtime, costs of inefficient overuse or underuse of machines, warehouse and storage costs). Adjustment costs are often assumed to be quadratic in any time period: Hence it is better to smooth any changes in inputs in response to demand shocks over a longer period of time, because larger changes in capital and machinery have disproportionately larger adjustment costs (Hamermesh & Pfann, 1996). Even when keeping the workforce constant, volatility will (as argued in the preceding text) induce stress, which comes at a cost in terms of increased risks of mistakes and injuries. Consequently, both unusually high and unusually low workloads reduce the perceived value of the jobs offered to any existing or potential employees hurting recruitment and/or retention. Finally, some aspects of revenue volatility increase costs via increased uncertainty (e.g., planning for contingencies that do not occur), while others increase costs even in situations of no uncertainty (e.g., adjustment costs of adapting to anticipated changes).

In short, all four reasons imply that, *ceteris paribus*, short-term revenue volatility will be negatively related to the relative viability of a new venture. We therefore hypothesize that:

Hypothesis 1 (H1): *Short-term revenue volatility is negatively related to new venture survival.*

Short-term revenue volatility and financial buffer resources. Maintaining a positive cash flow is essential for firms to survive over the long term (Venkataraman et al., 1990). However, survival is enhanced when ventures have access to financial buffers, so when cash flow turns negative, cash reserves become the first resort. Wiklund et al. (2010) suggested that high liquidity is beneficial to new ventures, in part because it protects against the volatility of revenue streams. A second very important financial buffer is provided by personal or family funding (Yang & Aldrich, 2017), but this is unavailable to low-wealth founders (Hvide & Møen, 2010). A third financial buffer is funding provided by an external financial institution in the form of a loan or overdraft.

When all such buffers are exhausted, ventures become vulnerable to the threat of having to cease trading, that is, they are at the boundary of their viability in an absolute sense (Coad, 2014). However, even when buffers are exhausted, the owners may favor continuing to trade over closing the venture, especially if they view the current conditions as temporary. In order to do so, however, they will have to rely on desperate measures, such as engaging in unauthorized borrowing from their bank by exceeding their overdraft limit. This type of borrowing is associated with punitive interest rates and a letter from the bank that such borrowing is unwelcome. This kind of risky financial activity is consequently a strong indicator that a venture has exhausted its available short-term financial buffer resources and balances on the boundary of absolute viability.

Short-term revenue volatility leads to the depletion of buffer resources for three reasons. First, any additional costs induced by volatility (as outlined in the previous section) contributes to the depletion of a venture's resources. Second, because a proportion of firm expenditure tends to be fixed, volatile revenue streams increase the risk of cash flow turning negative (Bruton & Bamford, 2016; Hisrich et al., 2013). Third, firms with higher revenue volatility generally need to set aside more resources, for example, by adding inventories to accommodate spikes in demand, which makes firms more vulnerable, should sufficient revenue streams not materialize (Bo, 2001). Resources dedicated to buffers against spikes in demand lock up cash, which could otherwise have been used as a buffer against negative cash flow (Hisrich et al., 2013). Given that the typical U.S. small business has less cash on hand than is needed to cover 1 month of expenses in the event of a total disruption in revenues (Farrell, Wheat, & Mac, 2016), revenue volatility, even over very short periods of time, can generate cash shortages for new ventures that exhaust their cash reserves, forcing them into unauthorized borrowing.

If, as we have theorized in the preceding text, volatility increases the risk of exhausting buffer resources, then there should be a positive relationship between short-term revenue volatility and the proportion of time a new venture spends in excess of the overdraft limit. We therefore hypothesize that:

> ***Hypothesis 2 (H2):*** *Short-term revenue volatility is positively related to the proportion of time that new ventures spend in excess of the overdraft limit.*

If, as we have hypothesized, short-term revenue volatility is negatively related to new venture survival, then this could explain why younger ventures have higher mortality rates than their older counterparts (Stinchcombe, 1965). However, for this to be the case, short-term revenue volatility needs to decrease with time and/or its effect needs to become less adverse with time. We now theorize how short-term revenue volatility evolves over time in a cohort of new ventures.

Changes in Cohorts of Organizations: Selection and Adaptation

The characteristics of a cohort can change through selection or adaptation mechanisms, or a combination of both (Aldrich & Ruef, 2006; Baldwin & Rafiquzzaman, 1995; Hannan & Freeman, 1977). Selection refers to the removal of selected members from the cohort through exits;[2] and adaptation refers to changes in individual organizations that influence how it is interacting with its environment, including its relations and interactions with other organizations (Hodgson, 2013). In a pure model of selection, ventures cannot change their underlying capabilities, and instead the population evolution is driven by the selective elimination of ventures with lower "fitness" (Jovanovic, 1982). In contrast, in a pure model of adaptation, the ventures never die, but individual ventures and their owners can adapt and learn (Cope, 2005; Ericson & Pakes, 1995; Minniti & Bygrave, 2001; Politis, 2005), thus changing the aggregate cohort composition. Adaptation and selection may pull in different directions, but together they explain all changes at the cohort level (Hodgson, Herman, & Dollimore, 2017).

Mathematical decomposition of adaptation and selection. The evolution of a cohort's short-term revenue volatility can be mathematically decomposed into adaptation and selection as follows. At the start of the period, denoted by time t, the average volatility of ventures i in the cohort of N ventures can be written as follows:

$$\overline{\mathrm{vol}_t} = \frac{\sum_{i=1}^{N} \mathrm{vol}_{it}}{N} \tag{1}$$

The average volatility of the M surviving ventures (with $M \leq N$) at the end of the period (i.e., at time $t+\tau$) can be written as:

$$\overline{\mathrm{vol}_{t+\tau}} = \frac{\sum_{i=1}^{M} \mathrm{vol}_{i,t+\tau}}{M} \tag{2}$$

This change in average volatility can be due to two factors: selection and adaptation. Selection refers to the change in average volatility that is due to the selection of M surviving ventures from the N initial ventures. The average volatility, evaluated at the initial period t, of the M surviving ventures, can be written as:

$$\overline{\mathrm{vol}_{t,M}} = \frac{\sum_{i=1}^{M} \mathrm{vol}_{it}}{M} \tag{3}$$

Hence, the contribution of selection to changes in average volatility is the difference between (1) and (3), that is, the effect of selection on average volatility is equal to:

$$\frac{\sum_{i=1}^{M} \mathrm{vol}_{it}}{M} - \frac{\sum_{i=1}^{N} \mathrm{vol}_{it}}{N} \tag{4}$$

which can be positive or negative, depending on whether the first term (initial average volatility, evaluated at time t, of the M ventures that survive until $t+\tau$) is larger than the second term (initial average volatility of all N ventures).

The contribution of adaptation refers to the changes over time within the same group of surviving ventures M, from the start of the period (equation (3)) to the end of the period (equation (2)), that is, the effect of adaptation is equal to:

$$\frac{\sum_{i=1}^{M} \mathrm{vol}_{i,t+\tau}}{M} - \frac{\sum_{i=1}^{M} \mathrm{vol}_{it}}{M} \tag{5}$$

Selection effects and adaptation effects are therefore conceptually distinct and, between them, account for all the change from average volatility at the beginning of the period (equation (1)) to average volatility at the end of the period (equation (2)).

Adaptation mechanisms and short-term revenue volatility. The literature highlighting adaptation mechanisms suggests that entrepreneurs and their organizations are able to learn and adapt their behavior to better cope with internal and external challenges (e.g., Covin, Green, & Slevin, 2006; Minniti & Bygrave, 2001; Yli-Renko, Autio, & Sapienza, 2001; Zahra, Ireland, & Hitt, 2000). For performance-improving adaptation to occur, two conditions must be met. First, organizations must be flexible enough to allow for the implementation of change initiatives. Although this may be a problem for established organizations because of factors such as sunk costs, internal political resistance, and taken-for-granted ways of thinking (Hannan & Freeman, 1977), it is less relevant for new ventures. Second, organizational decision makers must be able to evaluate, with some level of accuracy, the appropriateness of change initiatives. The literature on organizational learning and entrepreneurial learning argues that new ventures are able to change and to do so with some accuracy based on the feedback they receive (Minniti & Bygrave, 2001). This literature claims not only that entrepreneurs learn from previous experiences (Baù, Sieger, Eddleston, & Chirico, 2017) but also that new ventures learn differently and more effectively than established organizations (e.g., Sapienza, Autio, George, & Zahra, 2006; Zahra et al., 2000).

If short-term revenue volatility has a negative effect on viability, then "learning" by new ventures might be reflected in reductions in volatility. This might require ventures to establish and maintain stable and recurrent relationships with customers which, in turn, lowers customers' perceived uncertainty (Shepherd, Douglas, & Shanley, 2000). Routinization of organizational activities is the key to stable operations and forms the foundation for stable relationships with customers (Stinchcombe, 1965; Yang & Aldrich, 2017). Furthermore, the learning and adaptation literature suggests that, with time, the founder(s) and employees accumulate experience, which reduces the likelihood of unexpected disruptions to business operations. They may also learn about how customer preferences change, how to accommodate such changes, and how to shift demand from peaks to troughs.

In addition, stable revenue streams depend on new venture capabilities of billing, collections, and cash management (Wu & Knott, 2006), which we refer to as working cash management. Evidence, albeit from self-report data, of working cash management among small- and medium-sized enterprises (SMEs) is provided by Howorth and Westhead (2003). They find a great variability in practices among small and young ventures. Thus, given new venture learning, such practices would be expected to improve with time among surviving new ventures. Overall, therefore we hypothesize that:

> ***Hypothesis 3a (H3a):*** *Adaptation effects decrease average short-term revenue volatility in a cohort of new ventures.*

Selection mechanisms and short-term revenue volatility. Change in the composition of a cohort of ventures also occurs because the ventures exhibiting traits lowering their viability are eliminated from the cohort more frequently. As outlined in the theorizing leading up to Hypothesis 1, there are several reasons why short-term revenue volatility would be associated with increased mortality rates. Consequently, if Hypothesis 1—that short-term revenue volatility is adversely related to new venture survival—is true, then, in a cohort of new ventures, those with higher short-term revenue volatility would face higher risks of being selected out of the cohort, contributing to the lowering of the average short-term revenue volatility among those that remain in the cohort. Evolutionary theory therefore suggests that adverse selection based on short-term revenue volatility at the individual firm level should translate into a reduction in the average short-term revenue volatility at the cohort level of analysis. We therefore hypothesize:

> ***Hypothesis 3b (H3b):*** *Selection effects decrease average short-term revenue volatility in a cohort of new ventures.*

Data and Methodology

Sample and Data

This study uses the dataset developed by Coad, Frankish, Roberts, and Storey (2016), which tracks 6,578 new ventures over a 10-year period.[3] The dataset relies on data from the customer records of Barclays Bank. The only poststart data used in this study are those on financial transactions, with all other data being collected at, or immediately prior to, start. The new ventures are drawn from all sectors, except financial services, and all regions in England and Wales. The ventures started trading between May and June of 2004. This dataset comprises new venture account openings—it is not limited to those new ventures obtaining a bank service such as a loan or overdraft.[4] The dataset captures a large and representative sample of new ventures including the "short-life" new ventures (Batjargal et al., 2013; Coad et al., 2016).

Dependent and Independent Variables

Survival is the dependent variable in Hypothesis 1 and refers to the venture continuing operations, that is, the absence of exit. We do not distinguish between different types of exit (cf. Headd, 2003; Wennberg, Wiklund, DeTienne, & Cardon, 2010), nor do we frame exit in terms of individual- or firm-level failure (Jenkins & McKelvie, 2016). Every 6 months, all dormant accounts were identified. If they continued to be dormant for another 6 months, it was assumed the exit took place at the start of the first 6-month period. We checked exit routes and excluded ventures that were still trading but had switched to another bank.

Our dependent variable for the testing of Hypothesis 2 is time spent in excess of overdraft (*OD XS time*), which is the proportion of time a new venture spends in excess of the allowed overdraft limit each year. For example, if a venture spends 15 days in excess of the overdraft limit, then this would correspond to a value of 0.04 (i.e., 15/365).

Our main explanatory variable is short-term revenue volatility (*Volatility*). We operationalize short-term revenue volatility as the standard deviation in monthly credit turnover[5] over a 12-month period divided by the mean monthly turnover for that period.[6] This serves as a close approximation to sales revenue volatility, inclusive of taxes, and so is the term used throughout the article. The measure is conceptually distinct from the size of the new venture in the sense that it is the fluctuations relative to size that are captured, rather than standard deviation in an absolute sense.

Control Variables

The size and growth of new ventures have been put forward as key determinants of a firm's survival chances (Le Mens et al., 2011). Our indicator of size is (the natural logarithm of) credit turnover over a period of 12 months appropriately deflated to remove inflation[7] (*Log_revenues*). Growth of revenues (*Gr_revenues*) for venture i in year t is measured in the usual way by taking log-differences (Törnqvist, Vartia, & Vartia, 1985): Growth(i,t) = log(size(i,t) – log(size(i,t-1)). Our measure is reliable and comprehensive because it does not rely on self-reports since every financial transaction going through this account is documented.

We also control for the "usual suspects" that previous work has identified as having an influence on new venture survival (and entrepreneurial performance more generally). These include legal form, age, industry, and region of the firm; and number, age, education, and previous business experience of the owner(s). Legal form has been shown to be a significant determinant of new venture outcomes, with companies and partnerships generally having higher survival rates than sole proprietorships (Storey, 1994). Likewise, firm age is known to affect viability (Stinchcombe, 1965). We therefore control for legal form (*LegalF*) and firm age (*Firm age*). We also include region and industry dummies (*Region* and *Industry*) in our regressions (Ahlers, Cumming, Günther, & Schweizer, 2015) to control for region-specific and industry-specific components of survival (e.g., Botham & Graves, 2011; Dencker, Gruber, & Shah, 2009).

Founder age is expected to have a broadly positive relationship with new venture survival (Baù et al., 2017) being lowest amongst the young and inexperienced (Parker, 2018); hence, we control for founder age (*Founder age*) and founder age squared (*Founder age_sq*). The number and the gender of owner(s) are controlled for (*No. owners*, *Male owners* and *Female owners*), because a case has been made that they affect new venture survival (Klotz, Hmieleski, Bradley, & Busenitz, 2014). The education of the founder (Parker, 2018) and also the amount of previous (personal or parental) business experience (Dencker et al., 2009; Gimeno et al., 1997) are seen by some to capture different dimensions of human capital, and perhaps higher levels of entrepreneurial skills and capabilities, thus enhancing the survival of the business (variables *Education*, *Parental bus. exp*., and *Personal bus. exp*.).[8] There is more mixed evidence on the role played by sources of advice used by founders and new venture survival and performance (Chrisman & McMullan, 2004; Rotger, Gørtz, & Storey, 2012), but to allow for a possible influence of these variables we include dummies for eight different sources of advice (*Sources of advice*). We also include control variables relating to financial management that have not usually been included in previous investigations for reasons of data limitations; these variables relate to the authorized and unauthorized use of overdraft facilities: *OD limit*, *OD limit use*, *OD limit extent*, *OD XS*, and *OD XS time*. All variables used are further explained in Table 1, and descriptive statistics are provided in Table 2.

Statistical Tests and Hypothesis Testing

Hypothesis 1 is tested by investigating the relationship between *Volatility* and new venture survival, controlling for a range of other possible influences. Because *Volatility* is calculated over a 1-year period based on monthly revenue, it requires a new venture to survive for the full period to allow for meaningful calculation. Consequently, we investigate the relationship between lagged short-term revenue volatility and survival, for each year. That is, we investigate the relationship between *Volatility* in year *t*-1 and survival in year *t*. *Survival* is a dichotomous variable, observed for each year, so we use discrete-time logistic duration models (Coad, Frankish, Roberts, & Storey, 2013; Jenkins, 1995; Wiklund et al., 2010). Hypothesis 2 is tested by investigating the relationship between *Volatility* and *OD XS time*, controlling for other influences.

Results are shown in Table 3 and illustrated in Figure 1. Ordinary least squares (OLS) regressions for testing Hypothesis 1 are presented,[9] together with panel "within" regressions that control for possible unobserved time-invariant components in overdraft behavior, by including firm-specific "fixed effects" (Wooldridge, 2010). Possible multicollinearity was investigated by inspecting the correlation matrix and the variance inflation factor (VIF) statistics and was deemed not problematic (analyses available from the authors). The inclusion of lagged variables means we can only present regression results from Year 3 onward.

Selection was investigated by comparing those ventures that got selected out of the cohort with those that survived, and the effects of adaptation by comparing surviving ventures to themselves over time (as outlined in the section "Short-Term Revenue Volatility and Venture Exits"). Support for Hypotheses 3a and 3b would require that any decrease in *Volatility* over time, due to selection or adaptation, should be statistically significantly different from zero. The results are presented in Table 4 and Figure 2. To address issues associated with regression to the mean (Chen & Chen, 2010), we assess the general trend in adaptation for those surviving for the full duration of our study, presented in Figure 3.

Results

Short-Term Revenue Volatility and Venture Performance

Table 3 Column (2) shows our baseline results that *Volatility* in 1 year is a strong predictor of new venture exit the following year. Hypothesis 1 is therefore supported. Figure 1 depicts the mortality rates for the new ventures in our sample from Year 3 to Year 10 for new ventures with low (high) *Volatility*, using estimates from cross-sectional year-wise regressions (not shown here), based on whether the observation is in the lowest (highest) tercile of the *Volatility* distribution for

Table 1. Variable Definitions.

Variable	Description
Volatility	Short-term revenue volatility (*SD* of monthly turnover/mean monthly turnover)
Log_revenues	Natural logarithm of credit turnover during focal year. Values are expressed in 2004 GDP by applying the World Bank's Consumer Price Index deflator for the UK, taking 2004 as the benchmark.
Gr_revenues	Change in natural logarithm of credit turnover between focal year and previous year
LegalF	Legal form of business: 1 = Company[a], 2 = Partnership, 3 = Sole Trader
Industry[b]	Business activity: 1 = Agriculture, 2 = Manufacturing, 3 = Construction, 4 = Retail, 5 = Transport,
	6 = Accommodation, 7 = Information, 8 = Real Estate, 9 = Professional, 10 = Administrative,
	11 = Education, 12 = Health, 13 = Arts, 14 = Other. Converted into dummy variables, one for each industry.
Region[b]	Region: 1 = East Midlands, 2 = East of England, 3 = London, 4 = North East, 5 = North West,
	6 = South East, 7 = South West, 8 = West Midlands, 9 = Yorkshire and The Humber, 10 = Wales. Converted into dummy variables, one for each region.
Firm age[b]	Dummy variable for each individual year.
No. owners	Number of owners
Male owners	Male owner(s) only: 0 = No, 1 = Yes
Female owners	Female owner(s) only: 0 = No, 1 = Yes
Founder age	Mean age of owner(s) at startup
Founder age_sq	Square of *Founder age*
Education	Highest level of educational attainment by owner(s), in terms of the National Vocational Qualification (NVQ) scale: 1 = <NVQ2[a], 2 = NVQ2, 3 = NVQ3, 4 = NVQ4+
Parental bus. exp.	Previous business experience, Family: 0 = No, 1 = Yes
Personal bus. exp.	Previous business experience, Owner: 0 = No, 1 = Yes
Sources of advice	
EABL	Advice/support, Enterprise Agency/Businesslink: 0 = No, 1 = Yes
Accountant	Advice/support, Accountant: 0 = No, 1 = Yes
Solicitor	Advice/support, Solicitor: 0 = No, 1 = Yes
College	Advice/support, College: 0 = No, 1 = Yes

(Continued)

Table 1. Continued

Variable	Description
SR seminar	Advice/support, (Barclays) Start Right Seminar: 0 = No, 1 = Yes
PYBT	Advice/support, Prince's Youth Business Trust: 0 = No, 1 = Yes
Family	Advice/support, Family/friends: 0 = No, 1 = Yes
Other	Advice/support, Other source(s): 0 = No, 1 = Yes
OD limit	Approved overdraft limit available during (all or part of) year: 0 = No, 1 = Yes
OD limit use	Use of approved overdraft limit during focal year: 0 = No, 1 = Yes
OD limit extent	Average maximum proportion of approved overdraft limit used during focal year
OD XS	Excess use of overdraft during year x: 0 = No, 1 = Yes
OD XS time	Proportion of time spent in excess of overdraft limit during focal year
FinDef	Binary variable. Takes value one if the firm is recorded as entering financial default at any point in the year, otherwise takes value 0. Used as an alternative dependent variable in the robustness analysis.

GDP, gross domestic product ; *SD*, standard deviation.
[a]Used as reference in regression thus omitted.
[b]Included in regression, but results not reported due to space limitations.

Table 2. Summary Statistics for Year 1.

Variable	Mean	Median	*SD*	Skewness	Kurtosis	Min	Max	*N*
Founder age	39.039	38.157	10.224	0.424	2.753	16.197	78.160	6,569
No. owners	1.322	1	0.578	2.128	9.410	1	6	6,561
Male owners	0.669	1	0.471	−0.719	1.517	0	1	6,561
Female owners	0.190	0	0.393	1.576	3.485	0	1	6,578
Education_1	0.228	0	0.419	1.300	2.689	0	1	6,578
Education_2	0.332	0	0.471	0.716	1.512	0	1	6,578
Education_3	0.171	0	0.377	1.747	4.053	0	1	6,578
Education_4	0.270	0	0.444	1.037	2.075	0	1	6,578
Parental bus. exp.	0.633	1	0.482	−0.552	1.305	0	1	6,578
Personal bus. exp.	0.720	1	0.449	−0.982	1.965	0	1	6,578
Sources of advice								
EABL	0.102	0	0.303	2.625	7.888	0	1	6,578
Accountant	0.362	0	0.480	0.577	1.332	0	1	6,578
Solicitor	0.049	0	0.215	4.188	18.544	0	1	6,578
College	0.040	0	0.196	4.696	23.053	0	1	6,578
SR seminar	0.007	0	0.086	11.457	132.252	0	1	6,578
PYBT	0.014	0	0.116	8.422	71.924	0	1	6,578
Family	0.300	0	0.458	0.871	1.758	0	1	6,578
Other	0.064	0	0.245	3.563	13.693	0	1	6,578
LegalF_1 (Company)	0.372	0	0.483	0.530	1.281	0	1	6,578
LegalF_2 (Partnership)	0.133	0	0.340	2.155	5.646	0	1	6,578
LegalF_3 (Sole trader)	0.495	0	0.500	0.022	1.000	0	1	6,578
Revenue (2004 GBP)	114110	38734	508723	46.439	2805	31	31963724	5,523
Volatility	0.843	0.676	0.601	1.679	6.282	0	3.464	5,523
OD limit	0.195	0	0.396	1.538	3.366	0	1	6,578
OD limit use	0.186	0	0.389	1.611	3.596	0	1	5,523
OD limit extent	0.041	0	0.118	3.658	17.714	0	0.93	5,523
OD XS	0.407	0	0.491	0.377	1.142	0	1	5,523
OD XS time	0.041	0	0.103	3.754	19.837	0	1	5,523

SD, standard deviation.

the preceding year. While *Volatility* has large and statistically significant effects on *Survival*, there is no strong relationship between the studied human capital variables (i.e., previous business start-up experience or education) and new venture survival.[10] In further analysis (not shown here), the coefficients, and thus the odds ratios, for the impact of *Volatility* on venture survival was relatively stable over the years and there was no clear trend in its development.[11] Thus, there is no indication that the adverse effects of short-term revenue volatility on venture survival tend to decrease with time.

Columns (8) and (9) of Table 3 show that *Volatility* is positively related to *OD XS time*, and this effect is statistically significant. Hypothesis 2 is supported and implies that an increase in *Volatility* of one standard deviation is associated with an increase of time in unauthorized overdraft excess of 7.67 days.[12]

Table 3. Regression Results.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Dependent variable	Survival	Survival	Survival	Survival	Survival	FinDef	OD XS time	OD XS time	OD XS time
Model	Controls	All	Small	Large	Nonzero	All	Controls, OLS	All, OLS	All, FE
Founder age	0.0614**	0.0683**	0.0752**	0.0747**	0.0727**	−0.0290	−0.00148	−0.00174*	
	(0.0144)	(0.0147)	(0.0199)	(0.0220)	(0.0265)	(0.0341)	(0.000792)	(0.000787)	
Founder age_sq	−0.000638**	−0.000702**	−0.000783**	−0.000759**	−0.000810**	0.000231	5.60e-06	8.16e-06	
	(0.000170)	(0.000173)	(0.000236)	(0.000258)	(0.000313)	(0.000416)	(9.09e-06)	(9.04e-06)	
No. owners	−0.0283	0.0166	−0.0332	0.0504	0.129	−0.170	−0.000832	−0.00304	
	(0.0497)	(0.0504)	(0.0910)	(0.0622)	(0.0973)	(0.126)	(0.00188)	(0.00186)	
Male owners	−0.296**	−0.279**	−0.369*	−0.221*	−0.253	0.0189	0.00760*	0.00668*	
	(0.0812)	(0.0819)	(0.149)	(0.102)	(0.158)	(0.184)	(0.00331)	(0.00328)	
Female owners	−0.474**	−0.487**	−0.645**	−0.363**	−0.615**	−0.0200	−0.00344	−0.00326	
	(0.0944)	(0.0954)	(0.159)	(0.131)	(0.181)	(0.215)	(0.00421)	(0.00419)	
Education_2	0.0261	0.0319	−0.0153	0.0523	−0.170	−0.213	−0.00907**	−0.00890**	
	(0.0605)	(0.0612)	(0.0858)	(0.0894)	(0.114)	(0.124)	(0.00301)	(0.00298)	
Education_3	−0.0393	−0.00417	−0.0258	−0.00973	−0.0625	−0.252	−0.0116**	−0.0131**	
	(0.0714)	(0.0723)	(0.105)	(0.102)	(0.137)	(0.152)	(0.00341)	(0.00339)	
Education_4	−0.0522	0.0410	−0.00486	0.0744	0.0798	−0.111	−0.00971**	−0.0138**	
	(0.0674)	(0.0689)	(0.101)	(0.0966)	(0.133)	(0.142)	(0.00326)	(0.00325)	
Parental bus. exp.	0.00278	1.79e-05	0.00479	−0.00263	−0.0985	−0.104	0.00259	0.00260	
	(0.0470)	(0.0479)	(0.0674)	(0.0697)	(0.0905)	(0.0993)	(0.00213)	(0.00211)	
Personal bus. exp.	−0.0132	0.0127	−0.00107	−0.00417	−0.0402	−0.0237	0.0116**	0.0103**	
	(0.0532)	(0.0541)	(0.0709)	(0.0852)	(0.0996)	(0.118)	(0.00260)	(0.00257)	
Sources of advice									
EABL	0.101	0.0751	0.220*	−0.175	0.131	0.0218	0.00637	0.00703	
	(0.0794)	(0.0814)	(0.105)	(0.126)	(0.152)	(0.167)	(0.00392)	(0.00390)	
Accountant	0.0168	0.0138	0.0587	−0.0168	−0.196*	−0.112	0.00698**	0.00681**	

(Continued)

Table 3. Continued

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	(0.0483)	(0.0491)	(0.0732)	(0.0686)	(0.0911)	(0.105)	(0.00222)	(0.00220)	
Solicitor	−0.0963	−0.0681	−0.219	0.0579	0.0514	0.495*	−0.00258	−0.00361	
	(0.106)	(0.108)	(0.169)	(0.152)	(0.205)	(0.212)	(0.00499)	(0.00493)	
College	0.318**	0.316*	0.410*	0.158	0.177	0.299	0.00108	0.00244	
	(0.121)	(0.126)	(0.166)	(0.188)	(0.222)	(0.214)	(0.00551)	(0.00545)	
SR seminar	−0.188	−0.157	−0.442	0.408	−0.821	−0.368	0.0632**	0.0588*	
	(0.296)	(0.311)	(0.397)	(0.489)	(0.491)	(0.543)	(0.0244)	(0.0242)	
PYBT	0.122	0.106	0.0677	−0.0499	−0.116	−0.406	0.0363*	0.0350*	
	(0.243)	(0.253)	(0.277)	(0.624)	(0.478)	(0.511)	(0.0176)	(0.0172)	
Family	0.0105	−0.00247	0.0104	−0.00824	−0.0673	−0.0179	0.00737**	0.00789**	
	(0.0514)	(0.0521)	(0.0731)	(0.0759)	(0.0939)	(0.108)	(0.00254)	(0.00252)	
Other	−0.0835	−0.0897	−0.163	−0.0619	−0.133	0.350*	0.00675	0.00645	
	(0.0935)	(0.0953)	(0.125)	(0.149)	(0.178)	(0.177)	(0.00461)	(0.00460)	
LegalF_2 (Partnership)	−0.347**	−0.486**	−0.337*	−0.601**	−0.564**	−0.234	−0.00330	0.00335	
	(0.0788)	(0.0797)	(0.138)	(0.104)	(0.155)	(0.188)	(0.00366)	(0.00364)	
LegalF_3 (Sole trader)	0.0771	−0.0192	0.0726	−0.123	−0.0702	0.0962	0.00576*	0.00992**	
	(0.0585)	(0.0596)	(0.0900)	(0.0835)	(0.113)	(0.122)	(0.00279)	(0.00276)	
Log_revenues (lagged)	0.198**	0.0681**	0.136**	0.0536	0.145**	0.147**	−0.0198**	−0.0134**	−0.0256**
	(0.0186)	(0.0194)	(0.0339)	(0.0324)	(0.0410)	(0.0403)	(0.00101)	(0.00102)	(0.00346)
Gr_revenues (lagged)	0.354**	0.272**	0.208**	0.265**	0.484**	−0.0979	−0.0233**	−0.0196**	−0.00322
	(0.0327)	(0.0300)	(0.0442)	(0.0459)	(0.0735)	(0.0535)	(0.00232)	(0.00227)	(0.00245)
Volatility (lagged)		−0.648**	−0.478**	−0.853**	−1.121**	0.154*		0.0348**	0.0340**
		(0.0376)	(0.0516)	(0.0569)	(0.0825)	(0.0756)		(0.00268)	(0.00368)
OD limit (lagged)	0.102	0.0606	−0.0719	0.117	0.182	0.653**	0.0632**	0.0637**	0.0527**
	(0.100)	(0.100)	(0.179)	(0.127)	(0.183)	(0.191)	(0.00613)	(0.00607)	(0.00857)
OD limit use (lagged)	−0.0645	−0.00530	0.142	−0.0525	0.234	0.378	−0.0307**	−0.0322**	−0.0409**

(Continued)

Table 3. Continued

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	(0.117)	(0.117)	(0.213)	(0.145)	(0.216)	(0.205)	(0.00652)	(0.00646)	(0.00695)
OD limit extent (lagged)	0.0475	−0.0560	−0.153	0.00644	−0.334	0.468	−0.0732**	−0.0681**	−0.0872**
	(0.157)	(0.158)	(0.279)	(0.195)	(0.290)	(0.264)	(0.00484)	(0.00480)	(0.00797)
OD XS (lagged)	−0.302**	−0.302**	−0.213**	−0.373**	−0.235*	1.701**			
	(0.0511)	(0.0520)	(0.0756)	(0.0731)	(0.0970)	(0.149)			
OD XS time (lagged)	−1.797**	−1.613**	−1.607**	−1.737**	−1.690**	3.218**			
	(0.144)	(0.145)	(0.191)	(0.231)	(0.282)	(0.206)			
Observations	18,219	18,219	7,803	10,416	10,960	18,219	19,425	19,425	19,425
Number of panel ID									4,146
Adjusted *R2*							0.132	0.147	0.146
Pseudo *R2*	0.131	0.150	0.131	0.172	0.181	0.228			
Log likelihood	−6997	−6841	−3263	−3530	−2257	−1920	10526	10697	20302
Log likelihood, constant only	−8052	−8052	−3757	−4263	−2756	−2488	9122	9122	18756

Note. Constant term, region and industry dummies, and firm age dummies (i.e., year dummies) are included in the regressions, but not reported here. Robust standard errors in parentheses.
Key to significance stars: ** $p < .01$, * $p < .05$.

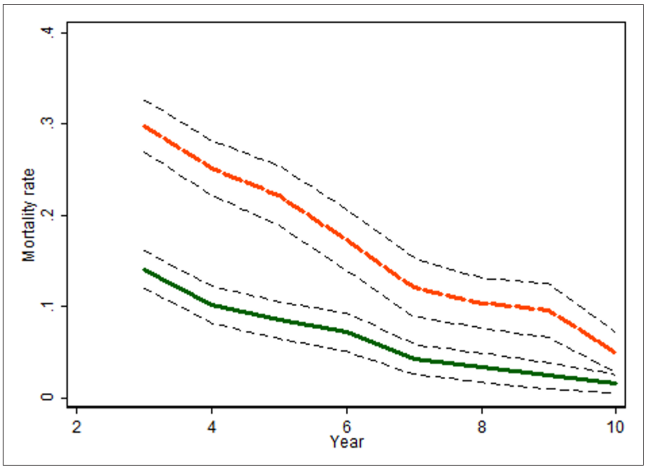

Figure 1. Mortality rates across years, for firms with high or low *Volatility*.

Mortality rates in year *t* based on marginal effects of being in a high or low *Volatility* tercile in year *t*-1, where all other variables are fixed at their mean values. Thick solid line: ventures in the lowest tercile of *Volatility*. Thick dashed line: ventures in the highest tercile of *Volatility*. Thin dashed lines denote 95% confidence intervals. New ventures are classified as having low (high) *Volatility*, based on whether the observation is in the lowest (highest) tercile of the *Volatility* distribution for that specific year.

Robustness Analysis for Firm-Level Regressions

Columns (3) and (4) show similar results for subsamples of small and large firms (i.e., those with below- or above-median sales in their first year). One possible concern could be that some firms have revenue models that are affected by intermittent seasonal demand, such that they have zero sales in some months and positive sales in other months. We verify that seasonality is not a major factor by repeating the analysis on a restricted subsample of firms with nonzero sales in each of the 12 months in a year. Column (5) of Table 3 presents these results, for the subsample of firms with nonzero revenues in each of the 12 months of the year. For this subsample, the coefficient on *Volatility* remains negative and significant and actually increases substantially in magnitude. This provides assurance that our results are not being driven by a category of firms with zero sales in some months, but that *Volatility* is detrimental to survival even among a subsample of firms that have nonzero revenues in every month of the year. To address concerns that our results are influenced by "successful exits," we repeat our survival regressions by taking financial default (*FinDef*), rather than *Survival*, as an alternative dependent variable (see Table 1 for a variable description). Column (6) shows that *Volatility* is statistically significantly related to entry into financial default.

Finally we explored the robustness of our results by repeating our analysis on industry-disaggregated subsamples and obtained broadly similar results.[13] To address the concern that industry dummies are an imperfect way to account for sectoral heterogeneity, we also created a firm-specific baseline short-term revenue volatility (taking the average for *Volatility* in a firm's first 5 years) and then regressed survival on a firm's idiosyncratic deviations from its firm-specific volatility benchmark. This further confirmed that higher-than-usual short-term revenue volatility decreases a firm's survival chances. We also repeated our analysis by dropping outliers at both ends of the *Volatility* distribution (with thresholds of 1% and 5% at each end) and again obtained similar results, which are available from the authors upon request.

Table 4. Decomposing the Changes in the Cohort's Average *Volatility* Into Between and Within Effects, During the Period T:t + s.

	s = 2	*s* = 3	*s* = 4	*s* = 5	*s* = 6	*s* = 7	*s* = 8	*s* = 9	*s* = 10
Average initial volatility	0.843	0.843	0.843	0.843	0.843	0.843	0.843	0.843	0.843
SE of the mean	*0.008*	*0.008*	*0.008*	*0.008*	*0.008*	*0.008*	*0.008*	*0.008*	*0.008*
No. obs	5,523	5,523	5,523	5,523	5,523	5,523	5,523	5,523	5,523
Average initial volatility (at *t* = 1) of survivors until year s	0.774	0.765	0.745	0.733	0.730	0.727	0.728	0.729	0.732
SE of the mean	*0.009*	*0.010*	*0.011*	*0.011*	*0.012*	*0.013*	*0.014*	*0.014*	*0.015*
No. obs	4,161	3,209	2,592	2,151	1,822	1,604	1,424	1,311	1,208
Average final volatility (at t = s) of survivors until year s	0.823	0.809	0.794	0.791	0.777	0.734	0.707	0.716	0.703
SE of the mean	*0.010*	*0.012*	*0.013*	*0.014*	*0.015*	*0.015*	*0.016*	*0.017*	*0.017*
No. obs	4,161	3,209	2,592	2,151	1,822	1,604	1,424	1,311	1,208
Share of the reduction in volatility due to selection	334.16%	226.84%	197.97%	211.19%	171.28%	106.22%	84.67%	89.50%	78.87%
t-test *p* values for selection	**	**	**	**	**	**	**	**	**
Share of the reduction in volatility due to adaptation	−234.16%	−126.84%	−97.97%	−111.19%	−71.28%	−6.22%	15.33%	10.50%	21.13%
t-test *p* values for adaptation	NA	NA	NA	NA	NA	NA	NS	NS	NS

NA, not applicable; *SE*, standard error.
** $p < .01$, * $p < .05$, NS $p > .05$,

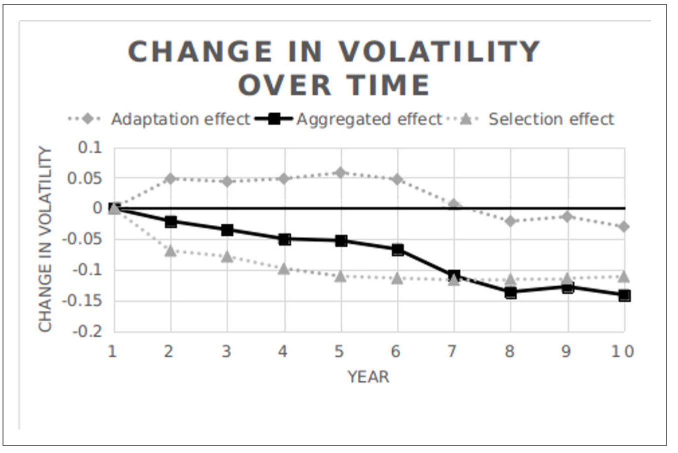

Figure 2. Decomposing the aggregate change in *Volatility* into selection effects and adaptation effects.

Selection and Adaptation

Figure 2 and Table 4 present the evolution of *Volatility* over different timescales as outlined in the section "Short-Term Revenue Volatility and Venture Exits"; *t* tests show that the reduction of *Volatility* due to selection is statistically significant in each year. They also show that the reduction in *Volatility* due to adaptation is never statistically significant. In fact, at shorter timescales of 1–6 years, *Volatility* appears to be rising slightly within surviving new ventures, instead of decreasing, indicating "negative" adaptation effects.

Our interpretation of this is based on the idea that less *Volatility* is preferable, given how strongly *Volatility* predicts venture exit. However, if there is an element of randomness to short-term revenue volatility, which is reasonable, then an increase in such volatility among survivors could be explained by regression to the mean effects (Chen & Chen, 2010).[14] Table 4 and Figure 2

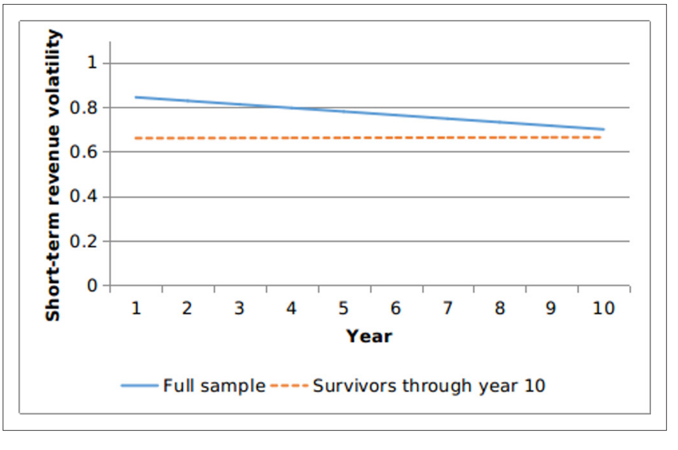

Figure 3. Trends in short-term revenue volatility.

Regression lines come from pooled OLS of *Volatility* on years since entry, for the two groups.

do not therefore disprove nonrandom adaptation effects but suggest that if such effects exist, they are offset by a regression to the mean effect.

To test for other signs of positive adaptation effects, we investigated the trend in *Volatility* among those we know survived for the full 10-year period. This graph is presented in Figure 3, where it is juxtaposed to the development of *Volatility* for the whole sample (including those new ventures that are eventually selected out of the sample). For the balanced panel of new ventures that survive for the entire period, the trend is actually slightly *positive*, but it is not statistically significant.[15] Thus, there is no evidence that adaptation effects lead to a statistically significant reduction in *Volatility*. Consequently, Table 4 and Figures 2 and 3 all support the hypothesis that selection effects reduce short-term revenue volatility over time but reject the hypothesis that adaptation effects reduce short-term revenue volatility. Therefore, we find support for Hypothesis 3b but not for Hypothesis 3a.

For the full sample (unbalanced panel, where ventures in the cohort exit due to attrition), the trend in Figure 3 is statistically highly significant, but the effect size is small:[16] Over a 10-year period, average *Volatility* decreases by 0.16, which corresponds to roughly a quarter of a standard deviation. Such a reduction in *Volatility* is small but meaningful. A reduction in *Volatility* of 0.16 corresponds to a reduction in the odds of dying (based on the average effect of *Volatility* over the studied period) of roughly 10%.

Discussion

This study takes important steps toward obtaining a better understanding of the effects of short-term revenue volatility and how such volatility develops over time in a cohort of new ventures. We now review and interpret our findings and suggest directions for future research. We begin with the study's implications for theories of the liability of newness and smallness. A second subsection examines its links to performance and uncertainty. In the third subsection, we offer our views on how it links with evolutionary theory. We then discuss the generalizability of our results.

Short-Term Revenue Volatility and the Liabilities of Newness and Smallness

This article has made the case that short-term revenue volatility is a liability in its own right, which is distinct from, but related to, the liabilities of smallness and newness. We show that venture age, size, and short-term revenue volatility are interrelated; but they are also distinct constructs in the sense that they are conceptually easy to distinguish, they are not perfectly empirically correlated, they contribute distinct risks (i.e., each is associated with higher mortality risks holding the others constant), and the liabilities associated with them are based on different theoretical foundations (although with some similarities).

Smallness is associated with higher mortality rates because small ventures have fewer buffer resources and because their stakeholders, such as customers, lenders, and employees perceive them as riskier (Aldrich & Auster, 1986; Freeman et al., 1983). We theorize that short-term revenue volatility is associated with higher mortality rates because such volatility requires more buffer resources and, similarly to smallness, such volatility increases perceived risks among stakeholders. We also theorize that short-term revenue volatility decreases the perceived value of a new venture in the eyes of the owner(s), thus reducing its viability (Coad, 2014). For these reasons, there are similarities between the theoretical underpinnings of the liability of volatility and those of the liabilities of newness and smallness, but these underpinnings are distinct.

Empirically, there are links, but also differences, between the constructs. The differences are clearest when analyses at the cohort and at the firm level are juxtaposed. At the cohort level, short-term revenue volatility is correlated both with age and with size (for the latter, see the Correlation table in the Supplementary Appendix). At the firm level, however, there is no evidence that firms learn to reduce short-term revenue volatility, or its adverse effects, over time. Smallness, by contrast, has been shown to be related to age at both levels of analysis (Coad, 2018).

It is noteworthy that short-term revenue volatility in one year is a strong predictor of venture exit in the following year, and the effect size is comparable to that of size. The effect of size (*Log_revenues*) decreases substantially when *Volatility* is included (see Table 3, Columns 1 and 2) and yearly logistic regressions (results available from the authors) show that size is only intermittently statistically significant when *Volatility* is also included in the model, implying that an important benefit of size is that it provides more stable revenue streams.

The robustness of the negative association between short-term revenue volatility and subsequent survival makes a strong case for further research on the liability of volatility. Research over the past decade has established the importance of investigating different aspects of growth and size and how they relate to and interact with other performance indicators such as profitability, liquidity, assets, and leverage in the new venture context (Delmar et al., 2013; Shepherd & Wiklund, 2009; Wiklund et al., 2010). Analogously, future research on the liability of volatility should incorporate additional aspects of short-term volatility (e.g., of costs, profits, cash flow, and buffer resources) and assess their combined effects on new venture performance and viability. It is also important to assess volatility over different time periods. While we have made the case that volatility over short timeframes (i.e., within a year) is important and underresearched, it is becoming increasingly clear that annual revenue exhibits a fair amount of volatility too (McKelvie & Wiklund, 2010). It is therefore important to study also the volatility of growth and whether the liability of volatility extends to longer time periods. Finally, future research on the liability of volatility should address not only the outcomes of volatility but also volatility as an outcome (cf. McKelvie & Wiklund, 2010).

The Effects of Short-Term Revenue Volatility on Performance and Its Links to Uncertainty

In addition to predicting new venture exit, we find that short-term revenue volatility also predicts the time a venture spends in excess of its overdraft limit. This suggests that part of the negative effect of short-term revenue volatility on venture survival reflects the depletion of financial buffers, supporting such untested claims in previous studies (Wiklund et al., 2010). Although our regression-based findings are unable to establish the precise causal mechanisms (depletion of resource buffers, reduced perceived value, or other explanations), we know that short-term revenue volatility precedes exit (i.e., it is the effect of *Volatility* in the preceding year on the *Survival* in the focal year that we study).

The inclusion of a large set of controls, and the additional robustness tests, reveal that short-term revenue volatility has a negative effect on new venture survival even for new ventures that are comparatively large, growing, and are able to meet their immediate financial obligations. The finding that short-term revenue volatility predicts new venture exit, even after controlling for borrowing behavior, suggests that short-term revenue volatility reduces the relative viability of the ventures, rather than acting solely to exhaust buffer resources. That is, many entrepreneurs who face short-term revenue volatility may opt for closing their ventures even though some buffer resources remain. In this case, additional credit or cash reserves may not increase the likelihood of venture survival; rather, short-term revenue volatility makes the risks and the uncertainty of new venture management more salient and that makes the venture less attractive than other alternatives for the founder (Coad, 2014). Consequently, additional financial buffer resources are likely to reduce new venture mortality (Wiklund et al., 2010), but not to be a panacea. Furthermore, increased financial buffers will, *ceteris paribus*, reduce profitability (cf. Delmar et al., 2013).

We have theorized four reasons why short-term revenue volatility decreases the relative viability of new ventures: (a) Volatility makes it harder to plan ahead; (b) volatility adds psychological stress; (c) volatility adds a risk premium; and (d) volatility raises average costs. While some of these reasons are conceptually distinct from uncertainty (e.g., various adjustment costs), several are associated with increased levels of uncertainty (e.g., about demand and scale and scope of required resources). The idea that increased perceived uncertainty explains exit is in line with findings that perceived uncertainty inhibits entrepreneurial behavior and that demand uncertainty leads to smaller scale launches (McKelvie, Haynie, & Gustavsson, 2011). If this is the case, then it points to a potential positive feedback loop in that perceived uncertainty leads to smaller start-up size, which leads to more volatility, which leads to increased perceived uncertainty. Our theorizing also suggests that while uncertainty is inherently intertwined with the concept of entrepreneurship (Knight, 1921), more uncertainty may in fact inhibit new venture viability. These findings remain in line with the idea that entrepreneurs have a higher tolerance for uncertainty (or related constructs such as ambiguity and risk).[17] If entrepreneurship is inherently associated with uncertainty, then it follows that entrepreneurs can bear some uncertainty, but it does not follow that they prefer more over less.

We consider it important for future research to clarify how uncertainty influences and interacts with key entrepreneurial processes (McKelvie et al., 2011). Our study points to the importance of asking how short-term revenue volatility influences perceived uncertainty and how such uncertainty influences stress, job satisfaction, and perceived investment value. Finally, we need to better understand the consequences for new venture survival of spikes of extreme volatility compared to long periods of elevated volatility.

Contributions to Evolutionary Theory in Entrepreneurship and Organization Studies

Our results show that selection effects decrease average short-term revenue volatility of the cohort over time, whereas this is not the case for learning or adaptation. It is, of course, possible that surviving ventures comprise subgroups that systematically develop in different directions. For example, some might focus on reducing short-term revenue volatility, whereas others might increase their tolerance for such volatility through building buffer resources. If this were the case, then we would expect to see a trend toward diminished adverse effects of *Volatility* as reflected in the odds ratio in the regression of *Volatility* on new venture survival. We examined this as a robustness test (see Note 11) and found no support for this explanation.

Skepticism about adaptation mechanisms is not new but has been justified previously by pointing to the inherent inertia within large and old organizations (Hannan & Freeman, 1977; 1984). Such inertia is considerably less relevant for new ventures and this is confirmed in our results, which show that short-term revenue volatility does change for individual ventures (but the average across survivors is stable). A potentially more valid argument against adaptation, which better reflects our findings, is the role of uncertainty and complexity in the new venture context (Knight, 1921; McKelvey, 2004). From this perspective, while young ventures are able to change, change is unlikely to improve venture performance in predictable ways because the owners are unable to determine what works and what does not with any level of satisfactory accuracy (Frankish, Roberts, Coad, Spears, & Storey, 2013; Lundmark & Westelius, 2014). Rather, our results indicate that configurations that (for whatever reason) exhibit lower short-term revenue volatility are favored by selection mechanisms. These patterns emerge over time in a cohort of thousands of new ventures, and the specifics of these configurations are likely not something that entrepreneurs would be able to recognize if they "accidentally" manifested in their own ventures, let alone spot in other ventures and imitate. Thus, the limited learning observed in other studies could be a result of copying the visibly successful (Baum & Singh, 1996; Delacroix & Swaminathan, 1991; Usher & Evans, 1996).

Our results also hint at the possibility of "negative" adaptation during the first few years of venture existence, in the sense that entrepreneurs may systematically tend to "learn" things that negatively affect their ventures' viability (Lundmark, Krzeminska, & Shepherd, 2019). That is, there may be particular patterns in what entrepreneurs infer from common experiences, and some such inferences may do more harm than good. This is in line with several studies pointing to previous business ownership experience being negatively associated with (Nielsen & Sarasvathy, 2016; Rocha, Carneiro, & Varum, 2015) or being unrelated to venture viability (Yang & Aldrich, 2017). While our results should therefore not be taken as evidence of negative learning, they do, together with other recent research, suggest that such links should be investigated further.

Our findings also provide insights into the longitudinal effects of selection mechanisms in the early years of the venture life cycle (Delmar et al., 2013). When the mortality rates are around 15%–25% and the odds of dying are markedly increased for ventures with high short-term revenue volatility, we would expect to see stronger cohort-level effects due to the weeding out of the new ventures with high short-term revenue volatility. While there is a meaningful reduction in short-term revenue volatility at the cohort level over time, it only corresponds to about a quarter of a standard deviation over a 10-year period. In evolutionary terms this is paradoxical—we have a strong selection mechanism weeding out high-volatility new ventures, but this only translates into a slow reduction in average volatility at the cohort level of analysis. A possible explanation could be the limited "inheritance" of short-term revenue volatility for a given new venture between periods. As a consequence, the selection environment is noisy and only imperfectly penalizes enduring characteristics associated with high short-term revenue volatility (cf. Coad et al., 2016).

Generalizing our Findings

Although this is a large-scale, longitudinal, panel data–based study examining the role of short-term revenue volatility among new ventures, it is of only one cohort. The outcomes we have identified therefore risk being specific to that cohort. We therefore conclude by speculating on the possible impact of two potentially important influences. The first is the role of the global financial crisis (GFC) and the second is the extent to which our findings might apply to different subgroups of new ventures.

In our cohort, slightly less than half survived long enough to enter the GFC of 2008–2009 (Davidsson & Gordon, 2016; Zarutskie & Yang, 2015) and this enabled us to examine whether the characteristics of the cohort changed during the downturn. We found that the cohort's average short-term revenue volatility decreased more sharply after Year 6 (2009–10) than in the preceding years (see Figure 2). While Davidsson & Gordon's (2016, p. 933) study of the effect of the GFC on new ventures in Australia found that new ventures were not much affected by the GFC and that "the surprising absence of direct effect of macroeconomic crisis on nascent entrepreneurs and their ventures is the most interesting and most important finding of our study," Zarutskie and Yang (2015) found that log revenues of new ventures in the United States were 3% lower at the depth of the recession. We cannot rule out macroeconomic influences on our results, but it is noteworthy that the duration of our study includes both macroeconomic munificence and contraction without any dramatic changes to the observed dynamics. Therefore, while there is no reason to believe that studying other cohorts would fundamentally change the main conclusions of this study, replication is vital and would provide a basis for further theorizing on the effects not only of volatility but also of macroeconomic munificence on new venture viability and performance.

A second inadequately covered issue in the article is the diversity of new ventures and the extent to which our findings apply to individual subgroupings. So, while we include sole traders, partnerships, and companies, we exclude subsidiaries of existing firms and other types of organizations. This could be important in generalizing our findings. For example, subsidiaries have been found to exhibit different dynamics to independent ventures in terms of mortality rates and responses to economic downturns (Bradley, Aldrich, Shepherd, & Wiklund, 2011). Even among independent ventures the role of volatility in influencing survival is likely to be different in high-tech spin-offs or venture capital–backed ventures (Brown & Lee, 2019). A further possible development could be to distinguish between "types" (Wennberg et al., 2010) and "speed" (Coad et al., 2013) of exit to determine whether different factors explain exit types.

Conclusions and Practical Implications

This article shows that short-term revenue volatility is a liability distinct from, but related to, the liabilities of newness and smallness. It finds that short-term revenue volatility is associated with the depletion of buffer resources, with financial default, and with new venture exit, which indicates that there are pressures on new ventures to decrease such volatility or to manage its consequences. However, we find no evidence that surviving ventures, on average, reduce their short-term revenue volatility or that the adverse effect of such volatility decreases over time. Nevertheless, average short-term revenue volatility decreases over time at the cohort level because volatile ventures exhibit higher mortality rates. Our interpretation of these findings is that the complexity and uncertainty of the new venture context makes it difficult for new ventures to reliably improve their performance.

These findings have practical implications for creditors seeking to predict new venture viability and for entrepreneurs who manage new ventures. First and foremost, we show that short-term revenue volatility is a strong predictor of subsequent exit. For creditors such as banks, data on short-term revenue volatility are therefore informative in making short-term credit assessments, but these are "private" to the bank and only become available once the enterprise has begun to trade. For entrepreneurs, we confirm that short-term revenue volatility is associated with the depletion of buffer resources and increased mortality risks. Because our findings indicate that surviving firms do not tend to decrease their short-term revenue volatility over the early years of existence, entrepreneurs may be better advised to protect against it than betting on their ability to reduce it. They can protect against the consequences of short-term revenue volatility by building additional financial buffers, either in the form of additional cash or in the form of an available overdraft. A simple, yet very practical, tip is to seek an overdraft before it is urgently needed.

The robustness and strength of our findings, combined with the dearth of research on short-term volatility, makes a strong case for further research on the liability of volatility. We have outlined several avenues for such research in this article that we hope will inspire and guide future research.

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ORCID ID

Erik Lundmark https://orcid.org/0000-0002-9417-1454

Notes

1. As the arguments for decreasing mortality rates after the peak suggested by the liability of adolescence are the same as the ones associated with the liability of newness, we continue to refer to it as the liability of newness.
2. As the focal cohort is defined by the time at which the ventures started trading, no new members can be added after this time. In studies of, for example, industries or regions, one has to consider entries too.
3. Our sample's number of ventures differs because a firm with missing sales data in Year 1 was dropped during data cleaning.
4. The United Kingdom, unlike many countries in continental Europe, is not characterized by multiple banking (Ongena & Smith, 2000).
5. That is the value of payments into a current account excluding payments from related accounts, for example, deposit accounts held by the business.
6. We dropped two outliers that had values above the theoretical maximum of 3.4641, which could arise if a firm has negative revenue streams. Negative revenue streams could arise if, for example, a cheque received in the previous period is observed to bounce.
7. Deflation is undertaken using World Bank data for the consumer price index for the United Kingdom (GBR): see https://data.worldbank.org/indicator/FP.CPI.TOTL?locations=GB (last accessed July 19, 2018).
8. Higher education levels may also signal that entrepreneurs have attractive outside options and may thus be more prepared to close their venture after unsatisfactory performance than those with fewer options (Gimeno et al., 1997; Parker, 2018).
9. Time spent in excess of the overdraft limit is a right-skewed variable. Further analysis with a $\log(1 + x)$ transformation of the dependent variable was therefore undertaken and yielded similar results.
10. These results are in tune with a growing number of studies that show that human capital measures are weak predictors of new venture performance; see Storey and Greene (2010) for a review and Unger, Rauch, Frese, and Rosenbusch (2011) for a meta study.
11. Further analysis of cross-sectional year-wise regressions shows that the weakest effect was seen in Year 8, –0.55 and the strongest effect in Year 9, –0.89. The regression line of the fitted coefficient values takes the following form: coefficient for *Volatility* = −.5973334 −.0130833 year, where the t-statistic for the coefficient on year is −0.73. $F(1, 6) = .54$, adjusted R-squared = −0.0710. Hence the slope of the regression line is far from statistically significant but, if anything, the tendency is toward a more adverse effect of *Volatility* on *Survival*.
12. The coefficient on *Volatility* in Columns (8) and (9) is around 0.035. This means that as *Volatility* increases by one standard deviation (i.e., by 0.601, see Table 2), the OLS regression–dependent variable *OD XS time* would increase by $0.601 \times .035 = .021035$. This increase of 0.021 corresponds to an increase of *OD XS time* (in terms of days) of $0.021 \times 365 = 7.665$ days. Hence, a one standard deviation

increase in *Volatility* corresponds to an increase of time in unauthorized overdraft excess of 7.665 days. This is a large effect size, if we consider that the median firm stays in unauthorized overdraft excess for 0 days and the average is 15 days. An increase of 7.665 days corresponds to an increase of over 50% of the average time in excess of new ventures.

13. In all but 2 out of 14 industry subsamples, *Volatility* has a negative and significant effect on subsequent survival (the industries with no statistically significant effects had relatively few observations).
14. Regression to the mean explains why those that exhibit high or low *Volatility* are likely to experience less extreme *Volatility* (not as high and not as low, respectively) in a subsequent time period; however, those with high *Volatility* are more likely to have been weeded out of the sample, thus leaving survivors that are likely to exhibit higher *Volatility* compared to themselves in the previous period.
15. For a pooled OLS regression of *Volatility* on years since entry, with 12,080 observations (i.e., firms surviving until the end of the 10-year period), the regression output is: constant = .657, slope = .00047, $F(1, 12078) = .07$, p value for the F statistic = .788.
16. For a pooled OLS regression of *Volatility* on years since entry, with 25,059 observations, the regression output is: constant = .857, slope = −0.0156, $F(1, 25057) = 121.47$, p value for the F statistic $< .0001$.
17. Alternative, yet consistent, ideas are that entrepreneurs are more optimistic (Baron, 1998; Storey, 2011) or less able to perceive risk or uncertainty (Simon, Houghton, & Aquino, 2000).

Supplemental Material

Supplemental material for this article is available online.

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Author Biographies

Erik Lundmark is Associate Professor at Macquarie Business School (Sydney, Australia). He currently studies the emergence of new ventures and market categories and has a keen interest in how we can facilitate reflexivity in entrepreneurship research. Prior to his

academic career, he worked as a manager in an entrepreneurial start-up firm and as a consultant in the IT-sector.

Alex Coad is Professor at CENTRUM-Católica Graduate Business School (Lima, Peru), and is interested in the areas of firm-level R&D investment, firm performance, entrepreneurship, strategy, and innovation policy. Alex is an Editor at the journals *Research Policy* and *Small Business Economics*, and Associate Editor for *Industrial and Corporate Change*. He can be contacted at acoad@pucp.edu.pe

Julian S. Frankish is Head of Business Economics and Research for the Business Banking unit of Barclays Bank UK plc.

David J. Storey is at the University of Sussex Business School. He has a long-standing interest in the factors influencing the performance of new and small firms.