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Firms' Financing Dynamics
Around Lumpy Capacity Adjustments

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Abstract

We study how firms adjust their financial positions around the times when they undertake lumpy adjustments in capital or labor. Using U.S. data from Compustat, we show that there are discernible patterns of financing lumpy adjustment, remarkably similar across capital and labor, but quite distinct between expansionary and contractionary lumpy adjustment episodes. We find strong evidence that both cash and debt capacity are actively manipulated to increase financial flexibility in the years before the ensuing expansion of firm capacity. Debt and cash contribute to financing the investment in capital or labor and leverage continues to rise significantly for two years after the lumpy expansion was initiated. Lumpy contractions are undertaken after years that show reductions in cash balances and above average levels of debt. During and after the contraction, firms rebuild cash and reduce debt growth significantly. These patterns are consistent with firms acting to restore financial health by adjusting their productive operations. We document that lumpy expansions and contractions in capital or employment are systematic time series drivers of firms' leverage and cash balance dynamics.

Keywords: Lumpy Adjustment, Firm Capital and Employment Dynamics, Leverage, Debt, Cash, Financial Flexibility.

JEL Classification: G30, G32, E32.

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1 Introduction

How do firms adjust their financial positions when they undertake lumpy adjustments in capital or labor? Such lumpy adjustments are arguably the most important decisions affecting firms' production and are subject to substantial costs. This paper explores and evaluates the dynamic patterns of different financing margins before, during and after the lumpy adjustment. Our study is important for understanding firm policies on capital structure and cash balances. Consider an example: a lumpy capital expansion undertaken by Schlitz Brewing company in 1974. Figure 1 displays the investment rate (investment over capital), cash and debt in a five-year window surrounding this expansion in operating capacity. We observe that capital adjustment is substantial and takes time to complete. The level of cash is already elevated in 1972 compared to "other", which captures the average during "normal" times, those outside the shown five-year lumpy adjustment window. Cash is then de-cumulated significantly as the adjustment unfolds and drops below normal levels. Relative to normal times, the level of debt is low in 1973 and then rises significantly in the following two years.

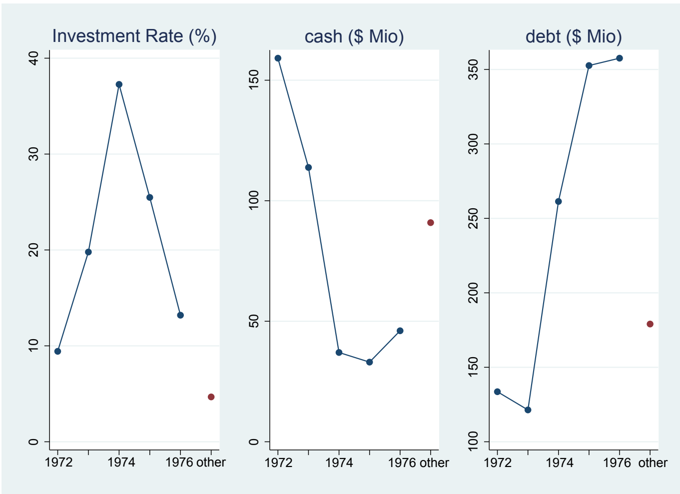

Figure 1: Behavior of investment rate, cash and debt around a lumpy capital adjustment episode for Schlitz Brewing. Lumpy capital expansion occurs in year 1974. *other* is the average value of the respective variable outside the 5-year adjustment window centered on 1974.

This example illustrates how Schlitz Brewing company used their financial margins to finance a large expansion in the capital stock. In this paper, we use U.S. firm-level data from Compustat, and analyze the dynamics of finance margins before, during, and after lumpy increases or reductions in capital or labor. We document that firms anticipate the incipient lumpy adjustment and *prepare to finance* it already in advance. For lumpy expansions in capital or employment, firms observe better fundamentals (proxied by Tobin's Q and the EBITDA-Asset ratio) the year before the expansion, and increase cash balances and reduce leverage . Then, during the expansion, the associated expenses are covered by drawing down cash holdings and increasing debt, thus driving up leverage. Interestingly, leverage continues to rise significantly for at least two years after the lumpy expansion was initiated. The joint movements of cash and leverage suggest that firms actively create debt capacity in order to use it later as the expansion of assets unfolds, and also that cash balances play a complementary role to the creation of debt capacity. Our findings provide strong evidence that both cash and unused debt capacity are actively manipulated before the ensuing expansion of firm capacity to increase financial flexibility.

The movements of cash balances and debt for asset expansions described above, are mirrored for lumpy contractions. Firms observe worse fundamentals (again proxied by Tobin's Q and the EBITDA-Asset ratio) the year before the contraction in capital or employment. At the same time, they experience reductions of cash balances, together with higher than average debt growth. During and after the contraction, firms rebuild cash and reduce debt growth significantly. However, relative to asset expansions these dynamics are more protracted. The dynamic interaction between finance margins and productive assets surrounding lumpy contraction episodes is consistent with firms acting to restore financial health by adjusting their productive operations.[1]

The dynamic movements in cash, debt, and leverage we document are economically significant relative to the average during periods where firms do not experience a lumpy adjustment, which we term "normal". We find that book leverage (the ratio of debt to assets) a year before lumpy real expansion in capital or employment is 10.9 to 13.7 standard deviations lower compared to the normal level of book leverage. Similarly, cash to assets a year before lumpy real expansion is 5.6 to 7.9 standard deviations higher compared to the normal level of cash to assets. The year that

[1] For the vast majority of firms, equity issuance is not a major source of finance associated with lumpy adjustment, and we show it only has some importance for the very largest firms.

firms undertake lumpy real expansion, the debt growth rate is 8 to 12.5 standard deviations higher compared to the normal debt growth rate.

Looking at lumpy contractions, we discern that firms undergoing employment reductions have more impaired financial health than firms undergoing disinvestment. A year before lumpy disinvestment, the ratio of cash to assets is 2.5 standard deviations lower than normal, while market leverage 2.8 standard deviations above normal. Two years after the disinvestment, the cash-asset ratio is 2.7 standard deviations below normal and market leverage is 4 standard deviations higher than normal. Despite disinvesting heavily, firms have not restored financial flexibility to normal levels two years after the episode. Regarding employment reduction bursts, book leverage falls from 4.1 to 1.8 standard deviations above normal, when comparing the year before adjustment to two years after adjustment. The ratio of cash to assets rises from 10.7 standard deviations lower than normal to 3.2 standard deviations lower than normal. Clearly, firms that undergo lumpy employment reduction, start with severely impaired financial flexibility and, through drastic adjustment in employment, manage to restore a large part of financial flexibility. This adjustment is not complete two years after the employment reduction burst.

We show that the dynamic patterns for debt and cash described above are present independent of firm size. This is remarkable as there are many papers that establish that the very largest firms display different behavior along a number of dimensions. In addition to the dynamic patterns, we also investigate the relative importance of financing margins and distinguish by firm size. We find that for the very largest firms, the top 10%, in addition to cash and debt, also equity issuance is relevant, while this plays a very minor role for the bottom 90% of firms.[2] Our main findings show that the majority of firms uses either the cash or the debt margin as the main finance margin during lumpy adjustments. Cash accumulation or debt reduction are the dominant margins in almost 50% of the sample of lumpy adjustment in the preparation year for both size categories. Debt accumulation is the dominant margin in the year of the adjustment for very large firms in over 50% of the sample, and it is the dominant margin in approximately 40% of the sample for smaller firms. Cash de-cumulation

[2] The relevance for equity issuance for the largest firms is consistent with Covas and Den Haan (2011).

in the year of the adjustment is the second dominant margin for smaller firms, while equity reductions is the second dominant margin for very large firms.

To the best of our knowledge, this is the first paper to provide a systematic study of financing patterns for both lumpy increases and lumpy decreases in capital or employment in the same sample of firms. An important aspect of the findings is that these patterns are dynamic in nature. Our rich econometric methodology, adopted from Sakellaris (2004), allows us to examine how different financing margins are employed in preparation, during, and after the year of the lumpy adjustment. The richness of our approach means that we are able to identify important and novel dynamic relationships among different financing margins and productive assets' movements. We observe that profitability indicators move in a systematic manner before actual adjustment takes place. For example, earnings, Tobin's Q, and total factor productivity increase significantly one to two years before an expansion indicating a change in investment opportunities. This implies that firm managers anticipate and plan lumpy adjustment and, hence, they undertake deliberate actions on the financing side to facilitate production adjustment.

Our paper is part of a growing body of literature that provides evidence for theories in which capital structure decisions are driven by financial-flexibility considerations. As access to external finance may be imperfect and subject to distress costs, firms want to keep handy internal reserves of cash and unused debt capacity. Characteristically, DeAngelo et al. (2018) refer to the "credit-card" function of debt. In this view, debt exists to a large extent as a tool to fund managerial operational plans. A large part of the empirical evidence rests on analyzing episodes of lumpy investment or large acquisitions.[3] The idea is, as explained in DeAngelo et al. (2011a), that "there is greater ability to detect any material capital structure changes when focusing on firms at times that they make large investment outlays." However, there are other instances of significant capital structure and cash balance changes that have not been examined to date. Specifically, when a firm makes lumpy increases or reductions in employment, or when a firm undergoes lumpy disinvestment in capital. These are the main production inputs and there is substantial evidence that adjustment in these

[3]See e.g. DeAngelo et al. (2011b), Im et al. (2021), Dudley (2012), Bargeron et al. (2018), Elsas et al. (2014) and Harford et al. (2009).

margins is often lumpy and subject to substantial costs (see e.g. Doms and Dunne (1998), Cooper et al. (2007) and Caballero et al. (1997)). Our paper differs from previous empirical work on the subject by examining changes in capital structure that accompany such lumpy adjustment episodes. Another distinguishing feature of our paper is that we pay particular attention to the role of cash balances in the financing patterns.

An important body of literature studies leverage discontinuities and identifies persistent leverage instabilities in firm histories. DeAngelo and Roll (2015) document large instabilities in industry median leverage ratios, and emphasize a close connection between departures from leverage stability and company expansion. Denis and McKeon (2012) study proactive leverage increases and provide evidence to suggest that debt issuance is primarily funding operating needs. DeAngelo et al. (2018) emphasize corporate de-leveraging as a meaningful and deliberate executive decision that serves as a means of restoring financial flexibility. At the same time, these studies suggest that tradeoff theories of capital structure that emphasize stable leverage targets are hard to reconcile with leverage variation in the data. A quote from DeAngelo and Roll (2015) is illuminating: '...but a closer look at the data indicates there is much that we simply do not know about time series variation in leverage'. Our study seeks to fill this gap. We undertake a comprehensive analysis of discontinuities in firms' real adjustment in capital and employment and connect them to adjustment in financial choices, leverage being one of them. We show that lumpy real adjustments are associated with systematic patterns in the policies—leverage, cash, and debt—that firms use to finance lumpy adjustment.

Our study contributes to understanding the time series drivers of leverage as called for by DeAngelo and Roll (2015). Specifically, our empirical analysis demonstrates that a systematic and fundamental driver of corporate leverage is lumpy adjustment in capital, and employment, both when firms expand and when they contract. DeAngelo et al. (2011a) develop a dynamic capital structure model with endogenous investment where increases in leverage is a significant means of financing investment; moreover they relate capital structure choices to different elements that describe investment opportunities, including the lumpiness of fixed investment. Denis and McKeon (2012), DeAngelo and Roll (2015) and DeAngelo et al. (2018) study episodes of large adjustments in corporate leverage and inform us about the reasons they were undertaken. Denis and McKeon (2012) find that the primary reason for large debt increases was to fund capital expansion and the secondary reason was increases in working capital.

Our distinct approach is to examine this association, but to employ a different yet complementary perspective. First, we identify episodes of large operational adjustments by the firm and then study what happens to leverage as well as other financing margins. Moreover, we are able to study both leveraging and de-leveraging episodes by analysing both asset expansions and contractions. DeAngelo et al. (2018) provide evidence consistent with firms de-leveraging to replenish financial flexibility, but also a strong empirical connection between de-leveraging and decisions to retain rather than pay out earnings. Our paper differs from the above in two aspects. First, we focus on the productive capacity adjustments that interact with movements in corporate leverage but also in other financing margins. Second, we examine these co-movements before, during, and after the lumpy adjustment episode.

Our paper is also related to the literature on corporate liquidity management in the presence of financing constraints (see the survey by Almeida et al. (2014)).[4] Our findings on the dynamics of cash balances and leverage during lumpy adjustment suggests that cash and leverage interact in a meaningful way. Cash build-up and leverage decreases go hand in hand during the preparation phase of an expansionary adjustment. This pattern indicates that firms do not prefer a rapid build-up in debt alone to finance an expansion. Cash plays a crucial role in retaining unused debt capacity and the joint dynamics are consistent with a strong value attached to financial flexibility.[5] Our findings, therefore, suggest that equilibrium models of capital structure should specify cash and debt as separate state variables consistent with the approach of Gamba and Triantis (2008) or DeAngelo

[4]Motivated by the large increase in cash balances for U.S. corporations (see Bates et al. (2009)), theory and empirical work studies the economic mechanisms that leads corporations to save or dissave. Bacchetta et al. (2019) emphasize firms' holding liquid assets in order to facilitate their ability to pay the wage bill. Riddick and Whited (2009) emphasize the trade-offs between interest income taxation and the cost of external finance that determine optimal savings. Bolton et al. (2013) demonstrate theoretically that improved external financing conditions lower precautionary demand for cash buffers, which in turn can incentivize cash rich firms to use cash for share repurchases when share prices are high.

[5]Graham and Harvey (2001) American CFO survey results suggest financial flexibility to be a key driver for corporate structure decisions.

et al. (2011a). Our findings, moreover, are in agreement with the message in DeAngelo et al. (2018) that traditional trade-off theories neglect the value of financial flexibility, and the motive for managing cash balances as a way to fund possible future needs, and so dynamic capital structure models should contain features that incorporate such a motive.

The rest of the paper is organized as follows. Section 2 describes the data and methodology. Section 3 establishes the dynamic adjustment patterns during lumpy adjustment, and quantifies the relative predominance of finance margins used during the lumpy adjustments. Section 4 discusses implications of our findings in relation to corporate structure theories. Section 5 concludes.

2 Data and Methodology

2.1 Data

We use firm-level data from the Compustat (North-America) Fundamentals Annual Files. We focus on US firms in the manufacturing (SIC code 2000-3999), wholesale trade (SIC code 5000-5199), retail trade (SIC code 5200-5999) and communications (SIC code 4800-4899) sectors with more than five years of data. Our dataset is an unbalanced panel with 9021 firms and 143,543 observations over the time horizon from 1971 to 2013.[6]

The key variables for our analysis are investment and the capital stock, given by the Investment (CAPX), Sales (SPPE) and Stock (PPENT) of Property, Plant and Equipment, and the Number of Employees (EMP).[7] The gross investment rate, CAPX over lagged PPENT, is used to define the positive investment adjustment. The net investment rate, the difference between CAPX and SPPE over lagged PPENT, is used to analyse disinvestment and very low investment rates. The growth rate in EMP is used to define the positive and negative employment adjustment. The precise definitions for the lumpy adjustment episodes are discussed in Section 2.2. We study three margins of finance

[6]The data from Compustat is supplemented with deflators from the Bureau of Economic Analysis and the Bureau of Labor Statistics and with wage data from the Social Security Administration.

[7]We deflate CAPX and SPPE using the implicit price deflator for private fixed nonresidential investment, and PPENT is deflated as in Hall (1990).

for lumpy adjustments, namely, debt, equity and cash. Our definitions for equity and debt follows Begenau and Salomao (2019). Specifically, equity issuance is defined as equity issuance (SSTK) minus cash dividends (DV) minus equity repurchases (PRSTKC), and total debt is the sum of Long Term Debt Total (DLTT) and Debt in Current Liabilities (DLC). Moreover, Cash holdings are defined as Cash and Short-Term Investments (CHE). Detailed information about variable construction and cleaning procedures is provided in Appendix C.

2.2 Methodology

This section first establishes definitions for the lumpy adjustments in the investment rate and the number of employees. We then discuss the methodology used to study patterns of firm behavior before, during and after these lumpy adjustments.

We focus on four types of lumpy adjustment in firms' productive assets. Specifically, we study large positive and negative adjustments in the capital stock, and large positive and negative adjustments in the number of employees. A firm-year observation at time k is considered a lumpy positive (negative) adjustment if (i) in year k the variable under scrutiny exceeds (is below) a certain threshold and (ii) in year $k-1$ the variable is below (above) the threshold. Thresholds for positive (negative) types of adjustment are chosen so that approximately 20% of the observations in our dataset are above (below) the threshold.[8] This implies that to qualify for a large positive adjustment in the capital stock the gross investment rate has to exceed 35% (investment spike, which we denote SPIKE). For an episode of capital disinvestment/low investment rate the net investment rate has to be smaller than 8% (capital disinvestment, which we denote DISINV). For large positive employment adjustment the growth rate of employees has to exceed 15% (which we denote POSEG). For large negative employment adjustment the growth rate of employees has to be smaller than -7% (which we denote NEGEG).[9]

[8] This threshold is consistent with those applied in similar studies, e.g. Cooper and Haltiwanger (2006) and Gourio and Kashyap (2007). Our results are robust to reasonable alternations in the thresholds. These results are available upon request.

[9] Given the definition for a lumpy adjustment, which requires an observation to be below the threshold prior

Our methodology is flexible and rich in that it allows to study patterns in many firm level variables and to be able to capture parsimoniously lead-lag relationships during lumpy adjustment. We study the dynamic behavior of many balance sheet variables around the four types of lumpy adjustment defined above. In particular, if a lumpy adjustment occurs in year k, we examine the behavior of variables of interest over five year windows, in years $k-2$ to $k+2$, using the empirical specification in Sakellaris (2004). To identify the dynamic pattern of variables around lumpy adjustments, we use the regression,

$$X_{i,t} = \mu_i + \nu_t + \sum_{j=-2}^{+2} \beta_j \cdot ADJUSTD_{i,t}^{k+j} + \beta_{other} \cdot OTHERD_{i,t} + \varepsilon_{i,t}, \tag{1}$$

where $X_{i,t}$ is the variable of interest – for example the investment rate – for firm i in year t and μ_i and ν_t denote firm and year fixed effects. $ADJUSTD_{i,t}^{k+j}$ is a dummy variable which equals 1 if firm i experienced a lumpy adjustment in year $t-j$.[10] For example, if firm i experienced an investment spike in year 2000, then $ADJUSTD_{i,2002}^{k+2} = 1$ and $ADJUSTD_{i,2000}^{k} = 1$. The five $ADJUSTD$ dummies for each adjustment therefore indicate a window that starts two years before and ends two years after the adjustment.[11] Due to the inclusion of fixed effects, nominal coefficient magnitudes are not meaningful, whereas relative magnitudes are. The inclusion of fixed year effects control for aggregate trends as well as other aggregate dynamics in the data that may be unrelated to the particular lumpy adjustment episode being studied. $OTHERD_{i,t}$ is a dummy variable that equals 1 if and only if firm i has experienced at least one adjustment and $ADJUSTD_{i,t}^{j} = 0$ for $j = k-2, k-1, k, k+1, k+2$. $OTHERD$ therefore captures the average level of X in years outside the five year window around the adjustment for firms that have experienced at least one adjustment. For the variables of interest,

to a year with a realization above the threshold, not all observations above the threshold are classified as lumpy adjustments. This can e.g. be due to consecutive occurrences above the threshold. Appendix A provides details about the frequency of the different lumpy adjustments in our dataset which ranges from 8% to 14%.

[10] We examine the responses to the four adjustments separately, so $ADJUSTD$ can be any of SPIKE, DISINV, POSEG and NEGEG.

[11] Note, that we only consider lumpy adjustment episodes if variable $X_{i,t}$ has non-missing observations for all five periods of the adjustment window, $k-2$ to $k+2$, or at least for periods $k-1$ to $k+1$.

it provides an indication of the variable's level during "normal" times, i.e. it is the average for years when the firm does not undertake lumpy adjustment. We would therefore expect a firm variable to revert to 'other' when the adjustment is complete and is not followed by another adjustment episode.

This framework is rich in its ability to identify lumpy adjustment by observation of any margin of firm adjustment. The nature of the adjustment will be determined by the frictions in operations and in finance. Importantly, as we demonstrate below, lumpy adjustment episodes typically take longer than one year and they can have effects on the evolution of financing variables both before and after the adjustment in productive assets. Thus once an adjustment has been identified, we study the interrelated behavior of firm variables in a window of five years centered on the lumpy adjustment-year.

3 Results

3.1 Dynamic adjustment patterns

We display the results from the regression specified in equation (1) graphically in a series of figures, each corresponding to the dynamic behavior of a specific firm-level variable around a five year window of lumpy firm adjustment. Specifically, we plot the difference from β_0 of each estimated value β_j (for $j = -2$ to 2), as well as of β_{other}. Each figure contains four graphs, one for each type of lumpy firm adjustment: 1) Investment spike (SPIKE), 2) Disinvestment (DISINV), 3) Positive employment burst (POSEG), and 4) Negative employment burst (NEGEG).

In the figures below, the x-axis label 'other' shows the difference between β_0 and the coefficient of $OTHERD$, β_{other}, the latter providing an estimate for the average level of the variables during normal times, i.e. periods outside of adjustment windows. A positive value of 'other' therefore indicates that the level of the variable under scrutiny, in year 'k', is below its normal level, and a negative value indicates that the level of the variable under scrutiny, in year 'k', is above its normal level.

The x-axis label 'std err' shows the standard error associated with β_0 and serves as a metric of whether the differences between the βs are significant. Throughout the study we define economic significance whenever coefficients differ by at least one standard error. Typically, in the results discussed below the standard errors for the other four estimated β_j's coefficients do not differ by more than 15% compared to β_0. In the following sections, we will discuss our findings by collecting plots of firm variables that capture the patterns around lumpy adjustment episodes for asset adjustment margins, movements in fundamentals, and financing margins.

3.1.1 Dynamics of profitability and Tobin's Q

It is interesting to examine the dynamic behavior of variables capturing firm fundamentals around the four types of adjustment episodes. We focus on Tobin's Q and operating income before depreciation.[12] Figure 2 displays the behavior of Tobin's Q around lumpy adjustment episodes. At times of expansions (i.e. SPIKE and POSEG at time 'k'), Tobin's Q is high relative to normal levels (captured by 'other'). Moreover, Tobin's Q is elevated in year 'k-1' for capital SPIKES, as well as for employment bursts to a lesser extent, compared to normal periods. Throughout the five-year windows of negative lumpy adjustments, Tobin's Q is significantly lower compared to normal periods. It declines towards the adjustment period 'k' after which it rises again.[13]

Figure 3 displays the behavior of EBITDA (operating income before depreciation) over lagged total assets. The shape of these dynamic plots are similar to those discussed in Figure 2 above. It is worth emphasizing that for asset expansions, this indicator for profitability is already significantly elevated both in year 'k-2' and 'k-1' before the adjustment year and remains elevated for the years following the adjustment year. Therefore, firms experience an economically significant rise in profitability, compared to normal times captured by 'other', which is quite persistent. This is interesting insofar as it provides evidence that profitability is leading the incoming expansion, rather than just tracking it. For contractions, from periods 'k-2' to 'k', profitability declines substantially to just

[12]Details about the definition and construction of all variables are available in Appendix C.

[13]It is important to state that due to fixed effects, comparisons across different lumpy adjustments are not meaningful quantitatively. What is quantitatively meaningful though is the comparison of outcomes at k-2,...,k+2 and 'other' for one particular type of adjustment.

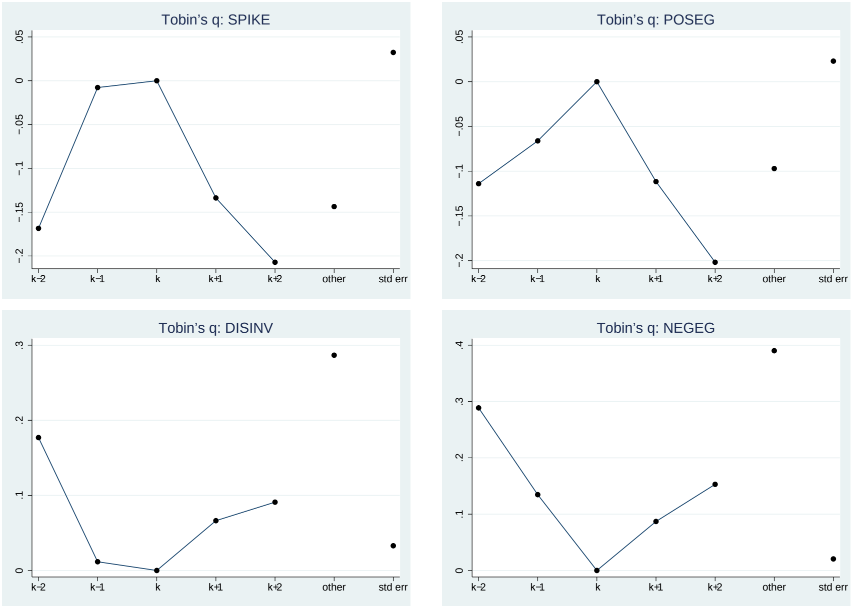

Figure 2: Behavior of Tobin's Q around lumpy adjustment episodes: (1) investment spike (top-left), (2) positive employment burst (top-right), (3) disinvestment (bottom-left), (4) negative employment burst (bottom-right).

below normal levels (for NEGEG), or declines towards a level (for DISINV) that is not economically different from normal times as indicated by the standard error.

The evidence from both figures suggests that profitability and Tobin's Q are important leading indicators for lumpy adjustment in fixed capital and employment.[14] This suggests that innovations to fundamental variables are very informative for future fundamentals in a way that makes the lumpy adjustment and its financing largely anticipated.

3.1.2 Lumpy adjustment in real productive assets

Figure 4 displays the behavior of investment rates, and employment growth, in each of the four adjustment episodes. Both variables rise (fall) sharply on the year of the positive (negative) adjustment, 'k', and return to normal levels (signified by 'other') only gradually. The size of the standard

[14]In Appendix B.1 we also show detailed results for total factor productivity (TFP) and the growth rate of sales which have very similar dynamic patterns. In particular, in contractions, relative to normal levels these variables are persistently below the normal level during almost the entire negative episode, whereas in expansions they are significantly elevated.

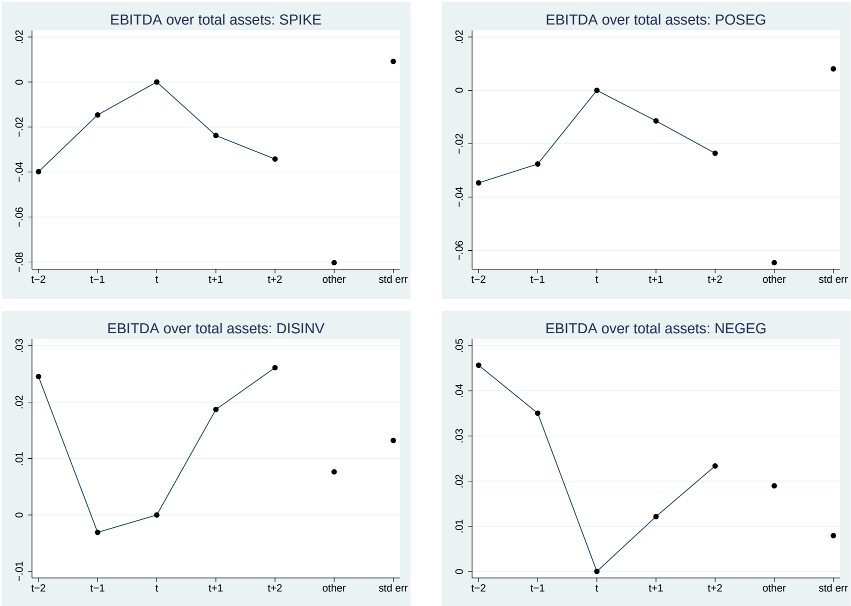

Figure 3: Behavior of EBITDA over total assets around lumpy adjustment episodes: (1) investment spike (top-left), (2) positive employment burst (top-right), (3) disinvestment (bottom-left), (4) negative employment burst (bottom-right).

error for the estimate of β_0 indicates that the behavior of investment rate and employment growth is statistically different during the year of the adjustment compared to the average behavior outside this window, i.e. one standard error variation in β_0 falls short of 'other', which captures the difference between β_0 and β_{other}. Figure 4 suggests that lumpy adjustments, especially in capital, take time to complete.

Figure 5 shows that sales of fixed capital goods in proportion to the capital stock are elevated (lower) during a negative (positive) adjustment. An exception is investment spikes where capital sales are close to normal levels (captured by 'other') and drop off after two years. This suggests that lumpy expansion in fixed capital, along with the new technology and organization that the new capital embodies, is associated with the firm retiring old technology or old organizational practices. The qualitative patterns of dynamic adjustment are therefore remarkably similar across the two categories of positive (or alternatively of negative) lumpy adjustment. On average, this adjustment takes more than one year to be completed, suggesting time-to-build effects and/or the existence of convex adjustment costs as well as persistent shocks to profitability.

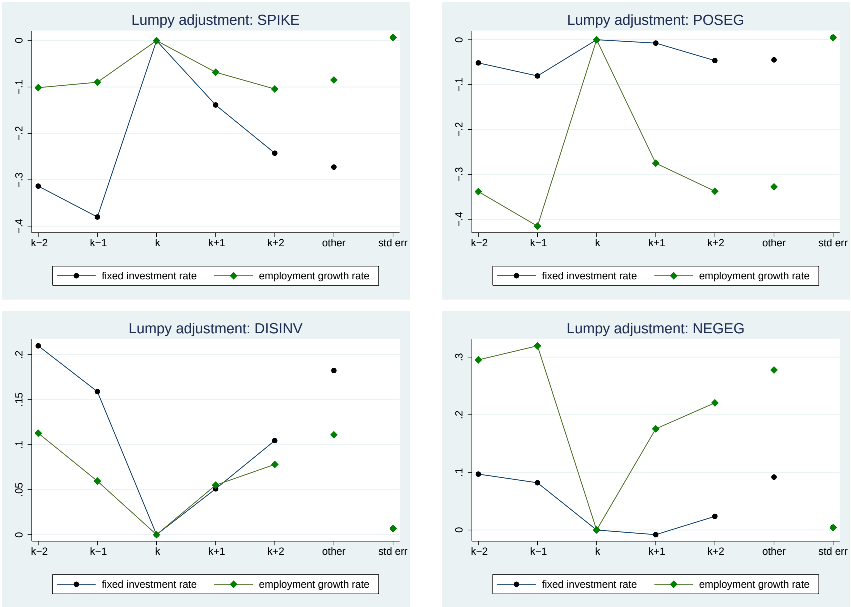

Figure 4: Behavior of productive assets around lumpy adjustment episodes: (1) investment spike (top-left), (2) positive employment burst (top-right), (3) disinvestment (bottom-left), (4) negative employment burst (bottom-right).

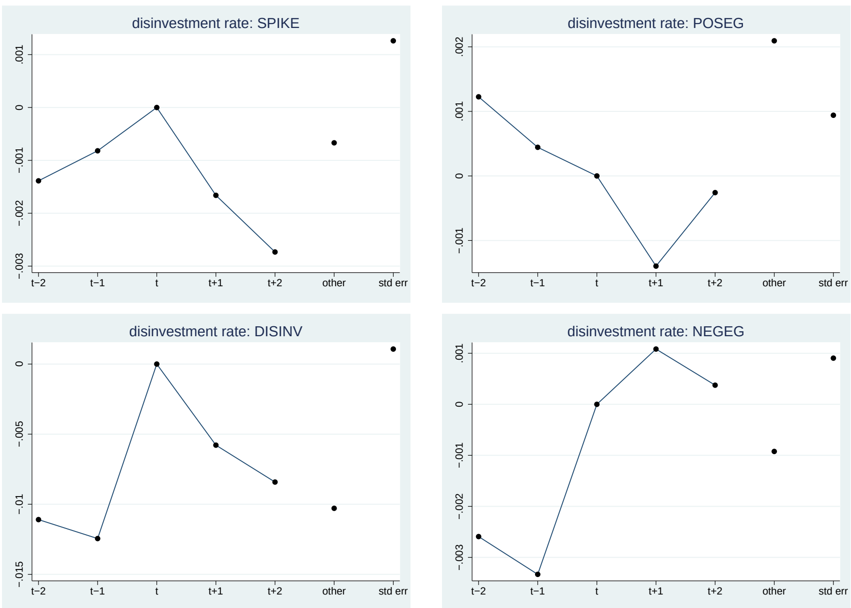

Figure 5: Behavior of fixed disinvestment rate around lumpy adjustment episodes: (1) investment spike (top-left), (2) positive employment burst (top-right), (3) disinvestment (bottom-left), (4) negative employment burst (bottom-right).

3.1.3 Lumpy adjustments and firms' financial positions

We now study the dynamic behavior of cash, leverage, and debt around lumpy adjustments. The financing patterns that emerge from this analysis suggest that finance margins adjust in the year preceding lumpy adjustment in capital or employment, but also in the years after the adjustment. Figure 6 displays cash balances relative to total assets. In positive adjustment episodes, firms rapidly accumulate cash in year 'k-1', and this appears to be an action in preparation for the lumpy adjustment they will undertake the following year. Following the adjustment, in years 'k' to 'k+2', cash-to-assets declines gradually and returns to normal levels. For negative adjustments, the pattern is largely symmetric, although the return to normal cash-to-asset ratios is slower compared to positive adjustments. The dynamic pattern we observe for negative adjustments suggests that the sales of capital and the reduction in the number of employees contributes to the adjustment of operations to rebuild the balance sheet.

Our results suggest that cash buildup (rundown), relative to assets, is a key characteristic of lumpy positive (negative) adjustment in firm productive assets. The fact that this is reversed gradually in years 'k' to 'k+2' indicates that firms maintain a target cash-to-asset ratio throughout their histories. Figures 4 and 6 confirm the notion by Riddick and Whited (2009) that financial (cash balances) and physical assets are substitutes; investment rates are below 'other' and cash-to-assets are above 'other' in the year preceding the adjustment. While the prediction by Riddick and Whited (2009) relates to fixed investment, our analysis suggests that the substitutability is present for the other major productive input, namely employment.

Figure 7 corroborates the pattern of cash adjustment displayed in Figure 6. The growth rate of cash is higher for lumpy capital expansions in year 'k-1' compared to the 'other' and then drops significantly below the 'other' in years 'k' and 'k+1'. Also for positive lumpy employment adjustments, the years leading to the adjustment exhibit a substantially higher growth rate than years 'k+1' and 'k+2'. For both negative lumpy adjustment episodes the growth rate of cash drops off substantially in the year leading to the event year and then slowly recovers although it falls short compared to the 'other' periods for the subsequent years.

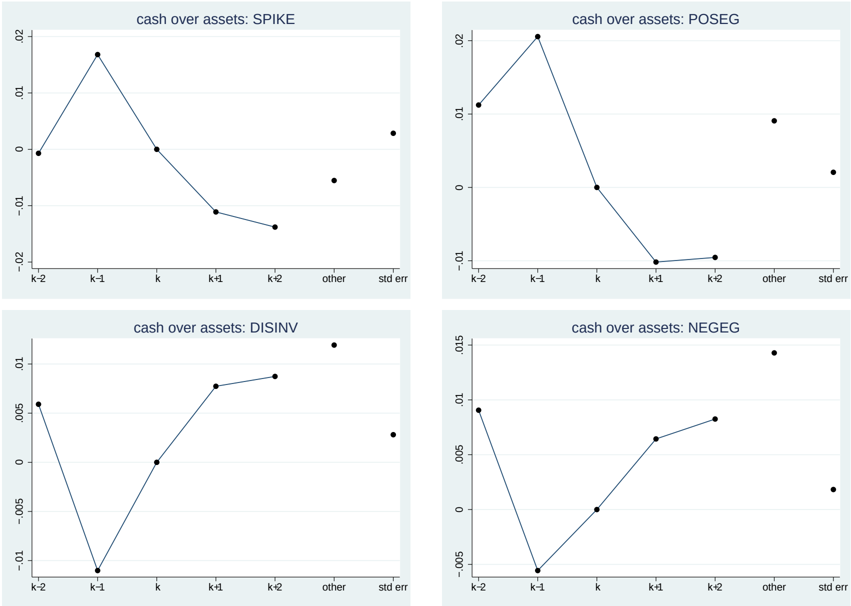

Figure 6: Behavior of cash over contemporaneous assets around lumpy adjustment episodes: (1) investment spike (top-left), (2) positive employment burst (top-right), (3) disinvestment (bottom-left), (4) negative employment burst (bottom-right).

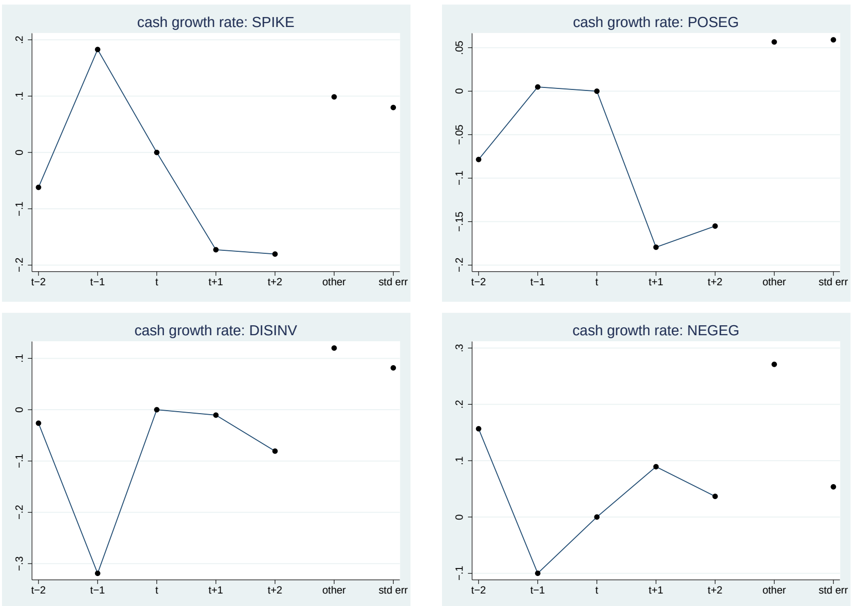

Figure 7: Behavior of growth rate of cash around lumpy adjustment episodes: (1) investment spike (top-left), (2) positive employment burst (top-right), (3) disinvestment (bottom-left), (4) negative employment burst (bottom-right).

Figure 8 displays the behavior of market leverage. Market leverage is defined as the ratio of total debt over the sum of total debt and market value, consistent with the definition of Denis and McKeon (2012) who study proactive leverage increases. We observe that leverage is significantly lower than 'other' before positive adjustments and drops even further the year before ('k-1'). Leverage is still subdued during the adjustment year at 'k', but starting at 'k+1' leverage rises back to normal rates. Thus, comparing leverage to its level during 'other', implies that in expansions firms start with a lot of debt capacity, which they use freely to expand physical assets. For negative adjustments, leverage rises substantially to levels higher than 'other' up to period 'k'. The sale of capital, or the reduction in the number of employees, then contributes to a decline in leverage in the following periods. The lumpy contractions, undertaken in situations with leverage way above normal levels, rebuilds firms' debt capacity. Interestingly, the reversion of leverage to the level of 'other' is quite slow, as firms are still way above 'other' even two years following the adjustment.

Figure 9 displays the behavior of book leverage. The patterns identified above for market leverage are qualitatively very similar for book leverage. This further corroborates our thesis that firms actively seek to create debt capacity. Therefore, during expansion episodes firms have unused debt capacity before and even during the episode. This result combined with the preparatory behavior of cash (see Figure 6), suggests that firms use the latter to further increase their debt capacity and it is suggestive that the tax dis-advantage of cash relative to debt is out-weighted by the option value to retain "financial flexibility". Clearly, the fact that firms de-cumulate cash balances once the expansion is underway is evidence that firms value financial flexibility. This could reflect a need to reduce reliance on costly external finance or alternatively because of managerial fears with distress costs associated with high leverage. During contractionary adjustments, undertaken to renew financial capabilities, we see a similar interaction of cash and debt. The increase in the former and the reduction in the latter contributes to firms' rebuilding their balance sheets.

Overall, our findings on the behavior of leverage are in line with the prediction from DeAngelo et al. (2011a) and evidence given in DeAngelo and Roll (2015) that departures from leverage stability are associated with company expansions. However, we also stress that departures from leverage stability can coincide with asset contractions which contribute to firms' rebuilding their balance sheets. Relative to these studies, our findings provide a new insight, namely, the fact that firms create debt capacity in anticipation of a lumpy expansion both by reducing leverage and by increasing cash balances. We also complement evidence by Denis and McKeon (2012) on the link between proactive leverage increases and funding fixed capital by adding the dimension of employment. Moreover, we provide evidence for leverage decreases towards normal levels and the latter are typically associated with negative adjustments in capital and employment.

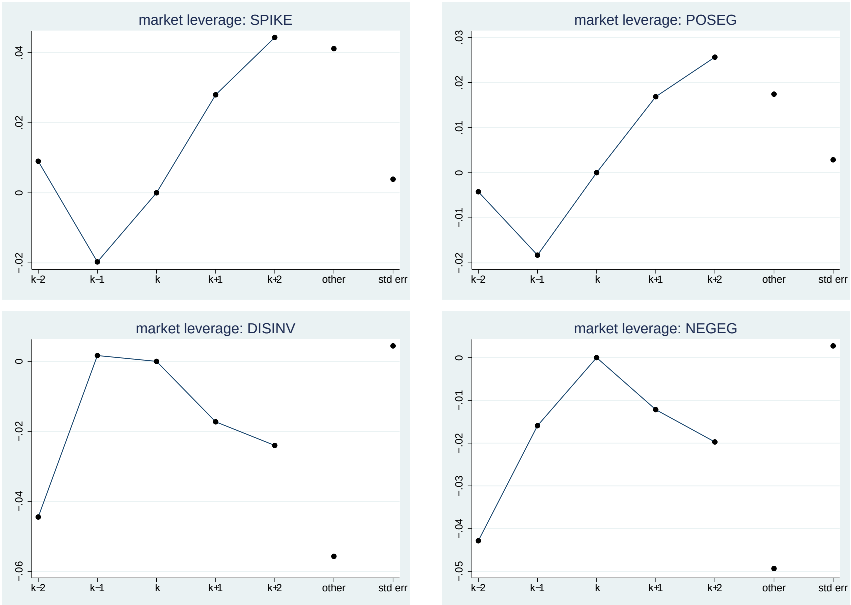

Figure 8: Behavior of market leverage around lumpy adjustment episodes: (1) investment spike (top-left), (2) positive employment burst (top-right), (3) disinvestment (bottom-left), (4) negative employment burst (bottom-right).

Figure 10 complements Figure 9 and displays the behavior of the growth rate of debt. For positive adjustments, firms accumulate debt during years 'k' and 'k+1', compared to the 'other', and return to the latter at the end of the episode. This is consistent with the behavior of market leverage examined above. The pattern is largely symmetric for negative adjustments, that is, in the years leading to negative adjustment firms exhibit higher growth rates compared to the 'other' and trigger a massive downward adjustment in the year centered around the adjustment. Debt growth stays subdued for the years following the adjustment year in 'k'.[15]

[15] We also examine the maturity structure of debt around lumpy episodes. The general pattern suggests that

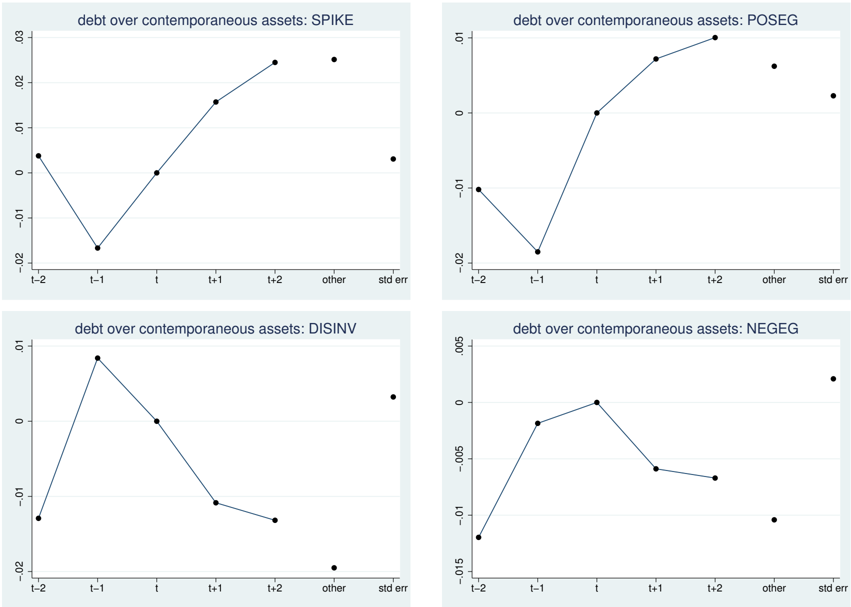

Figure 9: Behavior of book leverage around lumpy adjustment episodes: (1) investment spike (top-left), (2) positive employment burst (top-right), (3) disinvestment (bottom-left), (4) negative employment burst (bottom-right).

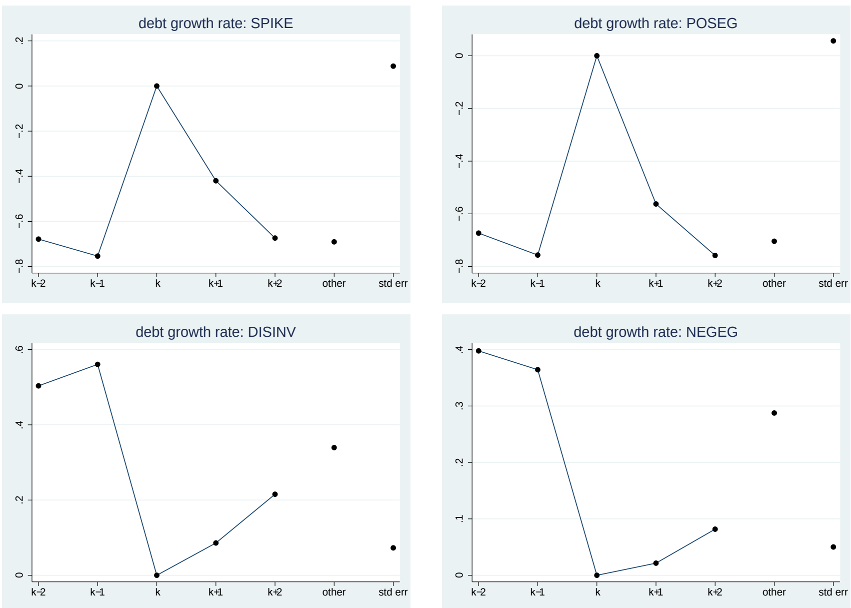

Figure 10: Behavior of growth rate of debt around lumpy adjustment episodes: (1) investment spike (top-left), (2) positive employment burst (top-right), (3) disinvestment (bottom-left), (4) negative employment burst (bottom-right).

We have also examined net equity issuance around lumpy adjustments. The dynamic patterns for lumpy adjustments indicate that net equity issuance is not a major source of finance or a means to rebuild financial capabilities as it is persistently below normal levels. Details are provided in Appendix B.2. While the dynamic patterns indicate a very limited role for equity issuance, our previous findings suggest high relevance of leverage, debt, and cash to finance lumpy adjustments in capital and employment.

3.1.4 Economic significance of dynamics in financial and profitability indicators during lumpy episodes

The dynamic analysis of the previous section provides rich qualitative information regarding the movements of real assets and financing margins during firm lumpy adjustment. This section quantifies the economic significance of those movements. Specifically, we use information from the regression in equation (1) to examine by how much the level of financing variables and profitability indicators differs economically from average levels during normal times. As before, normal times are captured by 'other'.

We focus on cash-to-assets, debt-to-assets, the growth rate of debt, market leverage, TFP, EBITDA, Tobin's Q, and sales growth. To get a precise indication of economic significance of the movements in the aforementioned variables during a lumpy adjustment episode, we compute $\frac{\beta_j-\beta_{other}}{stderr(\beta_{other})}$ for each coefficient β_j in a five-year adjustment window. This ratio indicates the distance of each β_j coefficient from 'other', in terms of standard errors of 'other'. Table 1 reports this ratio for each year of the adjustment window. In the results below, we take one standard error difference as our level of economic significance. A ratio greater than one (in absolute value) implies that the difference of the variable in question from its normal level is economically significant.

For SPIKE episodes, thirty seven out of total forty five coefficient differences are economically significant (i.e. have the above ratio greater than one). The largest absolute differences can be

lumpy expansions tend to happen by firms when they are tilted to long term debt compared to the 'other'. In lumpy contractions, there is a steady increase in the proportion of short-term debt converging to the proportions prevailing during 'other' periods. For details see Appendix B.3.

observed for cash-to-assets in year 'k-1' exceeding the standard error estimated for 'other' by 7.93 times and debt-to-assets in the same year exceeding the standard error estimated for 'other' by 13.71 times. Not only movements in book leverage, but also movements in market leverage are economically highly significant as it exceeds the standard error estimated for 'other' by 15.85 times during year 'k-1'. These magnitudes are very large and corroborate strongly the qualitative patterns from the dynamic analysis. They indicate a strong and significant, in a quantitative sense, preparation phase in year 'k-1' when debt capacity is created, via reduction in market leverage, and cash balances are built up. Similarly, the three profitability and productivity indicators, EBITDA, Tobin's Q, and TFP, consistent with the dynamic plots, are elevated compared to their normal levels, with ratios that far exceed one in year 'k-1'.

During the expansion phase in employees, POSEG, thirty five out of possible forty five coefficient differences as a ratio to the standard error of 'other' are economically significant. A similar strong preparation phase, consistent with the dynamic analysis, emerges, with cash-to-assets, debt-to-assets, and market leverage moving in a meaningful way to create additional debt capacity in order to serve the incoming adjustment in employees. Profitability and productivity in EBITDA, Tobin's Q, and TFP, are elevated compared to their normal levels, with ratios that far exceed one in year 'k-1'. This is similar to the SPIKE episode. Therefore, in both expansion episodes these variables strongly anticipate the incoming adjustment in real assets and coincide with the preparatory adjustment in finance margins.

For DISINV episodes, thirty one out of possible forty five standardized coefficient differences shown in Table 1 are economically significant. In year 'k-1' the ratio of cash-to-assets is 2.46 standard deviations lower than normal, while market leverage is substantially higher than normal. One of the largest absolute differences can be observed for cash-to-assets in year 'k+1', which is 2.76 standard errors below normal. At the same time market leverage continues to remain substantially above normal levels. Despite disinvesting in the capital stock, firms have not restored financial flexibility to normal levels even two years after the lumpy adjustment. Both, the DISINV and NEGEG adjustments are undertaken at a time of gloomy fundamentals. Tobin's Q and sales growth are substantially below normal levels for almost the entire five-year window under consideration.

For NEGEG episodes, forty two out of possible forty five standardized coefficient differences are economically significant. One of the largest absolute differences can be observed for cash-to-assets in year 'k-1' which is 10.71 standard deviations below normal. At the same time, book leverage is substantially higher, 4.07 standard deviations, than during normal times.It is evident that prior to period 'k' firms are subject to severely impaired financial flexibility. Cash balances and debt adjust economically significantly due to the lumpy employment reduction in period 'k'. During the following years, firms manage to rebuild a large part of financial flexibility, yet this adjustment is not complete two years after the employment reduction. Debt-to-assets are still significantly elevated, and cash-over-assets are still 3.23 standard errors below normal.

Overall, the dynamic plots discussed in section 3.1.2 and the evidence in Table 1 suggest two main ways that firms finance positive lumpy adjustments: first, adjusting cash-to-asset ratios, by fast build-up of cash (relative to assets) during expansions and decumulation of the extra cash as the expansion unfolds in years 'k' and beyond. Second, by making room for debt capacity in year 'k-1' and increasing debt significantly in the years of the adjustment. Contractions in the capital stock and the number of employees are undertaken during times of below normal sales growth and above normal leverage. These lumpy adjustments contribute to renewing firms' financial capability by driving down leverage and rebuilding cash.

3.2 The role of firm heterogeneity

The interrelations of several financial and real margins documented in the previous sections suggests that economically significant movements in debt, cash balances, and leverage coincide lumpy adjustment episodes. The goal in this section is to examine whether these patterns are broadly consistent across firms of different characteristics. We sort firms according to: i) market leverage, (ii) cash over assets, and (iii) size (measured by total assets). The reference period for this sorting is the year before the adjustment ('k-1'). We distinguish four parts of the respective distributions: 0-33%,

Table 1: Movements of financing and profitability indicators around lumpy adjustment in relation to normal times

		k-2	k-1	k	k+1	k+2
SPIKE	Cash/Assets	1.72	7.93	1.96	-1.98	-2.93
	Growth rate of cash	-2.03	1.05	-1.25	-3.45	-3.55
	Debt/Assets	-7.01	-13.71	-8.24	-3.09	-0.21
	Growth rate of debt	0.13	-0.73	8.00	0.91	0.20
	EBITDA/assets	4.47	7.26	8.87	6.25	5.09
	Tobin's Q	-0.78	4.24	4.49	0.31	-1.98
	log TFP	2.44	8.35	11.66	9.50	6.63
	Growth rate of sales	-1.25	-2.18	5.32	-0.47	-4.63
	Market leverage	-8.37	-15.85	-10.72	-3.43	0.83
DISINV	Cash/Assets	-1.49	-2.46	-2.49	-2.76	-2.72
	Growth rate of cash	0.05	-2.56	-0.93	-2.34	-1.84
	Debt/Assets	-0.99	0.03	0.30	0.88	1.01
	Growth rate of debt	1.15	1.41	1.06	-1.15	-1.25
	EBITDA/assets	1.24	0.49	0.88	1.17	1.38
	Tobin's Q	-1.49	-3.73	-4.47	-4.64	-3.90
	log TFP	1.36	0.38	0.03	0.62	0.75
	Growth rate of sales	-0.67	-3.19	-3.66	-4.49	-4.49
	Market leverage	-0.34	2.82	3.52	4.18	3.98
POSEG	Cash/Assets	1.03	5.62	-4.44	-9.44	-9.13
	Growth rate of cash	-2.29	-0.86	-0.94	-4.03	-3.60
	Debt/Assets	-7.24	-10.91	-2.73	0.42	1.68
	Growth rate of debt	0.54	-0.93	12.52	2.51	-0.96
	EBITDA/assets	3.72	4.60	8.02	6.60	5.10
	Tobin's Q	-0.74	1.34	4.22	-0.63	-4.55
	log TFP	2.47	5.52	14.59	15.67	11.94
	Growth rate of sales	-0.88	-7.18	12.01	8.77	-4.82
	Market leverage	-7.56	-12.46	-6.08	-0.20	2.86
NEGEG	Cash/Assets	-2.80	-10.71	-7.71	-4.23	-3.23
	Growth rate of cash	-2.09	-6.81	-4.98	-3.33	-4.30
	Debt/Assets	-0.73	4.07	4.94	2.15	1.75
	Growth rate of debt	2.17	1.51	-5.67	-5.24	-4.06
	EBITDA/assets	3.34	2.01	-2.37	-0.85	0.55
	Tobin's Q	-4.91	-12.36	-18.87	-14.66	-11.48
	log TFP	8.23	7.06	-8.43	-8.34	-6.42
	Growth rate of sales	-1.32	-4.21	-25.01	-21.14	-10.63
	Market leverage	2.35	12.09	17.85	13.45	10.71

Notes. The entries shown are computed as, $\frac{\beta_j - \beta_{other}}{stderr(\beta_{other})}$, where j=k-2, k-1, k, k+1, k+2. β_j and β_{other} refer to the estimated coefficients from regression (1). A table entry above one in absolute value indicates economic significance.

34-66%, 67-90%, and top 10%.[16]

We evaluate whether the preparation phase in finance we document is conditional on firms having high or low cash-to-assets and or high or low leverage at time 'k-1', and conditional on firm size. One could argue that firms with high cash balances in year 'k-1' do not need to build up more cash balances during the preparation phase. Moreover, firms with low market leverage may not need to build cash balances as they, in principle, have plentiful debt capacity to finance the real adjustment and cash is expensive relative to debt. We compute the dynamic plots by re-estimating the regression in equation (1) and conditioning on the criteria described in (i), (ii), and (iii), for a total of twelve different regressions.

We focus on cash-to-assets, the growth rate of debt, and market leverage as a means to test the robustness in the financing patterns documented in the dynamic analysis. Our key findings established in the discussion of Section 3.1.3 are broadly robust across the three firm sortings described above. Specifically, we observe, in the vast majority of lumpy positive adjustment episodes and distribution sortings examined, the preparation role of cash balances and leverage in the year preceding the adjustment, 'k-1' and the high growth rate of debt in the year of the adjustment, as well as the run down of the cash-to-assets ratio and the rise in leverage as the adjustment unfolds. Similarly, our findings for negative lumpy adjustments are generally robust across the different sortings examined. We report detailed results and further discussion in Appendix B.4. We now turn to examine the relative quantitative importance of the different finance margins in lumpy episodes.

3.3 Quantifying finance margins during lumpy adjustments

Although the dynamic analysis of section 3.1 reveals interesting adjustment patterns in various finance margins, it cannot establish the relative importance of those margins. In this section we quantify the importance of finance margins. Our analysis so far has omitted equity since our dynamic pattern analysis did not suggest that equity is a margin firms use systematically to finance

[16]To ensure all periods of a window are part of the same size category, we assign all periods of a window to be in the size category of period 'k-1'. Transition between size categories occurs very rarely. For each firm, we classify the periods outside an adjustment window to be in the same category as the majority of periods within windows.

lumpy adjustment. In this section we incorporate equity as a potential finance margin to obtain a precise answer of quantitative relevance of different margins. With equity in the mix, around lumpy adjustments firms can adjust their financial position via positive and negative changes in cash, debt or equity, respectively. For each firm-year observation we evaluate whether one of these six margins dominates the others. We define such dominance when the absolute adjustment in one of the financing margins accounts for at least 50% of the sum of the absolute adjustment of all margins. For example, we consider an increase in cash balances to be the dominant margin of finance, if it accounts for more than half of the sum of the absolute values of changes in cash and in debt, as well as equity issuance.

We consider movements in the finance margins described above in years 'k-1' and 'k' of the adjustment window, motivated by the preparatory role of cash and debt documented above. Tables 2 and 3 report for the four types of lumpy adjustment, and times 'k-1' and 'k' in the adjustment window, the share of firm-year observations for which one of the six financing margins plays a predominant role (as defined above). Motivated by the evidence in Covas and Den Haan (2011) who document different equity issuance behavior between small firms and large firms we report results separately for the bottom 90% and the top 10% of firms (in terms of total assets).[17] Overall, summing the shares of the most important three dominant margins reported in the tables indicates that these account for about over two thirds of all lumpy episodes. There is a relatively small share of adjustments that do not have a dominant finance margin. For the bottom 90% (top 10%) of firms the share of SPIKE, DISINV, POSEG, NEGEG adjustments that do not have a single dominant margin is approximately equal to 10% (20%).

Preparatory financing phase ('k-1') around expansions. Table 2 shows that in 25% of all SPIKE adjustments that are financed by a dominant margin, cash accumulation is recorded to be the dominant means of financing. This holds for both the bottom 90% and top 10% of firms. Debt reduction, which makes room for debt capacity, is the dominant margin in 23% of all SPIKE adjustments for smaller firms and 20% of all SPIKE adjustments for very large firms. The

[17] For each year we categorize all firm observations by percentile of total assets into different size classes. A firm is classified to belong to a certain size category according to the median size classification of its observations.

proportion of POSEG adjustments where cash accumulation and debt reduction is dominant is quite similar to the proportions of SPIKE adjustment as discussed above for both small and large firms. In sum, across all expansion episodes and for both the 90% and 10% size distribution of firms cash accumulation and debt reduction are dominant in almost 50% of the sample of lumpy adjustments, highlighting the fact that they are used very frequently as the preferred financial policy. Importantly, Table 2 demonstrates that cash reductions (not just slower cash accumulation relative to assets)—are a vital finance margin in a large number of expansionary episodes. Similarly, debt reductions in the preparatory year make room for additional debt capacity which is then used during the adjustment year.

A notable difference between small and large firms in that for employment bursts, negative equity issuance becomes a dominant margin for large firms in a high proportion (32%). Consistent with the evidence on dynamic patterns in Section 3.1, equity issuance (positive or negative) does not feature among the top three most observed financing margins for the bottom 90% of firms.[18] Overall, Table 2 highlights the fact that the qualitative patterns documented through the dynamic analysis in the sections above are of quantitative significance.

Adjustment year ('k') during expansions. For smaller firms, the most observed margin during year 'k' across positive capital, and employment adjustment is debt accumulation accounting for 37%, and 39% of adjustments in SPIKE, and POSEG, respectively. Cash reduction in year 'k', is the second most observed margin where it accounts for 21%, and 19% of capital and employment episodes respectively. There is some heterogeneity evident from the fact that there are adjustments in either capital or employment where firms accumulate instead of running down cash balances. For very large firms, the dominant margin in over 50% of positive adjustments is debt accumulation. Cash reduction is not as dominant as it is for smaller firms, being dominant in a significantly lower proportion of positive employment episodes compared to smaller firms. For large firms reductions in equity continues to feature as a dominant margin and together with debt issuance are much more

[18]For the bottom 90% of firms, positive (negative) equity issuance is the dominant margin in a relatively small share of adjustments, always smaller than 10%. For example, positive/negative equity issuance is the dominant margin in 8% (in year 'k')/9% (in year 'k-1') of SPIKE episodes.

prevalent margins for very large firms as compared to smaller firms. As in Covas and Den Haan (2011), these numbers suggest that very large firms may be substituting equity for debt during the adjustment year of lumpy expansions. Our analysis, however, unearths a new fact, relative to Covas and Den Haan (2011), namely the preparation of debt capacity for lumpy adjustment.

Contractions. Table 3 reports that for the bottom 90% of firms and for both capital and employment contractions, debt accumulation is the most observed margin in year 'k-1', comprising for 33% and 32% of episodes respectively. In year 'k', debt reduction is the most observed margin, accounting for 40% and 34% in capital and employment contractions respectively. Yet, there is some heterogeneity present in that we also have episodes where there are a non-negligible number of firms which reduce debt, both in years 'k-1' and 'k'. Cash reductions are also prevalent in either lumpy adjustment margin and both at times 'k' and 'k-1'. For the largest 10% of firms the negative equity issuance is the most observed margin during both episodes accounting for 32% of all episodes. But in year 'k' the largest firms behave more in line to the bottom 90% of firms in that they reduce debt across both episodes, these shares are indeed very similar at 41% and 38% in capital and employment contractions respectively. This evidence indicates that de-leveraging episodes may be tightly connected with lumpy contractions (or, in cases, driven by such contractions) as found in a large proportion of lumpy contractions in capital and employees and that active de-leveraging towards a target leverage may not be of primary importance of firms managers as argued by DeAngelo et al. (2018) or Denis and McKeon (2012).

In sum, the main differences in the financing patterns across the size categories are: 1) that relatively more smaller firms use the cash margin in the preparation year 'k-1' of the adjustment, and 2) relatively more of the largest firms use the equity issuance margin before and during the lumpy contraction episode.[19] The results in this section complement and confirm the analysis based on the dynamic plots as it shows that the documented movements in financing margins in years around lumpy adjustments are of quantitative importance.

[19] We have decomposed the movements in equity issuance within all episodes described in Tables 2 and 3 and found, using the same definition of dominance as above, that dividend payments, not share repurchases or issuance, are the dominant component driving movements in equity issuance for large firms in both expansions and contractions.

Table 2: Dominant finance margins: positive adjustments

Bottom 90% firms

SPIKE				**POSEG**			
year k-1		year k		year k-1		year k	
Dominant margin	Share	Dominant margin	Share	Dominant margin	Share	Dominant margin	Share
$\Delta Cash(>0)$	0.25	$\Delta Debt(>0)$	0.37	$\Delta Debt(<0)$	0.24	$\Delta Debt(>0)$	0.39
$\Delta Debt(<0)$	0.23	$\Delta Cash(<0)$	0.21	$\Delta Cash(>0)$	0.22	$\Delta Cash(<0)$	0.19
$\Delta Debt(>0)$	0.18	$\Delta Cash(>0)$	0.16	$\Delta Debt(>0)$	0.20	$\Delta Cash(>0)$	0.15
Sum of 3 other margins	0.34		0.27	Sum of 3 other margins	0.34		0.27

Top 10% firms

SPIKE				**POSEG**			
year k-1		year k		year k-1		year k	
Dominant margin	Share	Dominant margin	Share	Dominant margin	Share	Dominant margin	Share
$\Delta Cash(>0)$	0.25	$\Delta Debt(>0)$	0.53	$\Delta Equity(<0)$	0.32	$\Delta Debt(>0)$	0.58
$\Delta Debt(>0)$	0.20	$\Delta Equity(<0)$	0.16	$\Delta Debt(<0)$	0.20	$\Delta Equity(<0)$	0.14
$\Delta Debt(<0)$	0.20	$\Delta Cash(>0)$	0.13	$\Delta Cash(>0)$	0.19	$\Delta Cash(<0)$	0.08
Sum of 3 other margins	0.35		0.18	Sum of 3 other margins	0.29		0.20

For each lumpy adjustment type (SPIKE, POSEG) and time (k-1, k), we report in the table the share of firm-year observations in which one of the six financing margins – positive and negative changes in cash, debt and equity, respectively – is dominating all the others combined. This is the case if the absolute adjustment in one of the financing margins constitutes at least 50% of the sum of the absolute adjustment in the remaining five margins. For each year we categorise firms by percentile of total assets into different size classes. A firm is classified as belonging to the bottom 90%, top 10% by the median size classification of its history.

Table 3: Dominant finance margins: negative adjustments

Bottom 90% firms

DISINV				**NEGEG**			
year k-1		year k		year k-1		year k	
Dominant margin	Share	Dominant margin	Share	Dominant margin	Share	Dominant margin	Share
$\Delta Debt(>0)$	0.33	$\Delta Debt(<0)$	0.40	$\Delta Debt(>0)$	0.32	$\Delta Debt(<0)$	0.34
$\Delta Cash(<0)$	0.21	$\Delta Cash(>0)$	0.24	$\Delta Debt(<0)$	0.20	$\Delta Debt(>0)$	0.18
$\Delta Debt(<0)$	0.19	$\Delta Cash(<0)$	0.13	$\Delta Cash(<0)$	0.19	$\Delta Cash(<0)$	0.18
Sum of 3 other margins	0.29		0.23	Sum of 3 other margins	0.29		0.30

Top 10% firms

DISINV				**NEGEG**			
year k-1		year k		year k-1		year k	
Dominant margin	Share	Dominant margin	Share	Dominant margin	Share	Dominant margin	Share
$\Delta Equity(<0)$	0.32	$\Delta Debt(<0)$	0.41	$\Delta Equity(<0)$	0.32	$\Delta Debt(<0)$	0.38
$\Delta Debt(>0)$	0.31	$\Delta Equity(<0)$	0.30	$\Delta Debt(>0)$	0.29	$\Delta Equity(<0)$	0.32
$\Delta Debt(<0)$	0.17	$\Delta Cash(>0)$	0.12	$\Delta Debt(<0)$	0.22	$\Delta Debt(>0)$	0.13
Sum of 3 other margins	0.20		0.17	Sum of 3 other margins	0.17		0.17

For each lumpy adjustment type (DISINV, NEGEG) and time (k-1, k), we report in the table the share of firm-year observations in which one of the six financing margins – positive and negative changes in cash, debt and equity, respectively – is dominating all the others combined. This is the case if the absolute adjustment in one of the financing margins constitutes at least 50% of the sum of the absolute adjustment in the remaining five margins. For each year we categorise firms by percentile of total assets into different size classes. A firm is classified as belonging to the bottom 90%, top 10% by the median size classification of its history.

4 Discussion in relation to capital structure theories

Our findings contain several implications worth discussing. First and foremost, our findings suggest that lumpy adjustment, in capital and the number of employees, is inherently and meaningfully linked with firms' financial policies. Large discontinuities in firm leverage in particular are associated with large expansions and contractions in real assets and as such the latter can be viewed as systematic determinants of leverage dynamics. Therefore, our findings contribute to the understanding of the time series behavior of leverage as called for by DeAngelo and Roll (2015). Moreover, our findings corroborate very strongly the findings by DeAngelo and Roll (2015) that leverage instability is associated with company expansion, and by Denis and McKeon (2012) that leverage increases predominantly finance operating needs. Our findings on leverage dynamics suggest a very protracted period of adjustment of leverage that typically exceeds the intense middle phase of real adjustment. Large and significant leverage increases and decreases are observed for the entire five-year lumpy adjustment window. This evidence further indicates that lumpy adjustment is a significant determinant behind leverage dynamics and these dynamics are hard to reconcile with stationary leverage targets or deliberate attempts to re-balance leverage as argued by traditional trade-off models.

Our findings therefore imply that adjustment to a leverage target is not of a *primary* consideration of firm managers, as also argued by Denis and McKeon (2012). Flexible leverage targeting or leverage target zones — as argued by DeAngelo and Roll (2015) and reported by CFO surveys in Graham and Harvey (2001) — that are driven by the need to finance real adjustment, fits our evidence, which emphasises such real adjustments as a key time series determinant of leverage. Interestingly, flexible target zones for leverage are predicted by the model of DeAngelo et al. (2011a) when firms face fixed costs of adjustment — this is likely the case in our context with substantial lumpy adjustments in production inputs.

The empirical link highlighted in our study, between productive asset contractions and debt reductions, also stands in contrast with traditional dynamic trade-off models where firms cannot reduce debt beyond strategic default considerations. The leverage dynamics in these models are inconsistent with our empirical findings in two dimensions. First, they miss the link of large increases in leverage which we show to coincide with lumpy contractions in production inputs. Second, they miss the slower but substantial adjustment in leverage towards normal levels which we document in the two years after a negative lumpy adjustment.

Our study goes beyond leverage dynamics and establishes new evidence for the important role of cash balances in financing lumpy adjustment. We empirically establish a systematic preparation phase of finance where both cash and leverage through debt reduction enable the creation of debt capacity ahead of the incoming real expansion. The dynamics of cash balances therefore are consistent with theories where firms wish to preserve financial flexibility. The key finding that supports this claim is the accumulation of cash balances in preparation for the positive adjustment and the reduction of cash balances during the adjustment.

Therefore, our evidence suggests that theories of capital structure should treat cash as an important financial asset that allows firms to build financial flexibility, either because they have an incentive to avoid costly external finance or because of managerial fears (and distress costs) of high leverage. Importantly, our evidence indicates that cash balances and debt are not perfect substitutes in firms' capital structures, otherwise, cash would be actively used to retire debt ahead of the incoming adjustment to free up debt capacity. Gamba and Triantis (2008) emphasize the additional value to financial flexibility conferred by cash when the latter saves on future debt issuance costs. Although our evidence is consistent with such a role for cash, an equally appealing interpretation may be that cash reflects a precautionary motive that guards against uncertain market conditions for debt issuance.

Either way, our findings suggest that financial flexibility is an important consideration to be taken seriously by dynamic trade-off models and traditional tradeoff models of capital structure should incorporate a motive for the accumulation of large cash balances. Our empirical findings on cash balances during lumpy adjustment are consistent with the prediction of a simple model of costly external finance, endogenous investment and cash developed in Tsoukalas et al. (2017) and similar arguments in Almeida et al. (2014)) about the role of cash in funding profitable investment projects when external finance is costly and investment is lumpy.

5 Conclusions

A substantial amount of empirical evidence exists that capital structure decisions are driven by financial-flexibility considerations. In these considerations, debt exists to a large extent as a tool to fund managerial operational plans. Distress costs may also be a reason for limiting debt in the capital structure. Both financial flexibility and distress costs originate from firms' imperfect ability to access external financing when it needs to. The empirical evidence rests on analyzing episodes of lumpy investment or large acquisitions. However, there are other instances when the firm is making large adjustments to its operational assets, capital or employment, that should be having an impact on firms' financial decisions, that have not been examined to date. This is the first paper, to our knowledge, that studies the dynamics of financing decisions associated with firms' lumpy increases or reductions in employment, and lumpy disinvestment in capital. In so doing, we pay attention to the dynamics of both leverage and cash balances adjustments.

We show that there are discernible patterns of financing lumpy adjustment, remarkably similar across capital and labor, but quite distinct between positive and negative lumpy adjustment episodes. During lumpy adjustment episodes, cash balances play an important and complementary role to leverage. In all episodes, there is a preparation phase, roughly in the year before the adjustment takes place. Prior to lumpy positive adjustment, cash gets accumulated and leverage is decreased. This 'dry powder' gets used up during the adjustment and up to two years afterwards as cash balances go down and leverage is increased towards normal levels. Normal levels are described by firm-year observations when lumpy adjustment is absent. In lumpy contraction episodes, firms start with impaired financial flexibility and attempt to restore it to normal levels. Firms undergoing employment reductions have more impaired financial health than firms undergoing disinvestment. The process of rebuilding financial flexibility is protracted and is not complete two years after the adjustment episode.

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Supplementary Appendix (not for publication)

A Basic statistics about lumpy adjustments

Thresholds for positive (negative) types of adjustment are chosen so that approximately 20% of the observations are above (below) the threshold. However, the actual lumpy episodes considered occur with a lower frequency. The reason is that for a lumpy episode to be classified as such, we impose the target variable (e.g. the investment rate) in year k to be above the threshold and to be below the threshold in year $k-1$. This implies that e.g. of consecutive high investment rates that are above the threshold, only the first one would be classified as a lumpy adjustment episode. It has been documented in the literature that investment projects often take multiple years to complete and this is also confirmed by the dynamic plots showing the investment rate, Figure 4, where the investment rate remains substantially elevated above normal levels also in year $k+1$. Table 4 shows the occurrence of lumpy episodes as share of observations that can potentially be classified as lumpy episode.

Table 5 reports the joint occurrence of lumpy adjustment episodes in our sample. Different types of lumpy episodes are not necessarily synchronized although for some types of assets the joint probability of occurrence is higher that others. For example, investment spikes are accompanied by lumpy expansion in employment in 21.8% of the times, and sales of the capital stock coincide with lumpy reductions in the number of employees in 22.1% of the cases. It is much less frequent that a contractionary event coincides with an expansionary event in another margin.

Table 4: Occurrence of lumpy adjustment (in percent)

SPIKE	DISINV	POSEG	NEGEG	All lumpy adjustments
7.8	9.5	11.9	13.9	32.9

The table shows the share of observations classified as lumpy adjustment. SPIKE/DISINV is the positive/negative lumpy investment adjustment, and POSEG/NEGEG is the positive/negative lumpy employment adjustment.

Table 5: Joint occurrence of lumpy adjustment (in percent)

	SPIKE	DISINV	POSEG	NEGEG
SPIKE	100.0	0.0	21.8	6.7
DISINV	0.0	100.0	5.3	22.1
POSEG	15.9	3.3	100.0	0.0
NEGEG	4.2	11.9	0.0	100.0

The table shows the probability of an adjustment in a column conditional on an adjustment in a row. SPIKE/DISINV is the positive/negative lumpy investment adjustment, and POSEG/NEGEG is the positive/negative lumpy employment adjustment.

B Additional evidence on dynamic financing patterns

B.1 Dynamics of productivity and sales growth

Figures 11 and 12 display the behavior of log TFP and the growth rate of sales. These variables display a pattern largely similar to profitability and Tobin's Q (see Figures 2 and 3) and confirm the notion that fundamental variables are very informative for future fundamentals in a way that makes the lumpy adjustment and its financing largely anticipated. Specifically, they display an hump-shaped (inverted hump-shaped) behavior for positive (negative) adjustments centered on the year of adjustment. In contractions relative, to normal times, sales growth is persistently below the normal level during almost the entire negative episode (from 'k-1' to 'k+2'), whereas sales growth in expansions becomes significantly elevated primarily during the adjustment year. Measured TFP displays an (inverted) hump-shaped pattern during positive (negative) adjustments probably due to the firm adjusting its capacity utilization using margins that are not captured in the production function estimation.

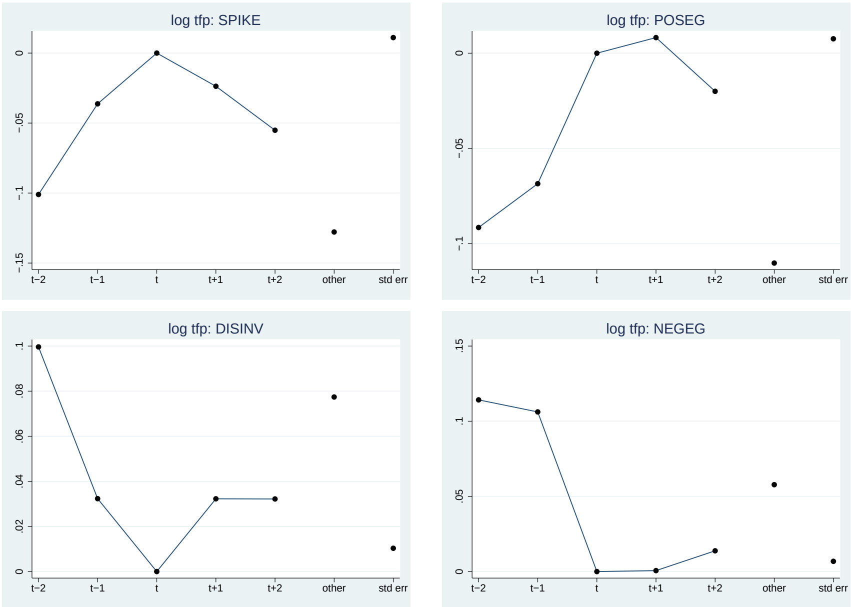

Figure 11: Behavior of log TFP around lumpy adjustment episodes: (1) investment spike (top-left), (2) positive employment burst (top-right), (3) disinvestment (bottom-left), (4) negative employment burst (bottom-right).

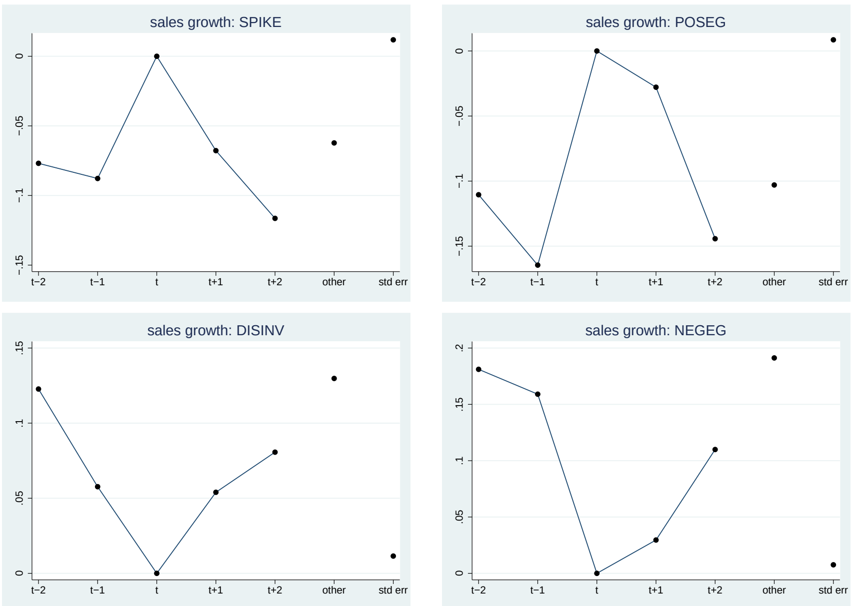

Figure 12: Behavior of the growth rate of sales around lumpy adjustment episodes: (1) investment spike (top-left), (2) positive employment burst (top-right), (3) disinvestment (bottom-left), (4) negative employment burst (bottom-right).

B.2 Equity Issuance

Figure 13 shows the dynamic patterns of equity issuance scaled by total assets around lumpy adjustment episodes. For lumpy expansions in the capital stock and employees, equity issuance increases towards time 'k', yet it is still substantially below normal levels. For negative adjustments, equity issuance relative to assets drops below normal levels and reaches a trough at time 'k'. These patterns suggest equity issuance is not a major source of finance for lumpy adjustments.

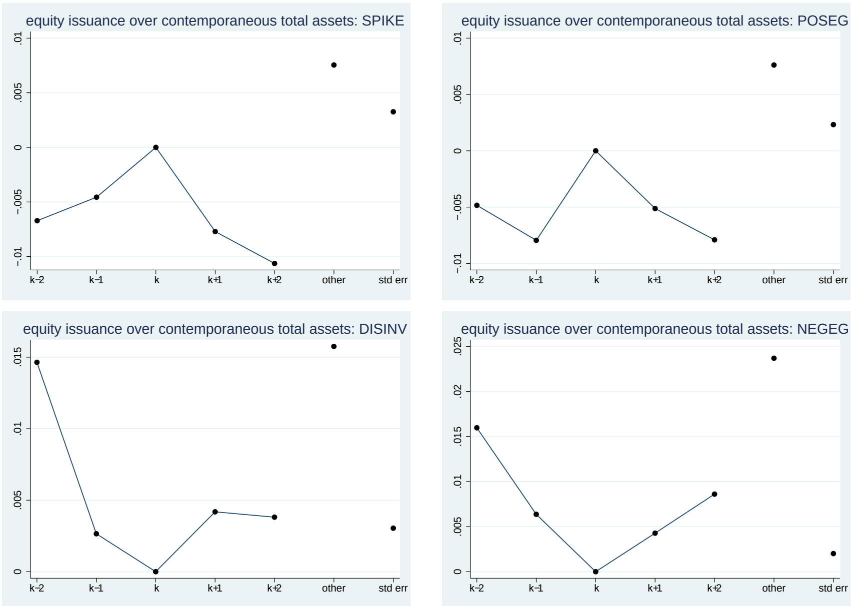

Figure 13: Behavior of equity issuance scaled by contemporaneous total assets around lumpy adjustment episodes: (1) investment spike (top-left), (2) positive employment burst (top-right), (3) disinvestment (bottom-left), (4) negative employment burst (bottom-right).

B.3 Maturity structure of debt

Figure 14 shows the behavior of the share of short term debt in total debt around lumpy adjustment episodes and hence gives an indication of the maturity structure of debt around lumpy episodes. Lumpy expansions and contractions tend to be undertaken when firms are tilted to long term debt compared to normal times. Before lumpy expansions firms reduce short term debt, relative to long term debt. In lumpy contractions, there is a steady increase in the proportion of short-term debt towards and beyond the lumpy expansion in period 'k'.

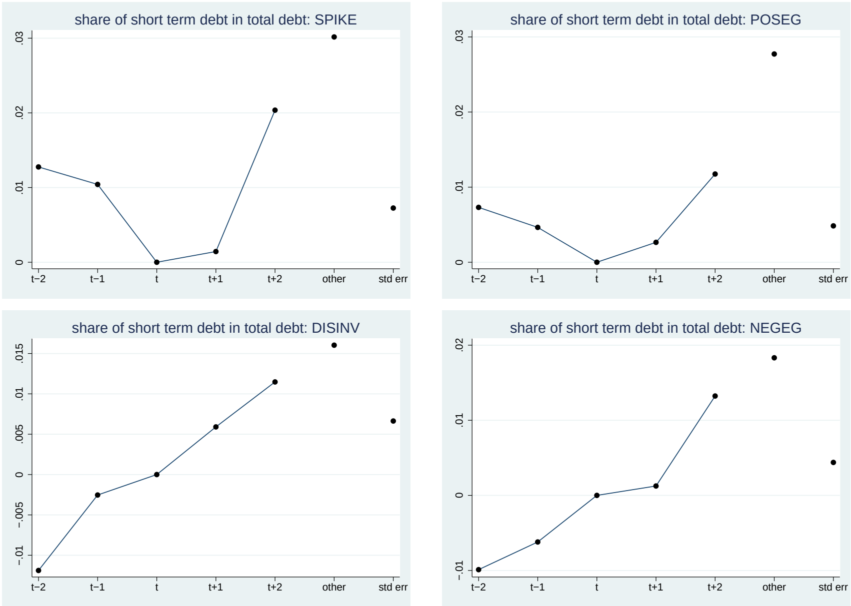

Figure 14: Behavior of the share of short term debt in total debt around lumpy adjustment episodes: (1) investment spike (top-left), (2) positive employment burst (top-right), (3) disinvestment (bottom-left), (4) negative employment burst (bottom-right).

B.4 Sorting firms by financial position and size

We discuss the dynamic financing patters when we sort firms according to the three criteria described in section 3.2, namely, i) market leverage, (ii) cash over assets, and (iii) size. When we condition the analysis according to the position of market leverage in the year preceding the adjustment, 'k-1' we observe the following. The dynamic pattern of cash-to-assets in Figure 15 is remarkably similar across firms and consistent with Figure 6. In positive events firms increase cash-to-assets significantly above the 'other' and reduce cash-to-assets as the episode unfolds. The exception is firms that belong to the top 10% of leveraged firms, where despite the increase in year 'k-1' their cash-to-assets is below 'other' through out positive adjustment. For negative episodes cash-to-assets declines in year 'k-1' and slowly recovers towards the 'other' (an exception being firms in the 0-33% of leverage for DISINV, where cash-to-assets drops monotonically from a high level relative to 'other'). Figure 16 displays the growth rate of debt. The dynamic patterns we observe are again broadly similar to the ones displayed in Figure 10. For positive adjustment, there is a surge in the growth of debt at the year of the adjustment across different firms, even for those who are in the top 10% of market leverage during the previous year. For negative adjustments, there is a drop off in the growth rate in year 'k'. This is certainly more apparent for firms in the upper two bins of the distribution. Interestingly, firms in the lowest 0-33% of the distribution exhibit a rise in the growth rate in DISINV, in year 'k'. We conjecture these are firms which have high cash-to-assets ratio relative to 'other' (see Figure 15) and they seem to use debt even in contractions given they have the debt capacity. Figure 17 displays the behavior of market leverage. It is interesting to see that in positive adjustments firms behave broadly similar in terms of preparing debt capacity. They all reduce leverage at 'k-1' and slowly increase it thereafter. Firms in the top 10% have leverage way above the 'other' at the beginning of the window but still reduce it up to the time of the adjustment. For negative capital adjustments, firms in the bottom two thirds of the distribution of leverage increase it monotonically towards the 'other', and this is different to the behavior of the top one third percent of firms in terms of market leverage.

When we condition the analysis according to the position of cash-to-assets in the year preceding the adjustment, 'k-1', we observe the following. In Figure 18, firms in the 0-33% of the distribution of cash-to-assets do not seem to exhibit differences, at least qualitatively, with respect to the dynamic pattern of cash-to-assets whether they undertake positive or negative adjustments. These firms are way below the 'other' and attempt to slowly rebuild cash balances as the episodes unfold. Firms in the remaining of the distribution behave broadly similar to the behavior we have documented in Figure 6. It is remarkable that even firms that are cash rich seem to prepare for positive adjustments in year 'k-1'. An exception here is the behavior of the top 10% of firms in the distribution where they do not seem to reduce cash-to-assets in year 'k-1' for capital contractions. Figure 19 displays the growth rate of debt. For positive episodes the behavior is broadly similar to the normal behavior we discussed in Figure 10. For negative episodes there are some differences with respect to the DISINV episode where we do not observe a drop-off in growth rates of debt for firms in the top one third of the distribution. Finally, Figure 20 displays the behavior of market leverage. For positive events, the dynamic behavior of leverage is remarkably similar to the behavior discussed in Figure 8 — firms create debt capacity in advance of the adjustment and this does not seem to be conditional on the level of cash-to-assets they hold. This finding is further evidence that debt and cash are not good substitutes during lumpy episodes. For negative adjustments and the bottom two thirds of firms in the distribution of cash-to-assets the dynamics are very similar to those in Figure 8. However, for firms in the one third of the distribution of cash-to-assets they typically increase leverage monotonically, although they begin the negative adjustment way below the 'other'.

Figure 21 displays the dynamics of cash-to-assets for firms sorted on different size. For positive adjustments cash-to-assets behaves qualitatively similar for different size firm and consistent with the dynamic behavior observed in Figure 6. The dynamics of cash-to-assets are also similar for negative employment events, with cash to assets dropping a year prior to the negative adjustment. A difference seems to arise in capital contractions where there is not strong evidence of reversion to the 'other' within the episode window. Figure 22 displays the growth rate of debt. Again we observe dynamic patterns which are very consistent with the one we have discussed in Figure 10 positive adjustments see a surge in the growth of debt in the adjustment year and negative adjustments a reduction in the growth of debt, although the timing is not always uniform across firms of different sizes. Figure 23 demonstrates that smaller and very large firms behave very similar with respect to the dynamics of leverage during positive adjustments: firms seek to create debt capacity in the year preceding the adjustment and increase debt in the year of the adjustment. It is remarkable that the largest firms behave in a similar fashion to small firms in terms of leverage and debt.

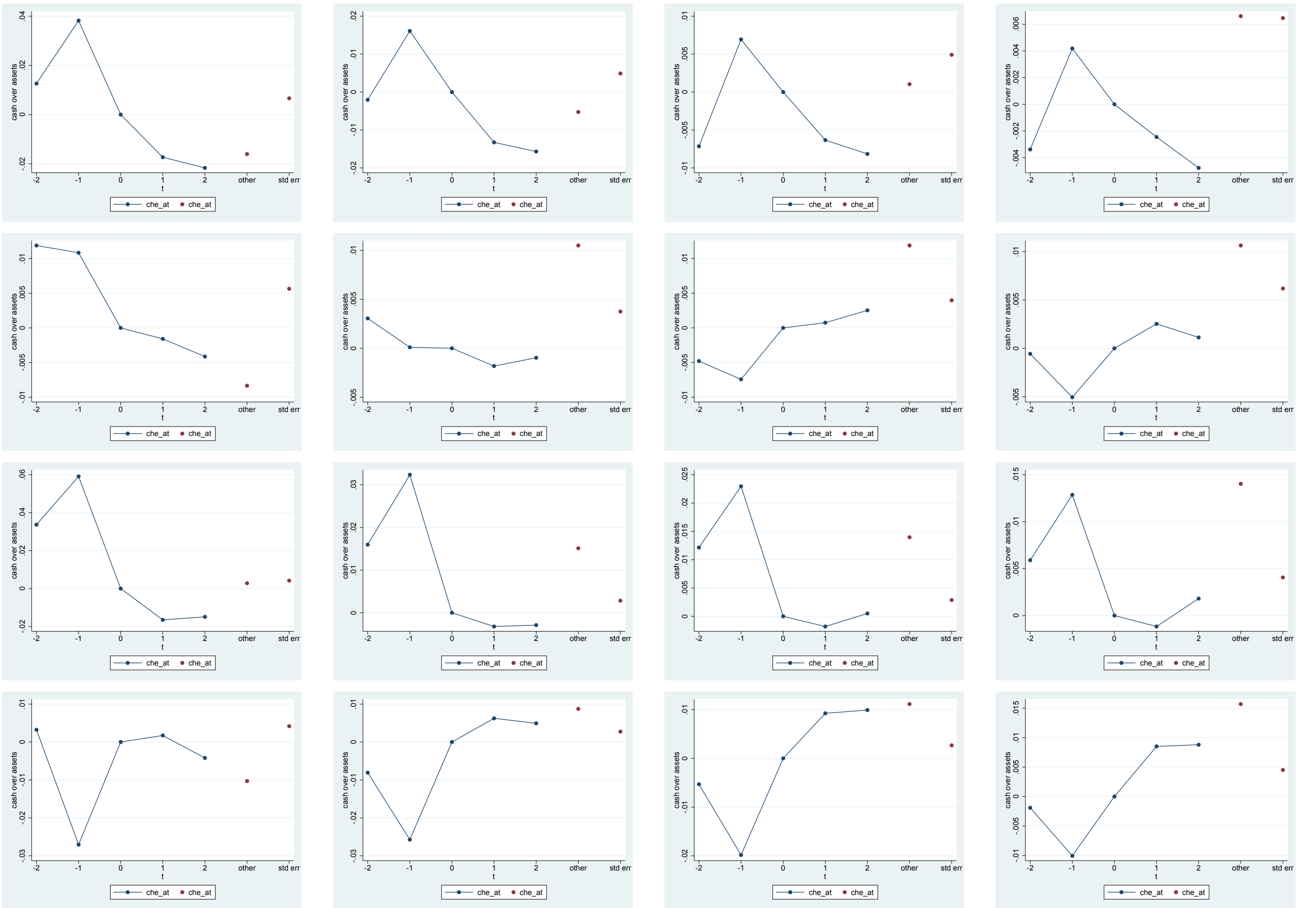

Figure 15: Behavior of cash over contemporaneous assets around events: (1) investment spike (row 1), (2) disinvestment spike (row 2), (3) positive employment burst (row 3) (4) negative employment burst (row 4). Figures from left to right show results according to market leverage at window position t-1, 0-33%, 34-66%, 67-90%, 90-100%.

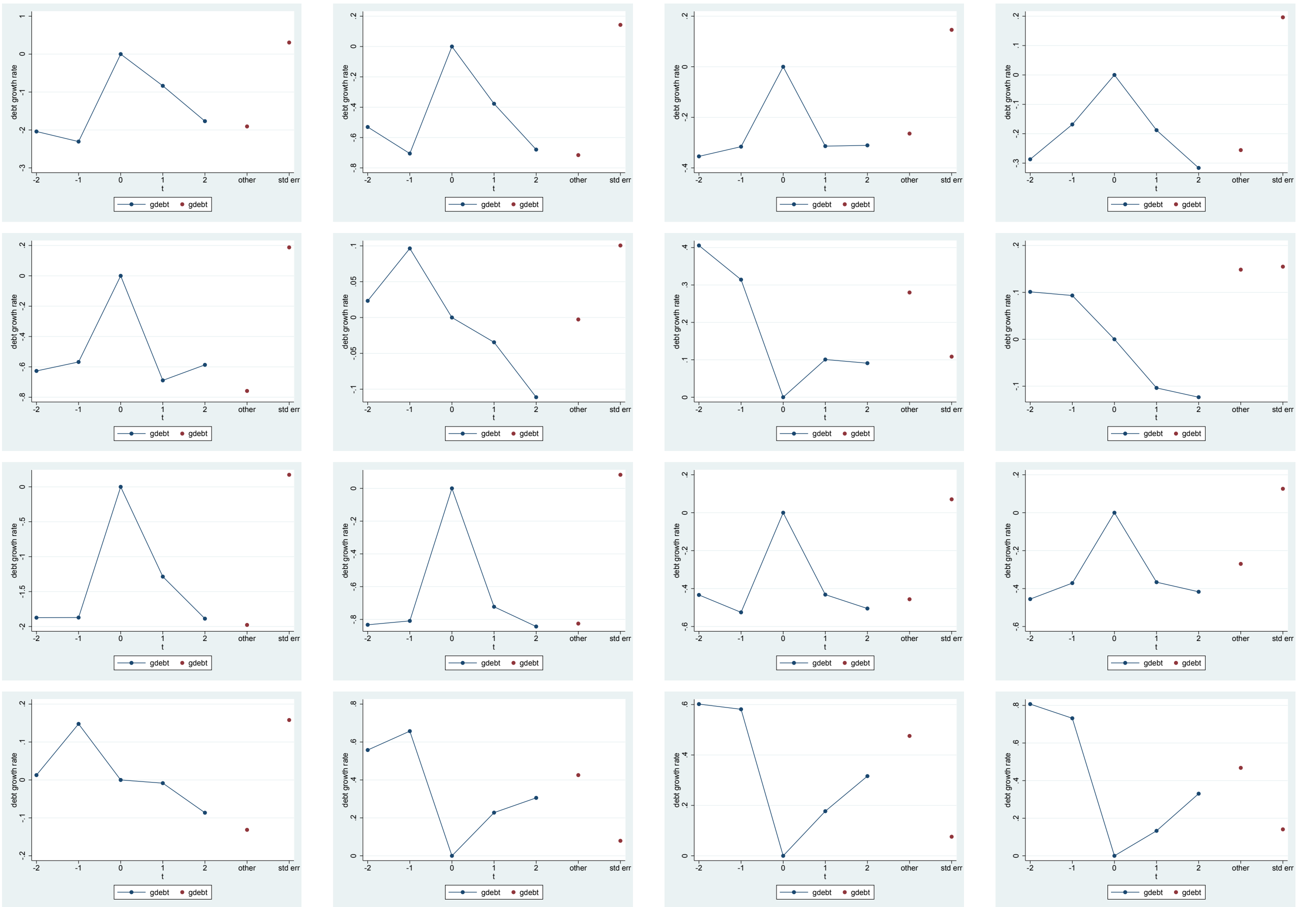

Figure 16: Behavior of the growth rate of debt around events: (1) investment spike (row 1), (2) disinvestment spike (row 2), (3) positive employment burst (row 3) (4) negative employment burst (row 4). Figures from left to right show results according to market leverage at window position t-1, 0-33%, 34-66%, 67-90%, 90-100%.

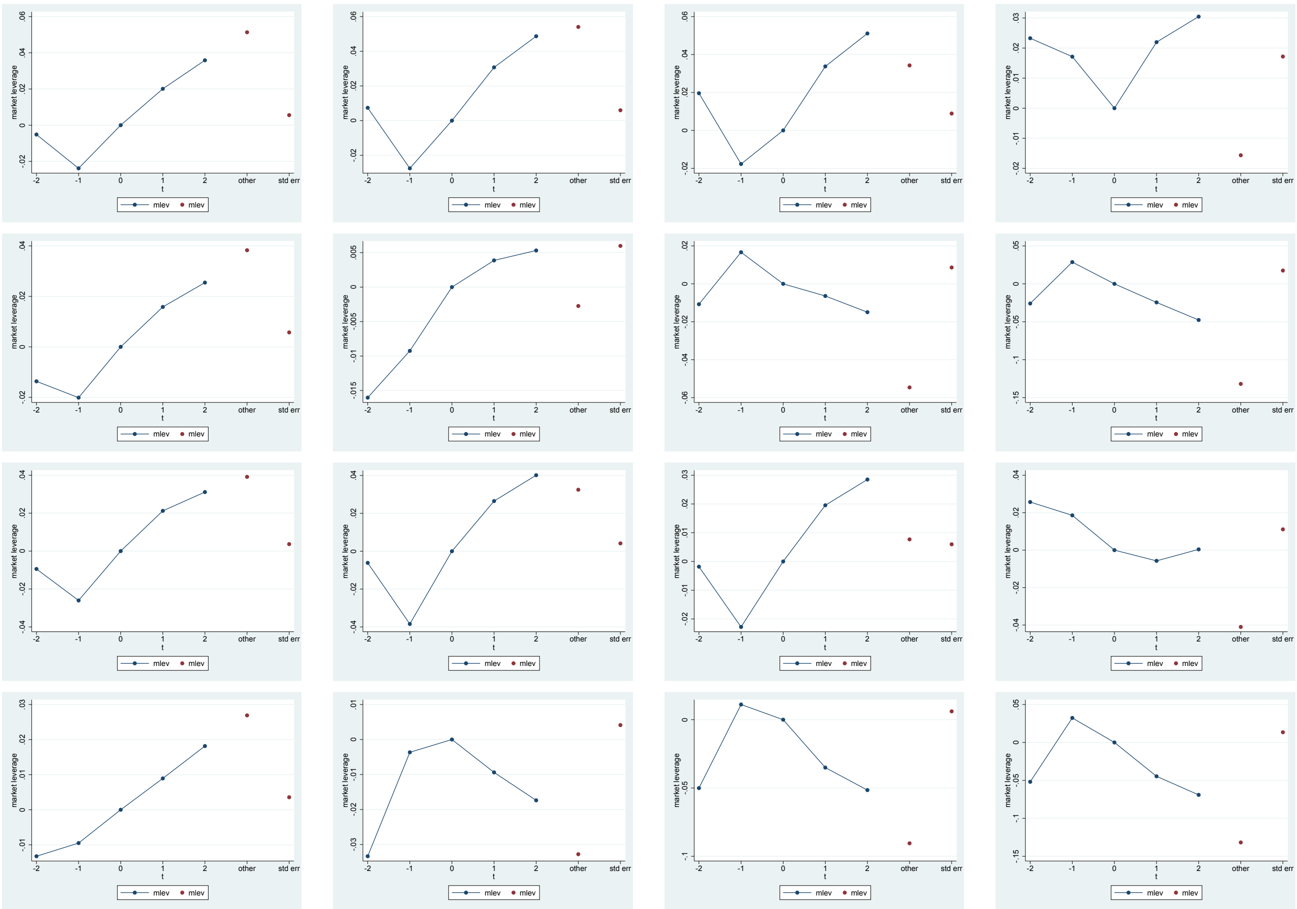

Figure 17: Behavior of market leverage around events: (1) investment spike (row 1), (2) disinvestment spike (row 2), (3) positive employment burst (row 3) (4) negative employment burst (row 4), (5) large positive inventory adjustment (row 5), (6) large negative inventory adjustment (row 6). Figures from left to right show results according to market leverage at window position t-1, 0-33%, 34-66%, 67-90%, 90-100%.

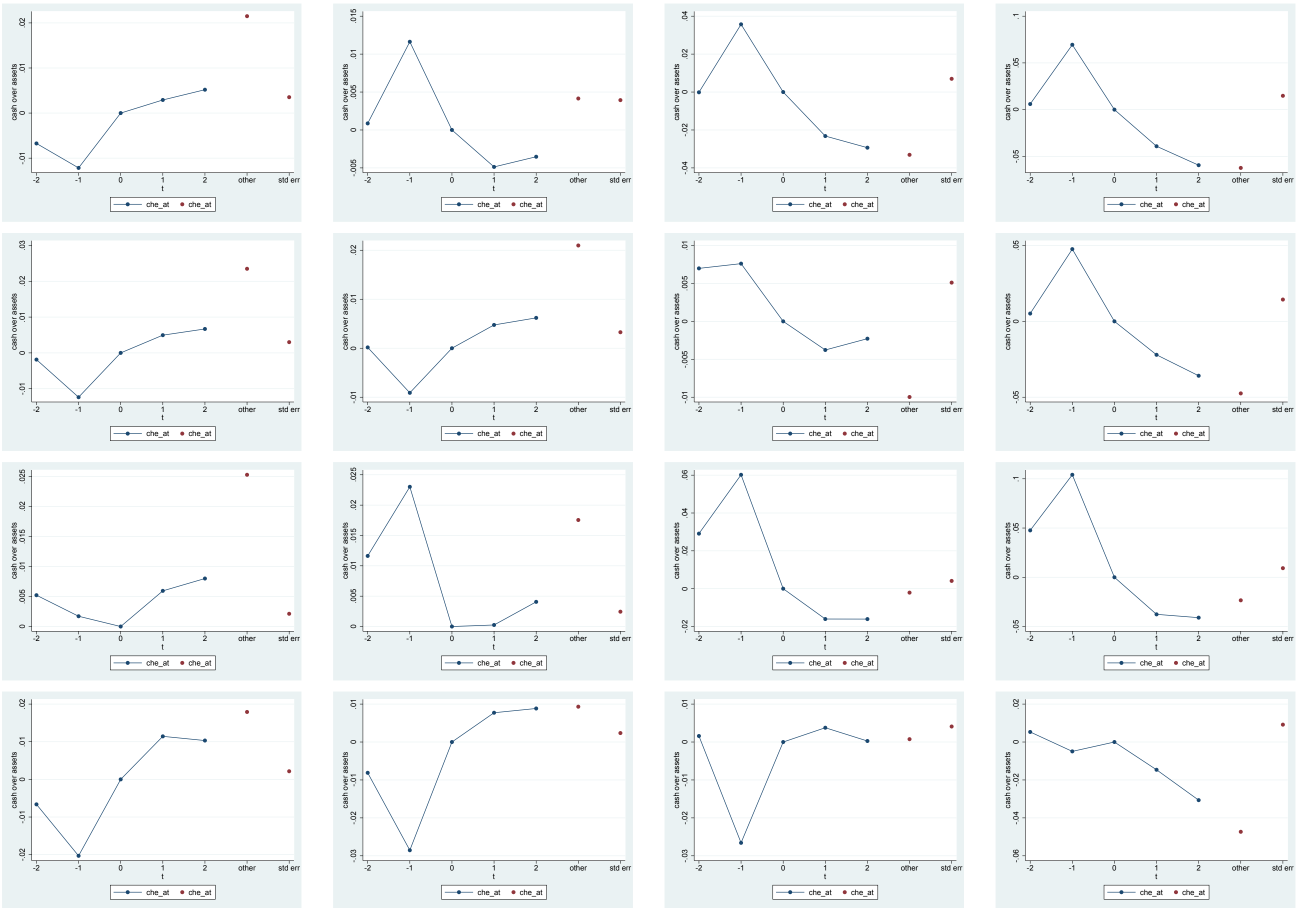

Figure 18: Behavior of cash over contemporaneous assets around events: (1) investment spike (row 1), (2) disinvestment spike (row 2), (3) positive employment burst (row 3) (4) negative employment burst (row 4). Figures from left to right show results according to cash over assets at window position t-1, 0-33%, 34-66%, 67-90%, 90-100%.

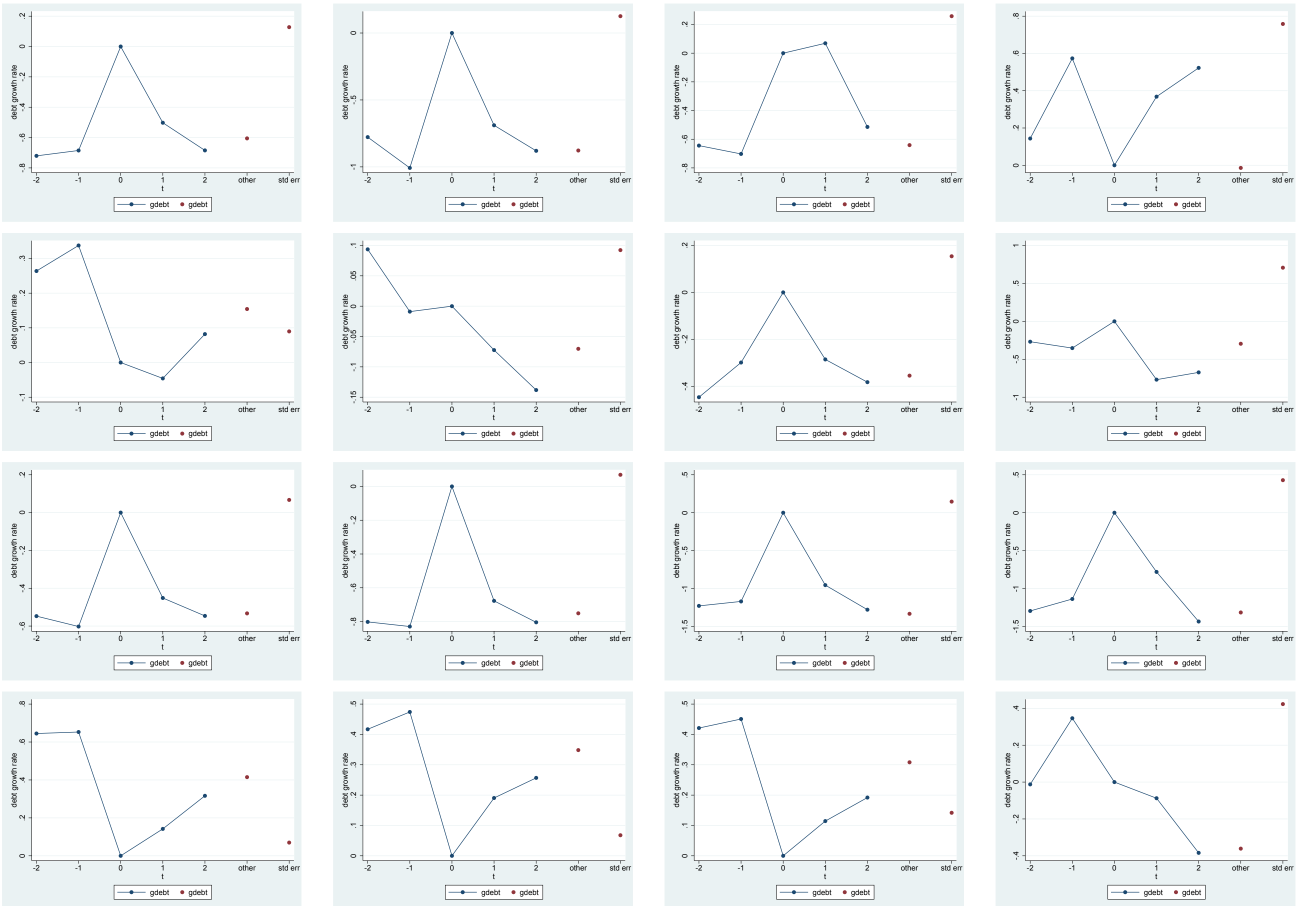

Figure 19: Behavior of the growth rate of debt around events: (1) investment spike (row 1), (2) disinvestment spike (row 2), (3) positive employment burst (row 3) (4) negative employment burst (row 4). Figures from left to right show results according to cash over assets at window position t-1, 0-33%, 34-66%, 67-90%, 90-100%.

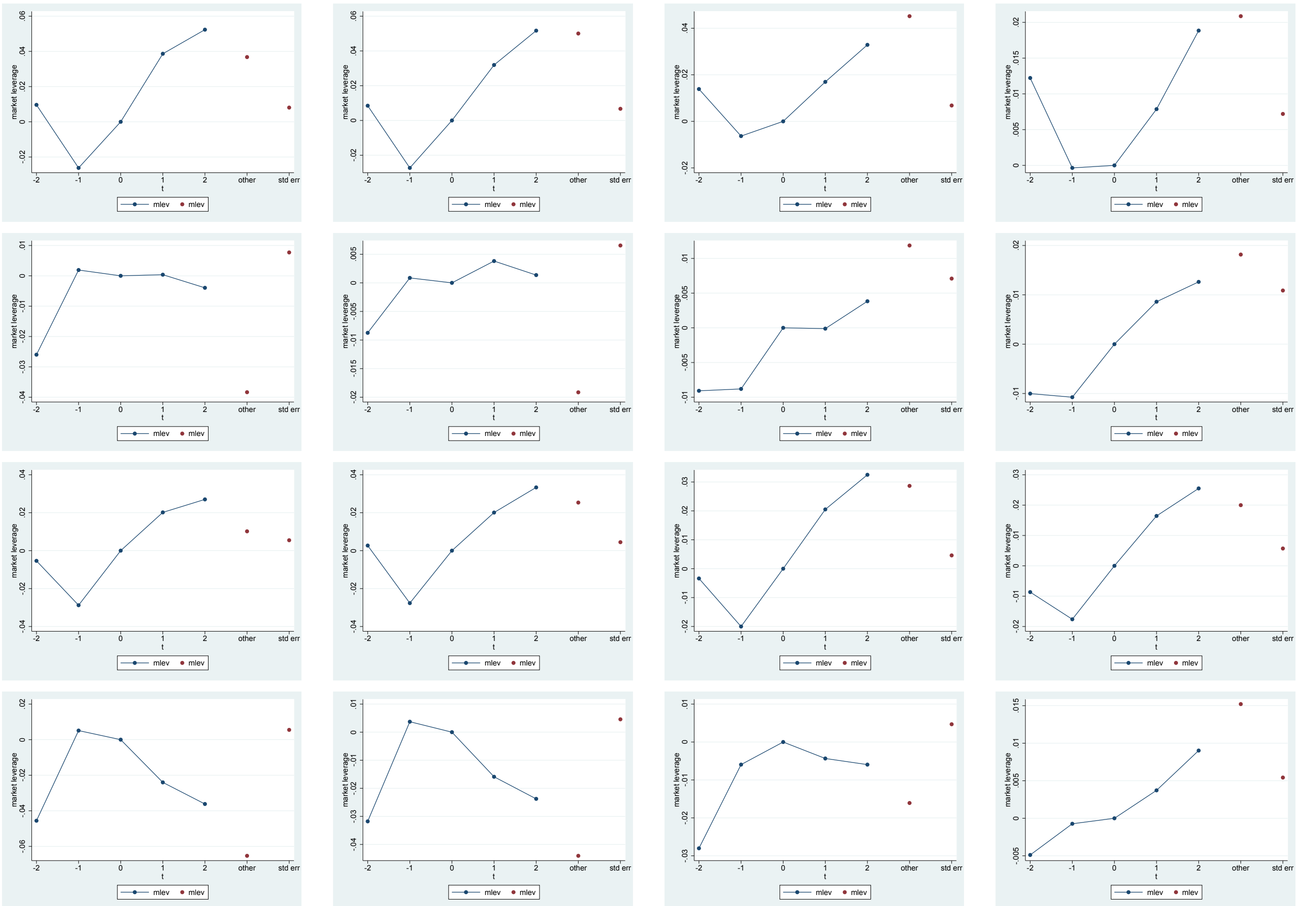

Figure 20: Behavior of market leverage around events: (1) investment spike (row 1), (2) disinvestment spike (row 2), (3) positive employment burst (row 3) (4) negative employment burst (row 4). Figures from left to right show results according to cash over assets at window position t-1, 0-33%, 34-66%, 67-90%, 90-100%.

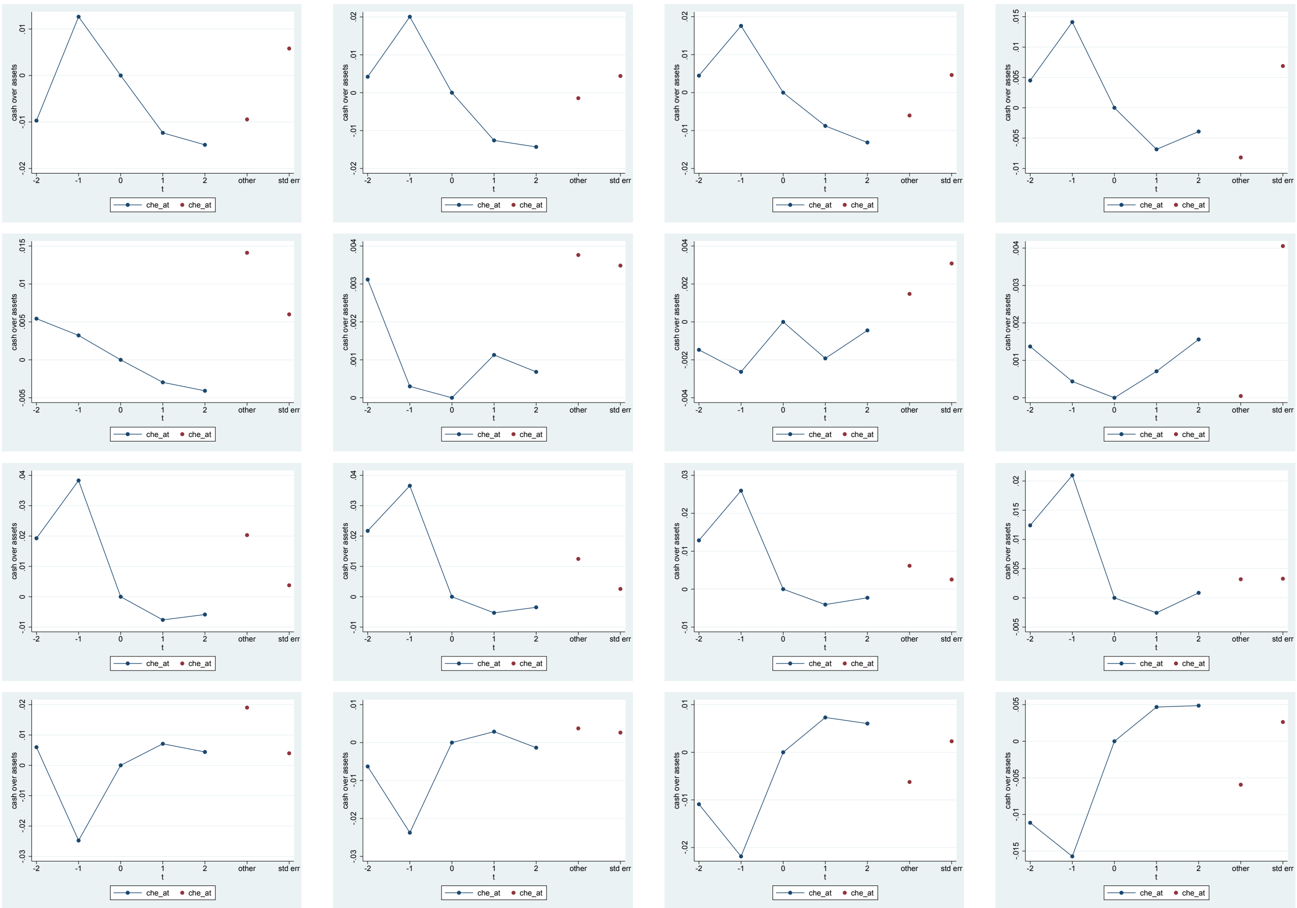

Figure 21: Behavior of cash over contemporaneous assets around events: (1) investment spike (row 1), (2) disinvestment spike (row 2), (3) positive employment burst (row 3) (4) negative employment burst (row 4). Figures from left to right show results according to size, 0-33%, 34-66%, 67-90%, 90-100%.

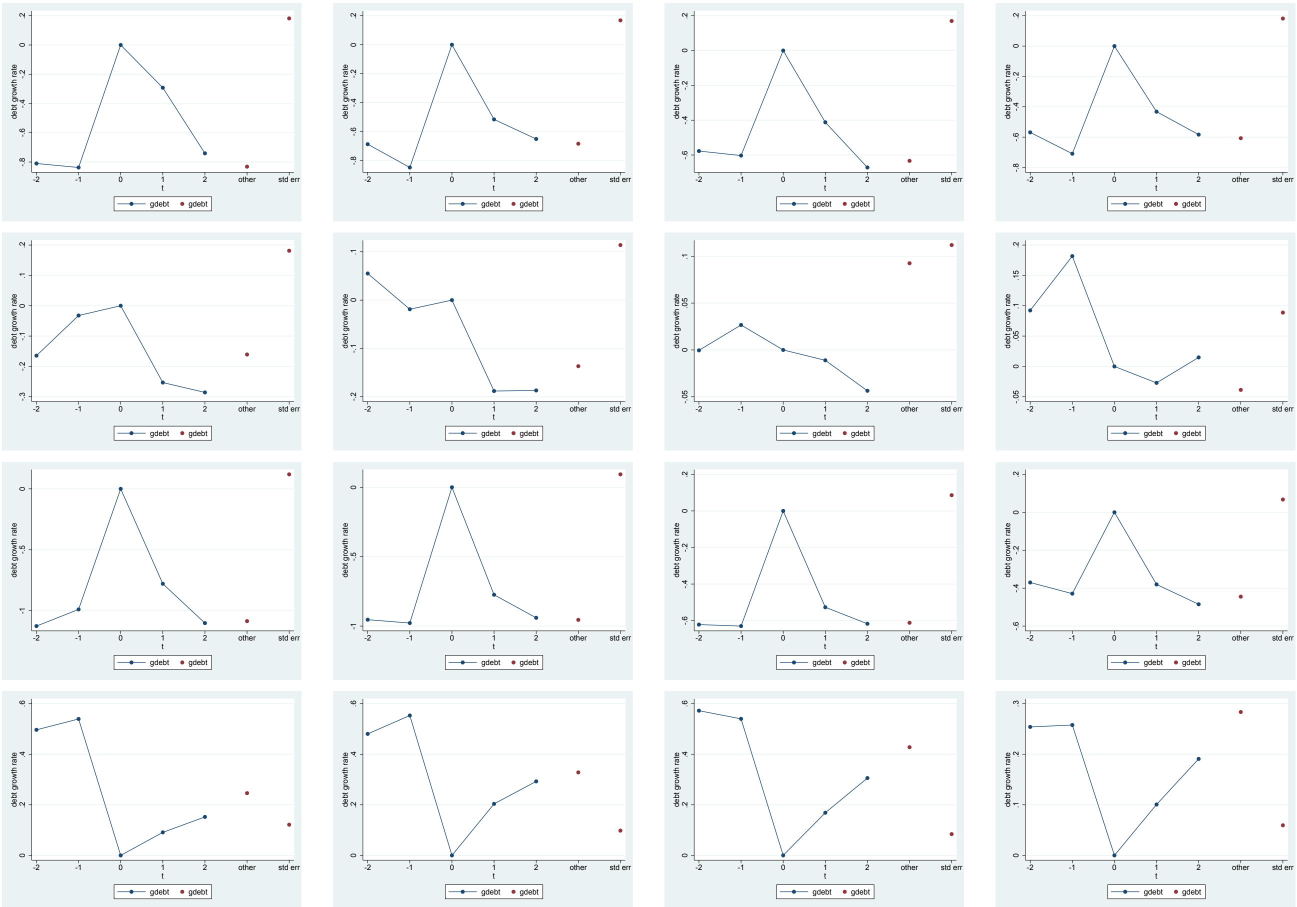

Figure 22: Behavior of the growth rate of debt around events: (1) investment spike (row 1), (2) disinvestment spike (row 2), (3) positive employment burst (row 3) (4) negative employment burst (row 4). Figures from left to right show results according to size, 0-33%, 34-66%, 67-90%, 90-100%.

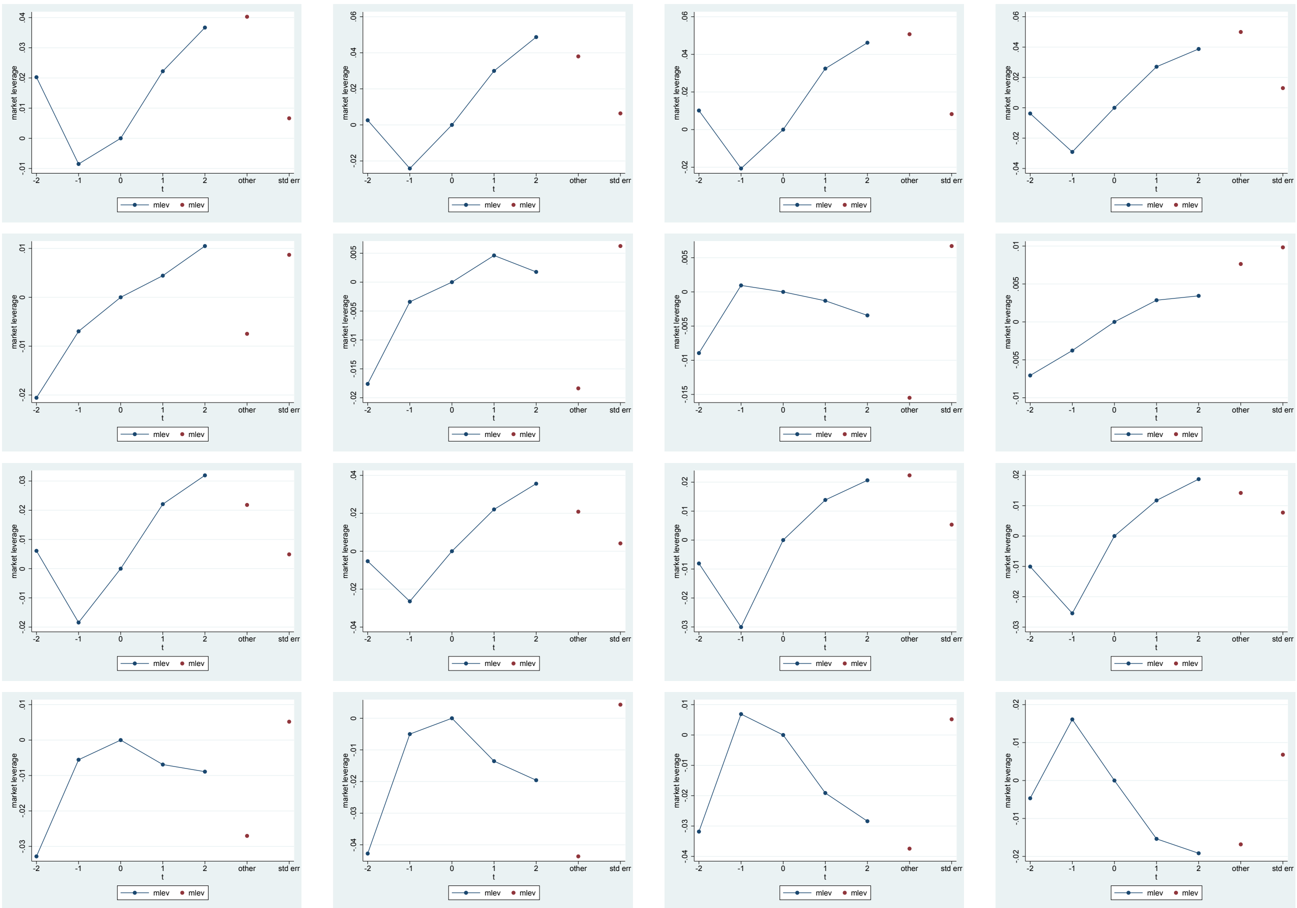

Figure 23: Behavior of market leverage around events: (1) investment spike (row 1), (2) disinvestment spike (row 2), (3) positive employment burst (row 3) (4) negative employment burst (row 4). Figures from left to right show results according to size, 0-33%, 34-66%, 67-90%, 90-100%.

C Data Appendix

Our dataset comprises information provided by COMPUSTAT (North-America) Fundamentals Annual Files (Monthly updates). In the sections below, we describe the relevant variables and their construction, followed by sample selection and cleaning criteria.

C.1 Data Sources and Variable Construction

- Fixed investment is Capital Expenditures (CAPX). Net investment is CAPX minus Sale of Property, Plant and Equipment (SPPE).
- The capital stock is the net value of Total Property, Plant and Equipment(PPENT).
- Total Inventories (INVT) is end of period total inventories, which are measured in LIFO terms. Inventory investment is defined as difference between beginning and end of period inventories.
- Net total sales is Total Sales (SALE).
- For cash holdings we use the COMPUSTAT variable Cash and Short-Term Investments (CHE).
- Total debt (DEBT) is constructed as the sum of Long Term Debt Total (DLTT) and Debt in Current Liabilities (DLC). Thereby we only consider observations for which book equity is larger than zero so that DEBT over contemporaneous assets is bounded between zero and one. Book equity (BE) is defined as Stockholder's Equity (SEQ) as in Covas and Den Haan (2011).
- Ebitda is Operating Income before Depreciation (OIBDP).
- Tobin's q (Q) is defined as (AT+(PRCC·CSHO)-CEQ)/AT, where PRCC is the Annual Price Close (fiscal year end), CSHO is Common Shares Outstanding, AT is Total Assets and CEQ is Common Equity.
- Market leverage (MLEV) is constructed in line with Denis and McKeon (2012) as total debt over the sum of total debt and market value (DEBT/(DEBT+MVAL), where market value MVAL

is given by the product of the Annual Price Close (fiscal year end), PRCC, and Common Shares Outstanding, CSHO.

- (External) equity issuance is defined according to Begenau and Salomao (2019) as equity issuance (SSTK) minus cash dividends (DV) minus equity repurchases (PRSTKC)

- We estimate firm level productivity (TFP) based on the methodology outlined in Olley and Pakes (1996). This methodology is widely used in the literature (see e.g. Imrohoroglu and Tüzel (2014)) which is why we outline here only the variables we used in the estimation. The key variables for this estimation are he beginning of period capital stock (PPENT), the stock of labor (EMP) and value added. We further require the average age of the capital stock which is calculated by the quotient of Accumulated Depreciation, Depletion and Amortization (DPACT) and current Depreciation and Amortization (DP). The final variable for age is smoothed by taking a 3-year moving average. For a firm with a history shorter than three years we take the average over the available years. Value added is constructed as the difference of sales and materials. While sales (SALE) is directly available in COMPUSTAT, we construct materials as total expenses minus labour expenses. Total expenses is sales (SALE) minus the sum of Operating Income after Depreciation (OIADP) and Depreciation (DP). Data on labor expenses is very sparse in COMPUSTAT, we therefore construct it as the product of employees (EMP) and aggregate yearly average wage index from the US Social Security Administration.[20]

- Cash flow is defined as the sum of Income Before Extraordinary Items (IB) and Depreciation and Amortization (DP).

- We define capital reallocation as the sum of acquisitions (ACQ) and Sales in Property, Plant and Equipments (SPPE). To maximise coverage, we treat missing observations for ACQ as zeros.

[20]This limitation of Compustat data is widely documented, see e.g. Imrohoroglu and Tüzel (2014), and a comparison of the Compustat variable for Staff Expenses (XLR) with our series on labor expenses suggests that our approximation is reasonable, delivering an unbiased estimate for labor expenses.

- R&D expenditures are given by Compustat variable Research and Development Expense, XRD.
- Total Liabilities are Compustat variable LT.
- Dividend payments are given by Dividends Total, DVT.

Deflators We apply the P_K, the implicit price deflator for private fixed nonresidential investment (available from the Bureau of Economics Analysis) to deflate fixed investment (CAPX) and sales of property plant and equipment (SPPE). Since investment is made at various times, capital stock variables, PPENT and PPEGT, are deflated using P_K following the methodology as in Hall (1990). For this purpose we calculate the average age of the capital stock in every year (by firm) and apply the appropriate deflator with timing 'current period' minus 'average capital stock age'. Following Imrohoroglu and Tüzel (2014) we calculate the average age of the capital stock as the quotient of accumulated depreciation (DPACT) by current depreciation (DP).[21] Inventory variables are deflated using, P_{invt}, the price deflator for finished goods (PPI). It is the finished goods PPI obtained from the Bureau of Labor Statistics, Producer Price Index: Finished Goods (PPIFGS). All other relevant variables are deflated using, the GDP deflator, P_{GDP}, available from the Bureau of Economics Analysis.

C.2 Sample Selection

We select the sample by making the following adjustments to the data retrieved from COMPUSTAT:

- We delete all regulated, quasi-public or financial firms (primary SIC classification is between 4900-4999 and 6000-6999). We only retain firms in manufacturing (SIC code 2000-3999), wholesale trade (SIC code 5000-5199), retail trade (SIC code 5200-5999) and communications (SIC code 4800-4899).
- If a firm's report date is before June, we allocate the respective observations to the previous year.

[21] We smooth the age variable by taking a 3-year moving average. If there are less than three years available, we take the average over these years.

- We delete firms reported earnings in a currency other than USD.
- As conventional in the literature, we account for the effects of mergers and acquisitions by deleting all firm-year observations including and after (i) an acquisition (ACQ) exceeding 15% of total assets (AT), (ii) sales growth exceeding 50% in any year due to a merger as indicated by SALE footnote AB, or (iii) the absolute difference between CAPX and CAPXV over PPENT exceeds 0.5 and is accompanied by a substantial increase (> 20%) of the absolute growth rate of PPENT. While CAPX includes all investment in property, plant and equipment including increases in the capital stock due to acquisitions of other companies, this is excluded in CAPXV. CAPXV is Capital Expenditures on Property, Plant and Equipment (Schedule V).
- We drop observations prior to 1989 for Ford, GM, Chrysler and GE as these are most affected by the accounting change in 1988 (for details see Bernanke et al. (1990)). We also drop observations for AT&T as the changes to the company structure in 1981 strongly affect aggregates.
- We drop observations if values are missing at the beginning or end of firm time series for all variables CAPX, SALE, PPENT, CHE, INVT and AT.
- We drop firms that never invest or hold inventories.
- We drop firms with less than six years of data.
- We drop all observations prior to 1971 and after 2013.

C.3 Cleaning Procedures

We apply the following filters to the variables used:

- We set negative values of the following variables to missing: CAPX, INVT, DVT, CHE, PRSTKC, DP, SPPE, DLTT, DLC, XRD, ACQ, SSTK, PRSTKC, DV.
- We set values smaller and equal to zero of the following variables to missing: PPENT, PPEGT, SALE, EMP, AT, MVAL, Q.

- For extremely high investment rates we check for potential miscoding in CAPX by evaluating whether the growth rate of PPENT actually changes substantially. In the top percentile of CAPX/PPENT we set values for PPEGT, PPENT and CAPX to missing unless the absolute difference between (CAPX-SPPE-ACQ)/PPEGT and the growth rate of PPENT does not exceed 0.1. We further set observations for CAPX to missing if for any particular observation CAPX/PPENT exceeds 5 and CAPX/PPEGT exceeds 2 to exclude effects of mergers and acquisitions. We further set values for CAPX, PPENT and PPEGT to missing if CAPX/PPENT exceeds 5 or CAPX/PPEGT exceeds 2.

- In the top percentile of SPPE/PPEGT we set values for SPPE to missing unless the absolute difference between (CAPX-SPPE-ACQ)/PPEGT and the growth rate of PPENT does not exceed 0.1. We further set values for SPPE to missing if SPPE/PPEGT > 0.9.

- We set values for AT, INVT, SALE, EMP, PPENT and CAPX to missing for extreme changes in these variables. In particular, values for EMP, SALE, PPENT (AT, INVT, CAPX) are replaced with missing in the bottom 0.5 (1) percentile of their respective growth rates. Values for EMP, INVT, SALE, AT (PPENT) [CAPX] are replaced with missing in the top 0.5 (0.01) [1] percentile of their respective growth rates. These percentiles are chosen so that values are set to missing if a variable's growth rate is approximately above 9 or below -0.9.

- We replace negative values for BE by missing. We further set values for BE to missing if (i) the ratio of BE to AT exceeds one, and (ii) all observations for BE that are within the 0.5th percentile.

- We winsorise the inventory to sales ratio and the disinvestment rate (SPPE/PPENT) at the bottom and top 1 percentile. We also winsorise Q at the bottom and top 0.5 percentile.

- We set values to missing in the top and bottom 0.1 (1) percentiles of EBITDA over AT (leverage, external equity issuance over lagged assets, external equity issuance, net debt over lagged total assets, change in net debt over lagged total assets, growth rate of shares outstanding, growth of net debt, average age of capital which is DPACT over DP).

- We replace values in the top 0.1 (0.5) [1] percentile with missing of the depreciation rate (CHE over lagged assets, change in CHE over lagged assets, debt over lagged assets, change in debt over lagged assets, asset sales over debt) [the growth rate of cash].

- We replace values in the top 0.5 (1) percentile of the growth rate of DEBT (XRD) with missing. These observations are also set to missing for total DEBT (XRD).

- We set values for cash flow to missing for the top and bottom one percentile of cash flow over contemporaneous (and lagged) total assets. We also set it to missing if the raw variables for CEQ or SEQ were reported to be negative.

- We set values to missing in the top 0.25 percentile of DVT over AT (and over lagged assets) and the top 0.5 percentile of DVT over SEQ. The time-year observations that have been set to missing for these two variables are also replaced by missing values in DVT.

- For the growth rate of TFP we set the top and bottom 0.1 percentile to missing. For these observations we also set TFP to missing.

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