Firm Cyclicality and Financial Frictions*

WORK IN PROGRESS

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Abstract

In this paper we use data from the universe of Danish firms to investigate what drives the cyclicality of firms by firm age and firm size, paying particular attention to financial frictions. We first document that employment and turnover are more cyclically sensitive at both younger and smaller firms. However, controlling for firm age, firm size ceases to be a significant predictor of cyclicality, highlighting that age rather than size is the relevant variable driving cyclicality. Motivated by this finding, we investigate the role of finance in driving the excess cyclicality of young firms. We find that measures of debt and cashflow are more cyclical at younger firms, and that the excess cyclicality of younger firms' employment and turnover is concentrated amongst relatively financially-intensive young firms. Conversely, financial variables are also more cyclical at small older firms, but they are able to absorb these financial flows without leading to increased cyclicality of employment or turnover. These results suggest an important role for financial frictions in driving outcomes over the business cycle, especially at younger firms.

Keywords: firm age, firm size, cyclicality, financial frictions

*The viewpoints and conclusions stated in this paper are the responsibility of the individual contributors, and do not necessarily reflect the views of Danmarks Nationalbank or Statistics Denmark.

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1 Introduction

Which firms drive changes in employment and turnover over the business cycle? Is it younger, growing firms, or older established firms? Is it small firms, or large firms? More fundamentally, why do certain firms respond more to the business cycle than others? The answers to these questions are important for many reasons, particularly that they might help us understand the fundamental shocks and channels driving the business cycle itself.

In this paper we use firm-level balance sheet data from the universe of Danish firms to make three contributions. Firstly, we document that growth rates of employment and turnover at both young firms and small firms are more sensitive to the aggregate business cycle, but that the effect of size essentially vanishes once we control for age. Secondly, we use financial data to document that the excess cyclicality of employment and turnover at young firms is related to financial variables, and provide evidence of a role for financial frictions. Thirdly, by comparing young small firms and old small firms, we provide evidence of a "financial cycle", over and above standard financial accelerator mechanisms.

A long literature dating back to Gertler and Gilchrist (1994) emphasises that firm size may act as a proxy for financial frictions, and thus argues that small firms being more cyclical than large firms could be interpreted as evidence in favour of financial frictions. More recently, it has been shown that firm age is a more important predictor of both the average level and cyclicality of firm growth than firm size (see Fort et al. (2013); Haltiwanger et al. (2013), for evidence from the US). Small firms are only more cyclical to the extent that they tend to be young, while older small firms display no excess cyclicality. Thus, the relationship between age, size, and cyclicality, including any underlying role of financial frictions, is complicated, and all elements must be studied at once in order to create a full picture.

With this in mind, what distinguishes our paper from previous work is the coverage and detail of our data. We have rich data for all firms in the Danish economy, and thus can study the behaviour of younger and smaller firms, who are typically unlisted and hence not available in public databases of listed firms. Additionally, our data is detailed, including measures of employment, turnover, firm age, and a broad range of financial data from firms' balance sheets. Accordingly, we can directly investigate the role of financial frictions across the whole firm age/size distribution using balance sheet data, which are typically hard to find for young, unlisted firms.

Our first contribution is to analyse the cyclicality of firms by firm age and size. We construct an accurate measure of firm age using a unique firm identifier which is created at the moment a firm is created. The advantage of this measure is that it measures true age since the inception of a firm, rather than, for example, measures of age relying on the time since firms were publicly listed. Following Mehrotra and Crouzet (2017), we define firm size using firm assets, and we bin firms by both size and age. After cleaning our data, we have roughly 1.25 million firm-year observations over the period 2001-2016. To measure the cyclicality of different firm groups, we split the data by bin and regress the growth rate of various firm-level measures on the growth rate of aggregate GDP.

When regressed separately, we find that firm cyclicality is related to both firm size and firm age: the growth rates of turnover and employment at both younger and smaller firms respond by more to changes in aggregate growth than older and larger firms. The results are economically significant. For employment, a 1pp increase in aggregate growth is associated with a 4.22pp increase in growth at firms aged 0-3, and only a 2.97pp increase at firms aged 20 years and older. Thus, by this measure the youngest firms are 42% more cyclical than the oldest over this period. Doing the same for firm size we find that the smallest firms are 21% more cyclical than the largest. These results demonstrate the

crucial importance of studying firm heterogeneity when analysing the business cycle.

However, while we find that firm size is important when analysed alone, we find that it is not an independent predictor of cyclicality when analysed jointly with firm age. Repeating our regressions with both size and age together, we find that size is no longer a significant predictor of firm cyclicality, while firm age remains strongly statistically significant, and the economic magnitudes remain large. Thus, in line with the findings of Fort et al. (2013), we find age to be the underlying driver of excess cyclicality of employment and turnover, while small firms are only more cyclical to the extent that they happen to be younger on average. We investigate these results further in a full "double interactions" specification, and find that excess sensitivity is concentrated within *young, small* firms. The effects for firms aged 0-3 and in the bottom 30% of the asset distribution are particularly large: for every 1pp increase in aggregate growth, their employment and turnover growth increases by any extra 8.83pp and 12.35pp relative to baseline.

The concentration of excess sensitivity amongst young, small firms is particularly interesting, because it suggestive of a role for financial frictions. As shown by Haltiwanger et al. (2013), small firms can be divided into small young firms, and small old firms, both with very different behaviours. Small and old firms can be thought of as businesses who have a small scale of operation, and have reached this size and are not drastically growing or creating jobs. Small and young firms, on the other hand, include firms who are growing very fast, having just recently started, and are creating many jobs on the path to potentially becoming much larger firms in the future. It is this second group of young and small firms who are particularly likely to be affected by financial frictions. Raising finance may be hard for any small firm, because accessing bond or equity markets is typically something that only larger firms can do. However, only small and young firms are likely to be up against their borrowing constraints, since they are in the process of growing, and hence this difficulty in accessing finance will have a material impact on their real outcomes such as hiring or turnover. Small and old firms may find it hard to access finance, but this will be less of a concern for them since they are not trying to grow, and so may have had time to accumulate financial buffers in order to protect themselves from financial shocks.

In our second contribution, we confirm the importance of financial frictions through two sets of results, which support the intuitions given above. Firstly, we rank firms by measures of what we call their "financial intensity", meaning the extent to which they are engaging with financial markets. Financial intensity is defined as the quartile, relative to their age group, of a firm's *level* of debt over assets. High values of either, relative to their age group, suggest that firms are using more debt and hence engaging more with financial markets. We find that the excess cyclicality of young firms' employment and investment is concentrated in more financially active firms. In particular, young firms in the bottom quartile of financial intensity display almost no excess sensitivity relative to older firms, and their excess sensitivity is smoothly increasing in financial intensity. Similar results hold for investment, and when measuring financial intensity using cash over assets.

Secondly, having confirmed that it is only plausibly financially-constrained young firms who display excess cyclicality over the business cycle, we proceed to directly investigate the cyclicality of financial variables across the firm age and size distribution. We look at three financial measures: firm's cash on hand, their long-term debt, and their overall liabilities (which includes both long- and short-term debt). For all three measures, we document that these financial variables are more volatile at younger firms. The fact that both financial variables and real outcomes, such as employment and turnover, are more cyclical at younger firms is consistent with a financial accelerator story, a la Kiyotaki and Moore (1997). In this theory, negative aggregate shocks reduce profitability, leading to the withdrawal

of debt financing at financially constrained (young) firms, which leads them to scale back hiring and production.

Of course, the result is only a correlation, and so does not demonstrate a causal relationship from debt to real outcomes, such as employment or turnover. Indeed, further investigation of the relationship between the cyclicality of financial variables and firm age and size reveals an interesting pattern. Unlike with employment and turnover, we find that our financial variables are still more cyclical at small firms, even when controlling for firm age. This disconnect between finance and real outcome variables at small firms presents a counterpoint to pure financial accelerator models, and it is towards this disconnect that we turn our attention in our last results.

In our third and final contribution, we finally investigate the cyclicality of financial variables in a "double interaction" regression by both firm age and size. We find that all small firms, including both young and old, have debt which is very cyclical. While the effect is stronger at small and young firms, small old firms still have debt which is many times more cyclical than large old firms. This contrasts with employment and turnover, where we found that small old firms did not have any excess cyclicality. Thus, the differences in the results for real variables and financial variables are all driven by the behaviour of small old firms.

A standard financial accelerator model cannot explain the behaviour of small old firms. If their employment and turnover are not highly cyclical, why would banks be withdrawing debt financing from these firms so sharply during recessions? After all, our results show that these firms have enough financial capacity – be it from retained earnings or the ability to inject equity – to absorb the withdrawal in financing without it negatively affecting their production. Instead, these results point to the importance of a direct *financial shock* in driving the cycle during this period. This shock directly impacts the availability of financing towards firms, and the fact that debt cyclicality is concentrated amongst small firms suggests that the shock originates in the banking sector, since older firms are able to shield their overall debt levels by substituting towards bonds and other non-bank debt. Our previous results show that older small firms are able to weather this "financial cycle" without it affecting their employment or turnover, while younger small firms are not. Thus, our results suggest both that financial frictions are important for driving the excess cyclicality of employment and turnover at young firms over the cycle, and that the cycle itself contains procyclical financial shocks, which affect all bank dependent firms who cannot find alternative sources of financing.

Related Literature. Our paper fits into the broad literature investigating the importance of firm size and firm age in determining firm cyclicality over the business cycle. An early contribution is Gertler and Gilchrest (1994), who investigate the cyclicality of small versus large firms and find that small firms are more sensitive to periods of credit market tightening than large firms. Khan and Thomas (2013) show that small firms contracted more than large firms during the financial crisis.

On the other hand, Moscarini and Postel-Vinay (2012) find that large firms are more cyclical, when aggregate conditions are measured using the (HP-filtered) level of the unemployment rate. Similarly, Mian and Sufi (2014) show that larger establishments contracted more in areas with larger declines in house prices. Fort et al. (2013) discuss the conflicting results by firm size, and add age to this analysis. They find that young firms are more cyclical than old firms, and that this difference is much more important than the differential between small and large firms. While they do not have direct financial data at the firm level, they use state-level house price data to argue that financial frictions may drive this result.

This paper is most related to papers which investigate differences in cyclicality across firms using

direct financial data at the firm level, paying particular attention to financial frictions. Sharpe (1994) uses Compustat data to document that high leverage firms are more cyclical than low leverage firms. Giroud and Mueller (2017) combine Compustat data with establishment-level employment data to show that the decline in house prices during the Great Recession, as investigated by Mian and Sufi (2014), was transmitted to declines in employment through high leverage firms. Conversely, Ottonello and Winberry (2018) use Compustat data find that firms with low default risk, including those with low debt burdens, are the most responsive to monetary shocks. Relative to their paper, our sample includes non-listed firms, and thus younger firms who may behave differently to financial frictions than older, listed firms. Jeenas (2019) investigates the role of liquidity and leverage in driving heterogeneous investment dynamics, and finds that leverage ceases to be important once liquidity is controlled for.

Within this literature are papers which directly investigate the interaction between financial constraints and firm size or age. Chodorow-Reich (2014) matches firms to banks and finds that firms borrowing from financially distressed banks contracted more during the Great Recession, and that this effect is largest at smaller firms. Mehrotra and Crouzet (2017) utilise new confidential US Census data to investigate cyclicality by firm size. They find that only the 1% of largest firms by balance sheet are more cyclical, and that cyclicality appears to be largely unrelated to measures of financial frictions. Relative to their paper, we are also able to focus on firm age and have data on employment. We find that financial variables appear to be important when investigating the age dimension.

Cloyne et al. (2018) use data for the US and UK to show that younger, non-dividend paying firms exhibit the largest and most significant changes in investment following monetary policy shocks. Due to data availability, they measure age as time since incorporation, rather than foundation, whereas we are able to measure age since foundation, and focus on overall cyclicality rather than the response to identified monetary policy shocks. Dinlersoz et al. (2018) merge balance sheet data from Compustat and Orbis into the US Longitudinal Business Database (LBD). Similarly to our analysis, they are able to analyse both private and public firms and can measure firms employment and age since foundation. Since their balance sheet data are not from registry sources, they do not have complete coverage and under-represent low revenue firms in their sample. They argue that small private firms are plausibly financially constrained both before and after the financial crisis, while larger private firms may have only become constrained during the crisis, and large public firms appear to never be financially constrained.

Early contributions developing the theory of financial frictions include Bernanke and Gertler (1989), Kiyotaki and Moore (1997), and Bernanke et al. (1999). More recently, Jermann and Quadrini (2012) develop a theory of financial shocks over the business cycle, and Khan and Thomas (2013) build a heterogeneous firm model with financial shocks. Finally, we connect to a literature investigating the cyclicality of firm financing. Using aggregate data, Jermann and Quadrini (2012) investigate the cyclicality debt and equity issuance. Covas and Haan (2011) show that the cyclicality of financing is different across firms of different sizes, with the procyclicality of equity issuance decreasing monotonically with firm size. Crouzet (2017) studies the choice of bank and bond financing in a calibrated heterogeneous firm model calibrated using the US' Quarterly Financial Report.

Poeschl (2018) studies the business cycle dynamics of maturity structure, and finds that the aggregate share of long-term debt in total debt is pro-cyclical, and moreso for small firms. Nikolov et al. (2018) use firm-level data to identify the sources of financial constraints for different groups of firms, and find results which favour trade-off models for larger Compustat firms, limited commitment models for smaller firms, and moral hazard models for private firms.

The rest of this paper is organised as follows. In Section 2 we discuss the data and construction of our key variables. In Section 3 we discuss the cyclicality of firms by age and size. Finally, in Section 4

we discuss the role of finance in driving the excess cyclicality of young firms, and separately investigate the cyclicality of financial variables.

2 Data

In this section, we briefly describe the firm-level micro data that we use in our empirical analysis. We begin by discussing the datasets we use, and then the construction of our key variables of interest.

2.1 Datasets: FIRE and FIRM

Our data sources are confidential administrative datasets, covering the universe of Danish companies. The data is provided by Statistics Denmark (DST). In order to analyse firm outcomes and financial balance sheet data together, we merge two datasets ("data registers"): the FIRE dataset ("Regnskabsstatistikken"), which broadly contains data on accounting variables, is merged with the FIRM dataset ("Firmastatistik"), containing data regarding "economic, employment and accounting information at company level. Both datasets are yearly.

It is worth noting that the quality of this data is generally believed very high, as Statistics Denmark is a government agency, and most of the variables we use is originally collected by SKAT,[1] the tax authority. Additionally, DST also runs independent checks on the datasets. Individual firms are identified by unique number that is generated at the time of registration, regardless if the given firm is actually active or not. The merging of the datasets is done using this identifier, and thus provides exact matches.

Subject to some minimal threshold on economic activity,[2] all firms are legally obliged to report data to SKAT or DST, which are then collected in these databased. We drop all observations that we deem as inactive by our definition, that is firms that provide no information about employment, sales, value added, or profits. For firms that are inactive at the beginning or at the end of their life-cycle, we drop the corresponding observations and adjust entry/exit date. We also drop all firms that never in their life employ more than 2 workers.[3] Finally, we also drop firms from sectors that with lots of publicly administered companies (public administration, defense, education, health care, theaters, concert halls, libraries), as well as firms that are listed as "extra-territorial bodies" and "households as employers".

Our final dataset is a panel of roughly 1.25M firm-year observations and covers the time periods 2001-2016, with approximately 90,000 firms per year. After data cleaning, our final dataset has near universal coverage of all firms in the Danish economy over this period. Crucially, our dataset therefore contains firms which are both publicly listed on the stock exchange and privately owned, and which span the entire distribution of firm age and size. Combined with the fact that we have financial data for all firms, this makes our dataset uniquely suited to studying the role of financial frictions across the whole firm life cycle, especially at younger firms.

Finally, for our cyclicality analysis we will compare firm-level growth rates to an indicator of aggregate economic conditions. As our aggregate indicator, we follow Mehrotra and Crouzet (2017) (CM hereafter) and use the growth rate of real GDP. Aggregate GDP data are publicly available and collected from DST National accounts.

[1] Sales, assets, liabilities, investment and information about employment based on payroll.

[2] In most situation, firms that report employment that corresponds to less than 0.5 full time worker are considered inactive by DST, but still present in our data.

[3] We do this to eliminate sole proprietorship firms and also firms that exist due to tax optimisation purposes.

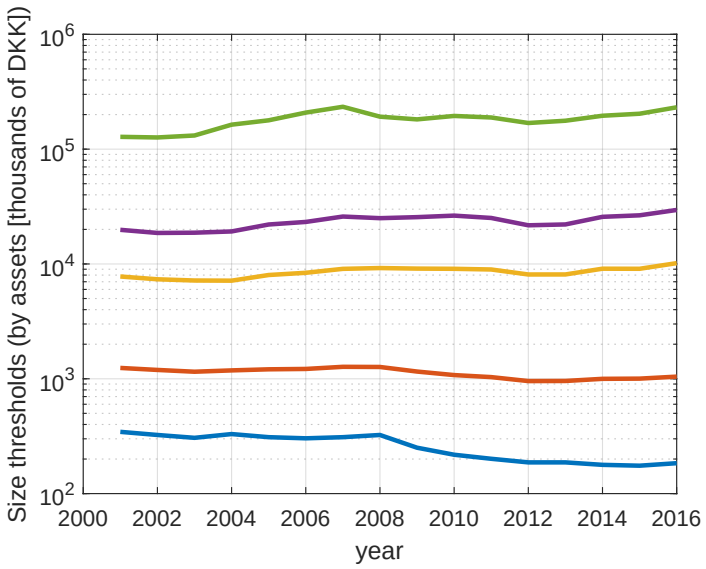
2.2 Key variables

Since or focus is on firm cyclicality and financial frictions, we will mostly use firm production and balance sheet variables from our merged dataset. On the production side, we use data on turnover, employment, and investment. On the financial side, we use data on total assets, total liabilities, holdings of cash or cash equivalents, and the stock of long term debt. We also use data on a firm's sector of operation.

To measure firm size, we follow Mehrotra and Crouzet (2017), and measure firm size by the value of its assets. The firm size measure is thus not static within a firm, and varies as the firm grows. For our empirical work, we put firms into bins based on certain quantile thresholds of size across the population of firms active that year. We introduce six size bins: 0-30th, 30-60th, 60-90th, 90-95th, 95-99th, and 99+. In Figure 1 we plot the asset thresholds defining these size bins, and how they evolve over time. As can be seen, these thresholds are relatively stable over time. There is a mild widening of the distribution over time, especially at the lower end where the 30th percentile of the asset distribution has fallen since the financial crisis.

For firm age, we are able to measure age since the time the firm is registered. This is measured as the first time the firm's unique identifier appears in our database. This is thus the true age since foundation of the firm, which distinguishes us from other datasets which can only measure age since, for example, the firm was publicly listed on stock markets. As with our size measure, in our empirical work we do not work with age directly, but put firms into age bins. We use four age bins: 0-3, 4-8, 9-19, and 20+ years old.

Figure 1: Assets thresholds for size bins over time



Asset thresholds defining firm size bins over time. In ascending order, the lines define the lower boundaries of the 30-60th percentile (blue), 60-90th percentile (red), 90-95th percentile (yellow), 95-99th percentile (purple), and 99+ percentile (green) bins. See text for further details on data construction.

3 Excess cyclicality by firm age and size

In this section we investigate the cyclical sensitivity of firms by size and age. We do so without any reference to financial frictions, or other underlying causes of the differing levels of cyclicality. Thus, the results in this section are meant to be interpreted as theory free, and provide us with our basic stylised facts about firm cyclicality in the Danish economy. Following Mehrotra and Crouzet (2017) "cyclical sensitivity" refers to the extent that a worsening in aggregate conditions is systematically associated with declines in outcomes at firms of various groups. We will informally use "excess sensitivity" to refer to a group of firms having particularly higher cyclical sensitivity relative to a baseline comparison group.

3.1 Estimation framework

In this section we briefly describe the estimation and measurement approach that we use throughout most of our main exercises in this paper. We measure firm-level outcomes using the normalised growth rates suggested by Haltiwanger et al. (2013). Let i index firms and t index years. For any firm-level variable $x_{i,t}$, we measure growth from $t-1$ to t as

$$\hat{g}_{x_{i,t}} \equiv \frac{x_{i,t} - x_{i,t-1}}{\frac{1}{2}(x_{i,t} + x_{i,t-1})}. \tag{1}$$

As discussed by Haltiwanger et al. (2013), this growth rate, which uses the average of the current and past value as the denominator, rather than just the past value, is more robust and typically has better properties in firm-level data. For our cyclical measure, we use the standard growth rate of aggregate GDP, which we denote as $y_t \equiv \frac{GDP_t - GDP_{t-1}}{GDP_{t-1}}$.

In our baseline exercises, we run all regressions as unbalanced panels in order to maximise coverage across our near-universal sample of firms. We thus do not separately investigate the role of firm entry or exit in driving cyclicality. Additionally, we do not include time-t firm-year observations of firms who exit in between $t-1$ and t in our regressions. The adjusted growth rates are defined for these firms, and have a value $\hat{g}_{x_{i,t}} = -2$, but we exclude them in order to focus on the cyclicality of surviving firms.

To analyse firm-level cyclicality, we regress firm level growth rates, $\hat{g}_{x_{i,t}}$, on aggregate growth, y_t, using dummy variables to separately estimate the cyclicality of different groups of firms. We include industry-level controls to strip out the potentially differing average cyclicality of different industries. Thus, the effects when comparing coefficients from different, for example, age groups should be interpreted as within-industry effects.

3.2 The cyclical sensitivity of firms: size versus age

We first investigate the relationship between firm age, firm size, and cyclicality over the business cycle. In this section we are interested in real production variables, and run the following regression for both turnover and employment:

$$\hat{g}_{x_{i,t}} = \sum_j (\alpha_j + \beta_j y_t) \mathbb{1}_{i \in I_t^j} + \sum_k (\psi_k + \phi_k y_t) \mathbb{1}_{i \in A(k)} + \sum_l (\gamma_l + \delta_l y_t) \mathbb{1}_{i \in S(l)} \tag{2}$$

This specification is an extension of CM's regression (their equation (1)) to include firm age categories. Here $\hat{g}_{x_{i,t}}$ denotes the firm-level normalised growth-rate of either turnover or employment at firm i. The equation is essentially a regression of firm-level growth rates on a constant term and the aggregate

growth rates, with interaction terms allowing for group-specific means and loadings on the aggregate growth rate. The indices j, k, and l index firm size bins, firm age bins, and firm sectors respectively. $\mathbb{1}_{i \in I_t^j}$ is an indicator variable for firm i being in size group j at time t, and similarly for age and sector.

Discussing the variables in turn, the index j denotes the size bin of firm i at time t. For each size bin, α_j captures the marginal effect on the average growth rate of firms of being in that size bin. We are more interested in the β_j parameters, which capture how the firm-level growth rates, $\hat{g}_{x_{i,t}}$, are differently related to the aggregate growth rate, $y_{i,t}$. The interpretation of β_j is that a 1pp increase in aggregate growth is on average associated with a "β_j"pp increase in firm-level growth for firms in size group j, on top of any additional effects captured by age or sector. Thus, the β_j capture the cyclicalities of each firm size group. Similarly, the ϕ_k and δ_l variables measure the cyclicalities of the different age groups and sectors.

We are primarily interested in the effect of firm age and size on cyclicality, and so will not display the sectoral coefficients, which we treat as control variables. We present our results from regression specification (2) in Table 1. We additionally report results from two simpler specifications of the model, where we first exclude the firm age dummies, and second the firm size dummies. The specification with firm size dummies only (columns 1 and 4) thus corresponds exactly to the specification in CM.

Column 1 gives the cyclicality coefficients for firm-level turnover, when we only consider differences in firm size. The results show that smaller firms are typically more cyclically sensitive than larger firms. The reference group in this regression is the smallest firms, who are in the 0-30th percentile size bin. For these firms, a 1pp increase in aggregate GDP growth is associated with a 4.44pp increase in the normalised growth rate of their turnover. For all larger size bins up to the 99th percentile, larger firms are significantly less cyclical than this smallest group. Firms in the 90-95th percentile have cyclicality $4.44 - 0.47 = 3.97$pp, which is 10.6% lower than the smallest firms.

Cyclicality is monotonically decreasing in size up to the 95th percentile. Interestingly, we find that the very largest firms (above the 95th percentile) are slightly less cyclical than the firms in the 90-95th percentile, and we cannot find a significant difference in the very largest group. This differs from the results in CM, who only find that the very largest firms are less cyclical: we also find differences in cyclicality across groups of smaller firms. The results are similar but slightly stronger for employment in column (4), because here we also find significant differences even amongst the largest firms. The smallest firms have cyclicality of 4.04pp, and the largest of $4.04 - 0.70 = 3.34$pp, which is 17.3% lower.

Moving on to firm age, we find stronger effects on the cyclicality of both turnover (column 2) and employment (column 5) when we span the age distribution than when we span the size distribution. Cyclicality is always monotonically decreasing in age. The youngest firms, aged 0-3, are the most cyclical, with turnover and employment reacting 5.21pp and 4.22pp respectively to a 1pp change in aggregate GDP. Moving to the oldest firms, aged 20+, reduces cyclicality by $1.73/5.21 = 33.2\%$ for turnover and $1.25/4.22 = 29.6\%$ for employment. Interestingly, the largest declines in cyclicality occurs at a very young age: the 0-3 age group is already much more cyclical than the 4-8 age group, and the declines in cyclicality past this point are at a slower rate. Thus, it seems that excess cyclicality is a phenomenon particularly concentrated amongst very young firms.

Finally, in columns 3 and 6 we run our full specification including both age and size dummies. For both employment and turnover the effects of firm size are now starkly reduced: their coefficients are drastically reduced and all but one (30-60th size bin for employment) cease to be statistically significant. The size coefficients are now all at least halved, and in many cases shrunk by much more. In contrast, the age coefficients continue to be highly statistically significant, and while shrunk slightly, are still of the same approximate magnitudes as their original values.

Table 1: Cyclicality of turnover and employment by firm size and age

	(1) g2_turn	(2) g2_turn	(3) g2_turn	(4) g2_emp	(5) g2_emp	(6) g2_emp
g_gdp	4.44***	5.21***	5.26***	4.04***	4.22***	4.47***
	(10.65)	(12.24)	(12.48)	(6.55)	(6.47)	(7.16)
30-60 × g_gdp	−0.31***		−0.08	−0.39***		−0.19*
	(−4.87)		(−1.33)	(−3.69)		(−1.79)
60-90 × g_gdp	−0.37***		−0.07	−0.32***		−0.07
	(−5.89)		(−1.14)	(−3.28)		(−0.68)
90-95 × g_gdp	−0.47***		−0.10	−0.33**		−0.01
	(−4.25)		(−0.89)	(−2.24)		(−0.09)
95-99 × g_gdp	−0.31**		0.08	−0.56***		−0.21
	(−2.44)		(0.61)	(−3.42)		(−1.28)
99+ × g_gdp	−0.33		0.01	−0.70***		−0.41
	(−1.24)		(0.04)	(−2.67)		(−1.55)
4-8 × g_gdp		−1.29***	−1.06***		−0.61***	−0.50***
		(−15.86)	(−13.45)		(−5.04)	(−4.14)
9-19 × g_gdp		−1.49***	−1.26***		−0.98***	−0.82***
		(−18.48)	(−16.19)		(−8.18)	(−6.93)
20+ × g_gdp		−1.73***	−1.49***		−1.25***	−1.05***
		(−21.66)	(−19.04)		(−10.65)	(−8.96)
Observations	1247144	1264405	1247144	1157759	1173736	1157759
Adjusted R^2	0.026	0.045	0.055	0.013	0.017	0.022
Sectors	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*
SE clustering	*firm*	*firm*	*firm*	*firm*	*firm*	*firm*

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Regressions in columns 3 and 6 correspond to regression specification in equation (2) for turnover and employment respectively. "g2_turn" refers to the normalised growth rate of turnover, and "g2_emp" to the normalised growth rate of employment. In all cases, the coefficient in the first column gives the cyclicality of there reference group, and the remaining columns give the interaction effect of moving to a given group. In the three specifications, the reference group is the smallest, youngest, and smallest and youngest firms respectively.

In the appendix we discuss results for the same exercise repeated for firm-level investment. It is well known that investment is lumpy, and many firms frequently report zero investment in a given year. Due to the high frequency of zeros, this makes it impossible to repeat the results for growth rates of investment, which would too often require division by zero. In the appendix we instead discuss results for changes in investment, where we also find a negative relationship between firm age and the cyclicality of investment.

Overall, these results tell us that if we have to focus on *either* size or age, age is the more relevant margin determining firm cyclicality. The two are highly correlated, which is why size appears as a significant predictor of cyclicality when analysed alone. However, by regressing the variables together we learn that variations in firm size have relatively little independent predictive power for cyclicality above their correlation with firm age. In the next section we finesse these results further using double-interaction regressions, and show that firm size does have some role in determining cyclicality, but only *within* the group of relatively young firms.

3.3 Double interaction regressions: the joint role of size and age

In the last section we considered how firm cyclicality varies by age and size separately. However, this precludes any non-linear relationships between age and size which might be important. For example, specification (2) imposes that the effect on cyclicality of increasing firm size is the same for both young and small firms. However, it could be that differences in size affect cyclicality differently for different groups, and that these relationships are hidden in the linear specification above.

To investigate potential nonlinearities, we run a regression with a full set of interactions between firm age and size:

$$\hat{g}_{x_{i,t}} = \sum_j \sum_k (\alpha_{j,k} + \beta_{j,k} y_t) \mathbb{1}_{i \in I_t^j} \mathbb{1}_{i \in A(k)} + \sum_l (\gamma_l + \delta_l y_t) \mathbb{1}_{i \in S(l)} \tag{3}$$

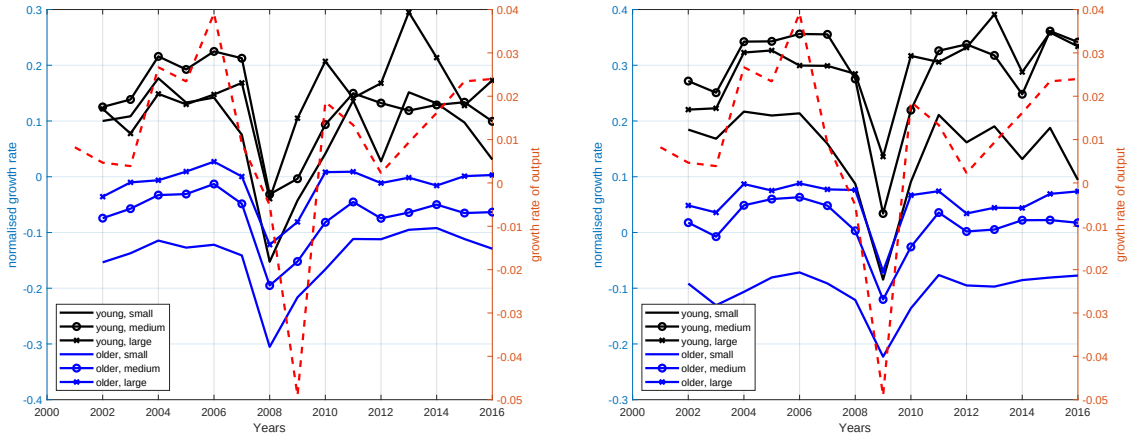
Differently from specification (2), we now have a separate cyclicality coefficient, $\beta_{j,k}$, for every age-size pair. The results are given in Table 2. The results are revealing, and show a distinct non-linearity in the age-size relationship. In particular, for smaller firms, those in the 0-30th size percentile, the difference in cyclicality between young-small firms and old-small firms is dramatic. The difference in cyclicality between young and old firms remains, but is increasingly less dramatic, within groups of larger firms.

The results show three general patterns. Broadly speaking: 1) for all size groups, firms become less cyclical as they age. 2) all old firms are not very cyclical, regardless of their size. 3) among young firms, small firms are the most cyclical and cyclicality declines with size. These results explain why size was found to be a less important predictor of cyclicality than age, since size is only an independent predictor of cyclicality amongst a subset of younger firms.

The results particularly show that the excess cyclicality of young firms is actually concentrated within the group of young-small firms: firms aged 0-3 in the 0-30th size percentile have huge cyclicalities of 12.35pp and 8.83pp per 1pp change in aggregate growth for turnover and employment respectively. This is around three times larger than the cyclicalities of firms of the same age in the 30-60th percentile size category.

We confirm these results visually using simple plots of the (unweighted) average growth rates of firm age-size groupings over time. These are given in Figure 2, with employment in the left panel and turnover in the right. The growth rate of aggregate GDP is given in dashed red, which defines the overall economic cycle. Comparing the lines for "older, small" firms and "young, small" firms reveals

Figure 2: Sales and employment growth by firm size and age



(a) Employment (b) Turnover

Panels plot the unweighted average growth rates for various firm groups over time. Young firms are below 5 years old, and the size groups refer to firms in the 0-30th, 30-90th, and 90+ percentile bins respectively. The dashed red line plots the growth rate of aggregate GDP.

the dramatic difference between the two. On the other hand, large firms are less cyclical, and the difference between the cyclicality of "young, large" and "older, large" firms is smaller.

Overall, the results of these exercises tell us two things. Firstly, of age and size, age is the most important driver of firm cyclicality, with the youngest firms being around 30% more cyclical than the oldest firms. Secondly, size does play a limited role, since within the group of young firms, it is the smallest who are the most cyclical.

Table 2: Cyclicality of turnover and employment by joint size-age bins

	(1) g2_turn	(2) g2_emp
0-30 × 0-3	12.35***	8.83***
× g_gdp	(36.59)	(26.93)
0-30 × 4-8	2.56***	0.81***
× g_gdp	(8.14)	(2.84)
0-30 × 9-19	1.55***	−0.62**
× g_gdp	(4.92)	(−2.15)
0-30 × 20+	0.89***	−1.82***
× g_gdp	(2.80)	(−6.09)
30-60 × 0-3	4.38***	1.66***
× g_gdp	(13.65)	(5.62)
30-60 × 4-8	0.72**	−0.55*
× g_gdp	(2.30)	(−1.94)
30-60 × 9-19	0.16	−0.76***
× g_gdp	(0.52)	(−2.71)
30-60 × 20+	−0.59*	−2.01***
× g_gdp	(−1.86)	(−7.08)
60-90 × 0-3	1.79***	−0.16
× g_gdp	(5.46)	(−0.52)
60-90 × 4-8	0.28	−0.88***
× g_gdp	(0.89)	(−3.14)
60-90 × 9-19	0.00	−1.01***
× g_gdp	(0.01)	(−3.68)
60-90 × 20+	−0.23	−1.31***
× g_gdp	(−0.72)	(−4.80)
90-95 × 0-3	1.71***	0.45
× g_gdp	(3.41)	(0.81)
90-95 × 4-8	0.66*	0.04
× g_gdp	(1.77)	(0.11)
90-95 × 9-19	0.68**	0.04
× g_gdp	(2.00)	(0.11)
90-95 × 20+	0.20	−0.36
× g_gdp	(0.60)	(−1.23)
95-99 × 0-3	1.05*	0.96
× g_gdp	(1.79)	(1.50)
95-99 × 4-8	0.17	−0.08
× g_gdp	(0.42)	(−0.19)
95-99 × 9-19	−0.04	0.30
× g_gdp	(−0.12)	(0.87)
95-99 × 20+	0.10	0.05
× g_gdp	(0.29)	(0.16)
99+ × 0-3	0.18	0.18
× g_gdp	(0.17)	(0.15)
99+ × 4-8	−1.42**	0.10
× g_gdp	(−2.33)	(0.17)
99+ × 9-19	−0.20	−0.31
× g_gdp	(−0.38)	(−0.63)
Observations	1247144	1157759
Adjusted R^2	0.026	0.015
Sectors	*yes*	*yes*
SE clustering	*firm*	*firm*

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Results correspond to regression specification in equation (3) for turnover and employment respectively. "g2_turn" refers to the normalised growth rate of turnover, and "g2_emp" to the normalised growth rate of employment. The reference group is the group of "largest and oldest" firms.

4 The role of financial frictions

In this section we examine the role of financial frictions in determining firm cyclicality. We start by investigating how the cyclicality of turnover and employment are affected when controlling for financial variables, and then study the cyclicality of financial variables themselves.

4.1 How do financial variables affect cyclicality of growth rate of sales and employment?

In this section we investigate whether the excess cyclicality of young firms can be plausibly linked to financial frictions. To do this, we split firms by measures of finance and see if this explains part of the cyclicality previously attributed to firm age. To avoid over-complicating the analysis, and since we found age to be the more important independent predictor of cyclicality, in this section we abstract from firm size differences.

Our goal is to assess whether firms, particularly young firms, who are plausibly more reliant on finance have higher cyclicality. To this, we construct two time-varying measures of what we call a firm's "financial intensity". The first is the ratio of the firm's long run debt to its assets. This is a measure of firm leverage, but concentrated on long-term debt. Firms with higher leverage are clearly more financially active, and also may be closer to their borrowing constraints. The second measure is the ratio of a firm's cash holdings to its assets. Holding cash within a firm is costly, and so holding more cash relative to your assets is a sign that firms are financially active, and possibly looking to make large investments.

For both measures, we assign firms a financial intensity rank of 1, 2 or 3, with 1 being the least financially intensive and 3 the highest. These rankings are produced as the three quartiles of the financial measure within each age group and sector. For example, this means that a firm with financial intensity 3 for debt to assets is in the top 33% of firms ranked by debt to assets in its age group and sector.

With our financial measures in hand, we perform double-interaction regressions of the following form:

$$\hat{g}_{x_{i,t}} = \sum_f \sum_k (\alpha_{f,k} + \beta_{f,k} y_t) \mathbb{1}_{f \in I_t^f} \mathbb{1}_{i \in A(k)} + \sum_l (\gamma_l + \delta_l y_t) \mathbb{1}_{i \in S(l)} \tag{4}$$

Here, I_t^f groups firms according to the chosen financial variable (either debt-to-assets or cash-to-assets) at time t. The coefficients $\beta_{f,k}$ measure the cyclicality of firms of financial intensity f and in age bin k. Accordingly, we allow the impact of finance to vary within age groups. As before, we include sector controls.

The results are given in Table 3, where we run the regressions for firm-level turnover, employment, and investment, and using both measures of financial intensity. The reference group are the oldest firms (20+ years) with the highest financial intensity. The results vary slightly across specifications, but broadly agree that the excess cyclicality of young firms is concentrated amongst the most financially intensive firms. Additionally, the results show much smaller impacts of financial intensity on older firms.

To see this, focus first on column 5, which splits the cyclicality of employment by age and financial intensity. By combining coefficients, it can be seen that the cyclicality of the youngest (age 0-3), most financially intensive (group 3) firms is $3.70 + 1.92 - 0.34 = 5.28$pp. By contrast, the cyclicality of the youngest (age 0-3) but *least* financially intensive (group 1) firms is $3.70 + 1.92 - 0.42 - 1.32 = 3.88$pp. Thus, the most financially intensive young firms are $5.28 - 3.88 = 1.40$pp more cyclical than the least

financially intensive. This is approximately equal to the entire difference in cyclicality of 1.25pp between the youngest (age 0-3) and oldest (age 20+) firms given in the baseline age results in column 5 of Table 1.

In summary, these results support the view that the excess cyclicality of young firms is largely driven by financial frictions. It is only the more financially intensive young firms, who have higher debt to asset ratios, who are the most cyclical. Finance appears to play an important role among young firms, while our measure of financial intensity is less important amongst older firms. This accords well with the view that it is only young firms, who are growing and in need of finance, who are impacted by financial frictions.

Table 3: Cyclicality of turnover, employment and investment by firm age and financial intensity

	(1) g2_turn	(2) g2_emp	(3) g2_inv	(4) g2_turn	(5) g2_emp	(6) g2_inv
g_gdp	3.58***	3.44***	−0.24	3.77***	3.70***	0.19
	(8.39)	(5.46)	(−0.29)	(8.84)	(5.86)	(0.23)
0-3 × g_gdp	1.68***	1.59***	3.87***	1.64***	1.92***	3.73***
	(10.72)	(7.39)	(8.52)	(10.44)	(8.29)	(8.23)
4-8 × g_gdp	0.47***	0.61***	1.26***	0.45***	0.91***	−0.08
	(4.26)	(3.86)	(3.06)	(4.12)	(5.30)	(−0.20)
9-19 × g_gdp	0.17	0.15	0.61	0.17	0.34**	−0.15
	(1.58)	(0.94)	(1.44)	(1.61)	(2.01)	(−0.35)
fin=1 × g_gdp	−0.00	0.12	0.83**	−0.30***	−0.42***	−0.16
	(−0.04)	(0.78)	(2.09)	(−2.86)	(−2.67)	(−0.39)
fin=2 × g_gdp	0.01	0.25	1.57***	−0.00	−0.03	1.20***
	(0.12)	(1.51)	(4.13)	(−0.04)	(−0.18)	(3.10)
fin=3 × g_gdp	0.20*	0.08	1.45***	−0.21*	−0.10	0.71*
	(1.73)	(0.47)	(3.76)	(−1.84)	(−0.56)	(1.85)
0-3 × fin=1	−0.41*	−0.92***	−2.54***	0.04	−1.32***	−1.49**
× g_gdp	(−1.88)	(−2.96)	(−4.19)	(0.20)	(−4.18)	(−2.47)
0-3 × fin=2	0.39*	−0.51	−0.60	−0.14	−1.40***	−1.04*
× g_gdp	(1.68)	(−1.57)	(−1.04)	(−0.60)	(−4.09)	(−1.77)
0-3 × fin=3	0.03	−0.40	−0.35	0.32	−0.34	−0.12
× g_gdp	(0.11)	(−1.20)	(−0.61)	(1.38)	(−1.02)	(−0.20)
4-8 × fin=1	0.18	−0.03	−0.58	0.35**	−0.50**	2.23***
× g_gdp	(1.18)	(−0.12)	(−1.05)	(2.24)	(−2.09)	(3.96)
4-8 × fin=2	−0.07	−0.20	−0.32	−0.37**	−0.82***	0.86
× g_gdp	(−0.41)	(−0.78)	(−0.60)	(−2.16)	(−3.09)	(1.57)
4-8 × fin=3	−0.28*	−0.05	−1.22**	−0.11	−0.35	0.06
× g_gdp	(−1.68)	(−0.21)	(−2.24)	(−0.69)	(−1.34)	(0.12)
9-19 × fin=1	0.19	0.16	−0.49	0.40***	−0.17	1.27**
× g_gdp	(1.24)	(0.72)	(−0.88)	(2.63)	(−0.74)	(2.22)
9-19 × fin=2	0.20	0.12	−0.57	−0.19	−0.33	−0.06
× g_gdp	(1.21)	(0.49)	(−1.04)	(−1.13)	(−1.31)	(−0.12)
9-19 × fin=3	−0.09	−0.02	−0.64	0.04	−0.05	−0.08
× g_gdp	(−0.57)	(−0.10)	(−1.14)	(0.25)	(−0.21)	(−0.14)
Observations	1193264	1110361	1034782	1193264	1110361	1034782
Adjusted R^2	0.043	0.019	0.025	0.043	0.019	0.020
Sectors	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*
SE clustering	*firm*	*firm*	*firm*	*firm*	*firm*	*firm*
fin variable	*CA*	*CA*	*CA*	*DA*	*DA*	*DA*

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

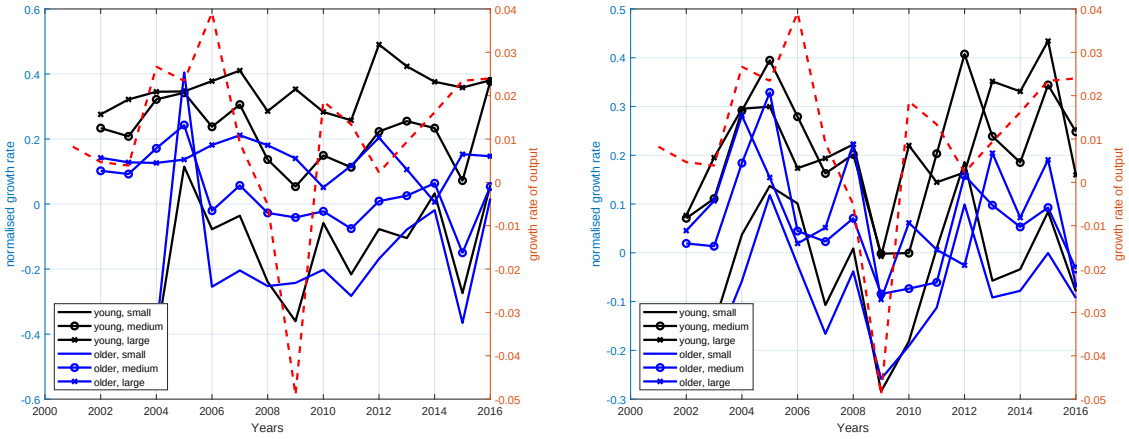
Regressions correspond to regression specification in equation (4) for turnover, employment, and investment respectively. "g2_turn" refers to the normalised growth rate of turnover, and "g2_emp" to the normalised growth rate of employment, and "g2_inv" to the change in investment. In all cases, the coefficient in the first column gives the cyclicality of there reference group, and the remaining columns give the interaction effect of moving to a given group. The reference group is the oldest, most financially intensive firms.

4.2 Cyclicality of financial variables

In the last section we established that only the excess cyclicality of, for example, employment at younger firms was concentrated among the most financially intensive younger firms. While this is compelling evidence by itself, if financial frictions are at the heart of this difference then we would also expect that financial variables themselves are more volatile at younger firms than at older firms. In this section, our final results therefore concern the cyclicality of financial variables themselves.

Rather than conditioning on financial intensity, we now return to our original regression specifications in (2) and (3), but now putting financial variables on the left hand side. We use three financial variables: cash, and long run debt (both of which we previously used) and now also total liabilities. For each variable, the regressions are run using their normalised growth rate.

Figure 3: Long run debt and cash growth by firm size and age



(a) Long run debt

(b) Cash

Panels plot the unweighted average growth rates for various firm groups over time. Young firms are below 5 years old, and the size groups refer to firms in the 0-30th, 30-90th, and 90+ percentile bins respectively. The dashed red line plots the growth rate of aggregate GDP.

In Table 4 we give the results of the regression specification (2), which computes the cyclicalities by age and size separately. The results accord well with the results for employment and turnover. For all measures, smaller firms are more cyclical than larger firms, and younger firms are more cyclical than older firms. The exception is the largest firms (99+ percentile) who appear to be slightly more cyclical than the next largest groups. Looking at the age-only regressions, financial variables are much more cyclical at younger firms. Cash is $1.92/3.96 = 48.4\%$ less volatile at oldest (age 20+) versus the youngest (age 0-3) firms, liabilities are $2.00/2.39 = 83.7\%$ less volatile, and long run debt actually becomes counter-cyclical at firms aged 9 and above.

However, there is an interesting difference between the results for financial variables and the results for turnover and sales given in Table 1. For turnover and sales, once age was controlled for, size was no longer a significant predictor of cyclicality. On the other hand, for financial variables, size is still a significant predictor of sales even after controlling for age. This suggests that finance and real variables are not exactly linked, and casts doubt on simple financial accelerator stories. To analyse this further, we again turn to our double-interaction specification.

In Table 5 we give the results of the specification (3), which allows for age-size dependent coefficients. Comparing the results to the same table for real variables, Table 2, clarifies the discrepancies. For

Table 4: Size versus age effects for cyclicality of financial variables

	(1) g2_cash	(2) g2_cash	(3) g2_cash	(4) g2_debt	(5) g2_debt	(6) g2_debt	(7) g2_liab	(8) g2_liab	(9) g2_liab
g_gdp	3.75***	3.96***	4.72***	2.52***	1.64**	3.36***	2.01***	2.39***	2.90***
	(6.60)	(6.88)	(8.17)	(3.99)	(2.55)	(5.27)	(4.69)	(5.40)	(6.68)
30-60 × g_gdp	−1.10***		−1.04***	−2.23***		−2.18***	−0.88***		−0.77***
	(−9.28)		(−8.82)	(−17.76)		(−17.30)	(−11.41)		(−10.04)
60-90 × g_gdp	−1.63***		−1.45***	−3.34***		−3.15***	−1.44***		−1.22***
	(−13.68)		(−12.02)	(−26.92)		(−25.15)	(−19.42)		(−16.24)
90-95 × g_gdp	−1.59***		−1.30***	−3.82***		−3.51***	−1.37***		−1.05***
	(−6.56)		(−5.35)	(−16.25)		(−14.81)	(−10.66)		(−8.03)
95-99 × g_gdp	−2.09***		−1.78***	−4.06***		−3.72***	−1.32***		−0.97***
	(−7.42)		(−6.27)	(−15.52)		(−14.09)	(−8.64)		(−6.24)
99+ × g_gdp	−1.34**		−1.03*	−2.18***		−1.84***	−1.10***		−0.76**
	(−2.36)		(−1.82)	(−4.32)		(−3.63)	(−3.50)		(−2.39)
4-8 × g_gdp		−1.31***	−1.09***		−1.18***	−0.81***		−1.34***	−0.99***
		(−9.59)	(−8.02)		(−8.29)	(−5.68)		(−14.18)	(−10.69)
9-19 × g_gdp		−1.57***	−1.28***		−1.76***	−1.23***		−1.67***	−1.29***
		(−11.32)	(−9.24)		(−12.27)	(−8.62)		(−17.87)	(−14.10)
20+ × g_gdp		−1.92***	−1.50***		−2.30***	−1.47***		−2.00***	−1.52***
		(−13.76)	(−10.68)		(−16.16)	(−10.29)		(−21.59)	(−16.53)
Observations	1224800	1224800	1224800	1161923	1161923	1161923	1235176	1235176	1235176
Adjusted R^2	0.010	0.005	0.011	0.021	0.003	0.022	0.051	0.015	0.057
Sectors	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*
SE clustering	*firm*	*firm*	*firm*	*firm*	*firm*	*firm*	*firm*	*firm*	*firm*

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Regressions in columns 3, 6, and 9 correspond to regression specification in equation (2) for cash, long run debt, and total liabilities respectively. "g2_cash" refers to the normalised growth rate of cash, "g2_debt" to the normalised growth rate of long run debt, and "g2_liab" to the normalised growth rate of total liabilities. In all cases, the coefficient in the first column gives the cyclicality of there reference group, and the remaining columns give the interaction effect of moving to a given group. In the three specifications, the reference group is the smallest, youngest, and smallest and youngest firms respectively.

turnover and employment, small old firms were essentially no more cyclical than large firms. It was only small young firms who were very cyclical. For financial variables this is not the case: even small old firms have excess cyclicality relative to larger firms.

In particular, it is still the case that small young firms are the most cyclical. Firms ages 0-3 and in the 0-30th size percentile have cash, debt, and liability growths which move an incredible 12.15pp, 16.05pp, and 16.33pp for every 1pp change in aggregate growth. However, small old firms (0-30th size percentile and aged 20+) are still cyclical to the order of 3.82pp, 8.65pp, and 6.15pp. Accordingly, all small firms have financial variables which are substantially more volatile than large firms.

How do we square these different results? Turnover and employment are the most cyclical only at young, small firms, while financial variables are more cyclical at both young small firms and old small firms. Having established in the previous section that financial frictions are a likely cause of excess sensitivity at young firms, it remains to explain why financial variables are so cyclical at old small firms. The results are hard to interpret through the lens of a financial accelerator model: why would lenders withdraw funding from old small firms during the recession when we have seen that their fundamentals – their turnover and employment – do not fall? Instead, these results point to the importance of a direct *financial shock* in driving the cycle during this period. This shock withdraws funding from all small firms during the period, regardless of the financial status. Thus, it affects the financing of both young and old small firms. What is different is that young small firms do not have the financial capacity to absorb this withdrawal of financing and must reduce their production and employment, while older small firms are able to weather the shock. Large firms appears to be insulated from this shock, perhaps because they have alternative sources of funding from equity or bond markets.

These results speak to the importance of developing models of financial frictions incorporating

several features: 1) a financial lifecycle, so that smaller firms are more bank dependent and unable to access certain kinds of funding, 2) a firm growth lifecycle, so that young firms are small, poor, and growing, and less able to withstand financial shocks, and 3) a financial shock which is heterogeneous across funding sources, and affects smaller firms more than large. All of these features are necessary to explain the above patterns, and in future work we aim to test whether a heterogeneous firm model enriched with appropriate financial frictions is able to match these patterns by age and size during the Great Recession.

Table 5: Cyclicality of financial variables by joint size-age bins

	(1) g2_cash	(2) g2_debt	(3) g2_liab
0-30 × 0-3	12.15***	16.05***	16.33***
× g_gdp	(18.74)	(26.95)	(42.11)
0-30 × 4-8	5.43***	10.29***	8.04***
× g_gdp	(8.51)	(17.69)	(21.79)
0-30 × 9-19	4.77***	9.67***	7.34***
× g_gdp	(7.45)	(16.55)	(19.84)
0-30 × 20+	3.82***	8.65***	6.15***
× g_gdp	(5.91)	(14.57)	(16.38)
30-60 × 0-3	3.41***	5.10***	5.27***
× g_gdp	(5.29)	(8.70)	(14.05)
30-60 × 4-8	2.07***	4.15***	3.45***
× g_gdp	(3.24)	(7.15)	(9.39)
30-60 × 9-19	1.57**	3.86***	3.14***
× g_gdp	(2.46)	(6.64)	(8.55)
30-60 × 20+	1.16*	3.57***	3.02***
× g_gdp	(1.80)	(6.11)	(8.21)
60-90 × 0-3	0.26	1.11*	1.39***
× g_gdp	(0.40)	(1.84)	(3.61)
60-90 × 4-8	1.37**	0.62	1.58***
× g_gdp	(2.14)	(1.06)	(4.30)
60-90 × 9-19	1.25**	0.79	1.66***
× g_gdp	(1.97)	(1.38)	(4.56)
60-90 × 20+	1.17*	1.61***	1.86***
× g_gdp	(1.84)	(2.80)	(5.10)
90-95 × 0-3	−0.58	−1.14	−0.43
× g_gdp	(−0.60)	(−1.23)	(−0.71)
90-95 × 4-8	1.47*	−0.39	0.96**
× g_gdp	(1.94)	(−0.55)	(2.18)
90-95 × 9-19	1.61**	−0.37	1.36***
× g_gdp	(2.24)	(−0.56)	(3.35)
90-95 × 20+	1.01	0.49	1.33***
× g_gdp	(1.49)	(0.80)	(3.44)
95-99 × 0-3	−0.31	−3.10***	0.03
× g_gdp	(−0.28)	(−2.96)	(0.04)
95-99 × 4-8	0.01	−1.99***	−0.76
× g_gdp	(0.01)	(−2.62)	(−1.52)
95-99 × 9-19	0.37	−0.28	0.25
× g_gdp	(0.49)	(−0.40)	(0.58)
95-99 × 20+	0.28	−0.91	0.74*
× g_gdp	(0.40)	(−1.47)	(1.90)
99+ × 0-3	−3.01	−1.15	−1.68
× g_gdp	(−1.40)	(−0.55)	(−1.09)
99+ × 4-8	−3.87***	−1.25	−2.21**
× g_gdp	(−2.90)	(−1.01)	(−2.57)
99+ × 9-19	−1.14	−0.36	−0.63
× g_gdp	(−1.06)	(−0.36)	(−0.94)
Observations	1224800	1161923	1235176
Adjusted R^2	0.007	0.010	0.024
Sectors	*yes*	*yes*	*yes*
SE clustering	*firm*	*firm*	*firm*

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Results correspond to regression specification in equation (2) for cash, long run debt, and total liabilities respectively. "g2_cash" refers to the normalised growth rate of cash, "g2_debt" to the normalised growth rate of long run debt, and "g2_liab" to the normalised growth rate of total liabilities. The reference group is the group of "largest and oldest" firms.

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A Additional results

A.1 Investment

Table 6: Cyclicality of investment by size and age. *inv* is gross investment, *inv*2 is net investment.

	(1) g2_inv	(2) g2_inv	(3) g2_inv	(4) g2_inv2	(5) g2_inv2	(6) g2_inv2
g_gdp	1.18	3.17***	3.88***	2.51***	3.21***	4.37***
	(1.62)	(4.24)	(5.25)	(3.32)	(4.16)	(5.69)
30-60 × g_gdp	1.59***		1.24***	0.65***		0.37**
	(8.97)		(6.99)	(3.48)		(1.97)
60-90 × g_gdp	0.63***		0.74***	0.43**		0.45**
	(3.68)		(4.37)	(2.42)		(2.53)
90-95 × g_gdp	0.63**		1.11***	1.39***		1.63***
	(2.26)		(3.95)	(4.70)		(5.48)
95-99 × g_gdp	1.70***		2.24***	3.11***		3.39***
	(5.66)		(7.39)	(9.61)		(10.35)
99+ × g_gdp	0.64		1.15**	2.45***		2.71***
	(1.26)		(2.22)	(4.53)		(4.99)
4-8 × g_gdp		−3.96***	−2.81***		−3.10***	−2.07***
		(−20.23)	(−14.70)		(−15.25)	(−10.41)
9-19 × g_gdp		−3.93***	−2.85***		−2.89***	−1.98***
		(−20.01)	(−14.86)		(−14.10)	(−9.85)
20+ × g_gdp		−4.66***	−3.81***		−3.04***	−2.38***
		(−24.09)	(−19.74)		(−15.01)	(−11.76)
Observations	1247694	1277402	1247694	1247694	1277402	1247694
Adjusted R^2	0.103	0.035	0.107	0.080	0.022	0.083
Sectors	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*
SE clustering	*firm*	*firm*	*firm*	*firm*	*firm*	*firm*

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note that investment appears to become more cyclical at larger firms. However, this may reflect the increased scale of investment at larger firms rather than its cyclicality, since these results are for the changes in investment, rather than the growth rates.