Journal of International Money and Finance 115 (2021) 102358

Contents lists available at ScienceDirect

Journal of International Money and Finance

journal homepage: www.elsevier.com/locate/jimf

Employment adjustment and financial tightness – Evidence from firm-level data ☆

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ARTICLE INFO

Article history:
Available online 28 February 2021

JEL classification:
E24
E3

Keywords:
Financial tightness
Employment
Labour hoarding

ABSTRACT

Firms tend to only partially adjust their workforce to changes in output. Typically, labour is hoarded in downturns; subsequently, firms have to hire less workers in upturns, but they can do so only if they can bear the current costs of keeping superfluous workers so that the firms can save rehiring costs in the future. Therefore, labour hoarding can be seen as an investment and may be influenced by factors, such as the firms' financial shortages, that tend to impede investments. Using Swiss firm-level data, we show that for firms in financially strained situations, the sensitivity of employment to fluctuations in output increases considerably. When output changes, financially tighter firms resize their labour force more than firms that have abundant funding. Both limited internal funding opportunities as well as the reduced access to external finance are important. The strongest impact, however, is observed when internal and external financial tightness occur jointly. In that case, compared to firms that are not in a financially strained situation, firms in a financially strained situation lay off twice as many employees. The amplifying effect of financial tightness is similar in upturns and downturns, implying that financially tight firms not only reduce their workforce more when demand decreases but also hire more labour when demand increases.

1. Introduction

Employment typically rises in booms and decreases in recessions. However, often firms only partially adjust their workforce; that is, they 'hoard labour' in downturns and subsequently hire less in upturns. Because of the costs associated with hiring and firing staff, labour hoarding can be the optimal response of firms facing labour market frictions. Employers confronted with a temporary drop in output retain more employees than they actually require because they expect to need those workers again in the future. Labour hoarding has therefore an investment-like feature: the costs of hoarding labour in the short term are higher than the average unit costs. These costs have to be carried in the present. By contrast, in the

☆ We thank an anonymous referee from this journal, one from the SNB working paper series, Simon Gilchrist, Sandra Hanslin, Christian Hepenstrick, George Sheldon, and Rolf Scheufele for insightful discussions and suggestions. We also thank Markus Däppen for his help and knowledge regarding the data. We thank the participants at several seminars and conferences for useful comments and suggestions. The views, opinions, findings, and conclusions or recommendations expressed in this paper are strictly those of the author(s). They do not necessarily reflect the views of the Swiss National Bank. The SNB takes no responsibility for any errors or omissions in, or for the correctness of, the information contained in this paper.

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https://doi.org/10.1016/j.jimonfin.2021.102358
0261-5606/

future, when demand picks up, the gains of labour hoarding materialise in the form of lower labour adjustment costs, such as lower recruiting and training costs. Similar to investment decisions, labour hoarding decisions do not immediately generate returns. No contemporaneous pay-off can be used to pay the extra wages.

While there is ample evidence for the existence of labour hoarding, less is known about the reasons why some firms hoard more labour than others. The timing mismatch between the costs of and the gains from labour hoarding has to be financed and, presumably, as it similarly does on the investment in physical capital, the financial health of a firm will impact its ability to hoard labour. In this paper, we therefore examine the differences in financial tightness across firms and assess how it influences the firms' hoarding behaviour. Focusing on the effect of financial tightness on the cyclicality of employment, we examine the hypothesis that in a downturn, firms that are in a financially tighter situation are not able to hoard labour to the same extent that firms that are not in a financially tight situation are able to do and consequently have to hire more labour in a subsequent upturn.

To estimate the impact of the firms' financial situation on labour hoarding, we use a large panel of firm-level balance-sheet and income statement data broadly drawn from the population of Swiss firms. The data is collected by the Swiss Federal Statistical Office and underlies the official figures for industry-level and aggregate value-added.[1], Unlike many data sets using firm-level balance-sheet information, the panel does not select in favour of publicly listed firms. This is important because financial tightness presumably matters even more for the smaller, non-listed firms, which have less access to external finance than the larger publicly listed firms. Furthermore, using Swiss data has a specific advantage: In many countries, the firms' employment adjustment behaviour is affected by strict labour market legislation. Employment protection rules hamper the flexibility of changes in employment. Thus, against the backdrop of high labour adjustment costs with legal restrictions, a sluggish reaction of the firms' labour demand to shocks in those countries may reflect optimal behaviour. The Swiss labour market, by contrast, in international comparison, is ranked as one of the most flexible, with relatively few regulations regarding the hiring and laying off of staff (Tella and MacCulloch, 2005).[2] In addition, by combining balance sheet and income statement data, we are able to analyse which source of financial tightness is relatively more important for labour hoarding – we distinguish between tightness in internal funding, such as low liquidity and low profits, and tightness in external funding, such as low collateral or a small balance sheet. Furthermore, we can observe the average wage paid in a firm. With this variable, we can analyse if firms that employ high-wage workers also tend to hoard more labour. This outcome would be expected from evidence that shows that hiring costs are larger for skilled workers than for unskilled workers (Blatter et al., 2012).

Preview of results. Our results show that financial tightness considerably increases the sensitivity of employment to fluctuations in output. When output changes, financially tighter firms resize their labour force substantially more than firms that have abundant funding availability. In particular, firms with low liquidity and low profits, as well as firms with a small balance sheet, have to lay off substantially more workers during downturns. The estimated effect of low collateral is weaker and not always robust. The strongest impact is observed when internal and external tightness occurs jointly. The amplifying effects of financial tightness is quite similar in upturns and downturns. Financially tighter firms not only reduce their workforce more when demand decreases but also hire more labour when demand increases. Our results are therefore consistent with the view that financial tightness hampers the labour hoarding ability of firms. We find further that the effect of financial tightness on labour hoarding is more pronounced for firms paying high wages. High-wage firms hoard more labour, suggesting that high-wage employees are associated with higher hiring and firing costs. Taken to the macro level, we show that up to 25% of the variance in aggregate employment can be explained by financial tightness.

Related literature. In analysing labour hoarding in combination with financial tightness measures, our paper links with two strands of the literature: On the one hand, we contribute to the literature on labour hoarding, which focusses on the observed procyclical labour productivity caused by the firms' tendency to retain more workers than necessary during downturns and therefore hire less workers during upturns.[3] This firm behaviour is explained by the potentially large costs that are associated with adjustments in employment. These costs include not only direct costs, such as redundancy costs and the costs for searching, hiring and training new staff but also indirect costs, such as the reduced motivation of the remaining staff or the

[1] The data cover not only manufacturing but also most goods and services-producing industries, which represent together approximately 70% of Swiss GDP and 80% of full-time employment.

[2] Most labour contracts in Switzerland have a mutual notice period of two to three months. An employer may terminate the employment of an employee with a notice period of two (three) months if the employee has been employed in the company for less (more) than 10 years. At the same time, wage cuts are arguably not widely used as an alternative to cut employment, because there is evidence that wages are downward rigid, even during periods of very low or even negative inflation, as shown in Fehr and Goette (2005) and Funk and Kaufmann (2020).

[3] See, for example, Crawford et al. (2013),Bryson and Forth (2015), Barth et al. (2017) and Gertler and Gilchrist (2018) for evidence from the Great Recession and Biddle (2014) for an overview and further references to the literature.

risk of losing market share if demand were to pick up suddenly, leaving a firm without enough staff to meet the higher demand.[4] Social pressure, which is typically stronger in family firms, establishments located closer to headquarters and smaller firms, has also proven to have a moderating effect on the firms' firing decisions.[5] On the other hand, we contribute to the literature on employment and financial constraints, which provides evidence that financial constraints have a direct effect on employment. This literature, however, does not distinguish between hoarding behaviour and permanent employment adjustment.[6]

The role of financial constraints in labour hoarding, i.e., the sensitivity of employment to changes in demand, has been analysed less extensively. Giroud and Mueller (2017) show that demand shocks during the Great Recession had large effects on employment in firms with high leverage. More recently, using Taiwanese data on manufacturing firms, Chen and Kao (2020) show that for firms facing less pressure from financial constraints, labour hoarding is more pronounced. In addition, the literature on short-time working programmes is related to our paper, since these programmes can be viewed as a subsidy on labour hoarding. Using the data for Germany and Switzerland, Balleer et al. (2016) and Kopp and Siegenthaler (2020), respectively, show that the availability of short-time working programmes dampened the decline in aggregate employment during the Great Recession. Cahuc et al. (2018) find that short-time working subsidies only save jobs in firms hit by a sharp drop in their revenues but do not save jobs in less severely hit firms. Credit-constrained firms in particular benefit from the use of short-time work to finance their labour hoarding. Such subsidy schemes can be seen as an additional source of financing that relaxes financial constraints, increasing thereby the ability to hoard labour in a recession, which can be welfare improving (Giupponi and Landais, 2018). The findings in these papers suggest that during a recession employment declines more in firms that face financial constraints, which is in line with the findings reported in this paper. In addition to the existing evidence, while focusing on labour hoarding and not the evaluation of short-term working programmes, we examine several financial tightness indicators of an internal (reduced internal funding opportunities) type and an external (reduced access to external funding opportunities) type; we find that both types matter for labour hoarding. We show that financially healthy firms reduce employment less in downturns but also hire less in subsequent upturns, which is consistent with the notion of labour hoarding. In addition, we provide a counterfactual exercise and show that reduced financial tightness would result in a lower variation in aggregate employment because firms would engage in more labour hoarding.

Structure of the paper. The next section discusses our empirical model. Section 3 describes the firm-level data used in our analysis. The estimation results are presented in Section 4 and are complemented with a discussion of the identification issues in Section 5. The macroeconomic implications are analysed in Section 6. Section 7 draws conclusions.

2. An empirical model of labour demand

This section shows the empirical estimation equation we estimate and how this equation is motivated by the literature on labour demand and the firms' financial situation.

Our underlying empirical model is a partial adjustment model, which models labour demand $e_{i,t}$ of firm i in period t (all in logs) as the weighted sum of past employment and the adjustment to desired $e^*_{i,t}$ employment as follows:

$$e_{i,t} = \alpha e_{i,t-1} + \beta e^*_{i,t}, \tag{1}$$

where $e^*_{i,t}$ denotes short-term equilibrium employment, which is defined as optimal employment in the absence of adjustment costs. Such a partial adjustment model can be derived as the optimal adjustment of labour demand if a labour adjustment is costly due to factors, such as hiring and firing costs. We show a sketch of the derivation of this equation from the firms' profit maximisation subject to quadratic adjustment costs in Appendix A.

Following a negative demand shock leading to a decrease in $e^*_{i,t}$, labour demand remains above $e^*_{i,t}$ in the period in which the shock occurs. There are two reasons for this. First, adjustment costs are assumed to be convex; therefore, a one-time adjustment of the labour force generates higher costs than a series of small adjustments cumulating to an reduction of the same magnitude.[7] Second, if a demand shock is temporary, a complete downward adjustment in labour would have to

[4] See Biddle (2014) and references therein.

[5] See, for example, Bassanini et al. (2017) and Kim et al. (2019).

[6] For example, the reduced capability of credit suppliers to lend is shown to have been an important determinant of the firms' employment adjustment decisions during large recession (Benmelech et al., 2011; Benmelech et al., 2019). Further analyses focusing on the supply of credit as a source of financial constraint have been carried out by Chodorow-Reich (2014),Duygan-Bump et al. (2015) and Basci et al. (2011), amongst others. Cantor (1990),Sharpe (1994), Funke et al. (1999),Ogawa (2003) and Drakos and Kallandranis (2006), in contrast, examine the impact of firm-side financial constraints. They find that a firm's leverage ratio is an important determinant of employment. Falato and Liang (2016) demonstrate that the tightness of loan covenants has a substantial impact on employment cuts. Related to this, Adelino et al. (2015) find that small businesses in areas with greater increases in house prices experienced a stronger growth in employment than large firms in the same areas and industries, emphasizing the role of the collateral channel. In addition, Borisov et al. (2015) find that firms that are able to increase their funding availability by going public increase their employment more than similar firms that remain private. Cunat et al. (2019) examine the impact of financial constraints on the firing decisions of firms. They show that financially constrained firms tend to fire more workers with shorter tenure and less of those with longer tenure, even though the ones with shorter tenure tend to have higher productivity potential. This leads to a misallocation of labour (similar to capital in Bernanke et al. (1996)). Related to this, Züllig (2020) shows empirically and theoretically within a search-and-matching model that firms shift the composition of their workforce towards workers with lower wages when hit by a financial shock. Finally, and in some contrast to the literature, García-Posada Gómez (2019) assesses the impact of credit constraints on inventories, investment and employment and finds that these constraint primarily affect investment but not employment.

[7] Blatter et al. (2012) document that hiring costs are convex in Switzerland.

be fully reversed when the demand shock fades. Because labour adjustment is costly, it is optimal for firms to adjust their labour only partially when a demand shock is expected to be temporary. In this case, firms hoard labour.

While there is no obvious reason why convex adjustment costs should interact with a firm's financial situation, a large literature has documented that financial constraints imply higher cost of financing (Bernanke et al., 1996).[8] The higher the costs of financing are, the less firms value future adjustment costs versus today's non-adjustment costs. Since hoarded labour has to be financed in advance (by paying salaries to extra workers when demand decreases) and pays off in the future (by saving future hiring costs when demand increases again), the adjustment of labour to demand shocks is likely to be larger if firms are faced with financial shortages.

A typical empirical specification of the partial adjustment model assumes that desired employment $e^*_{i,t}$ is a linear function of demand $y_{i,t}$ and wages $w_{i,t}$ (see Appendix A or, for example, Nickell, 1986 or Ogawa, 2003) plus other exogenous factors $X_{i,t}$. Taking first differences ensures the stationarity of the variables. This yields the basic empirical labour demand equation as follows:

$$\Delta e_{i,t} = \tilde{\gamma}_n \Delta e_{i,t-1} + \tilde{\gamma}_y \Delta y_{i,t} + \tilde{\gamma}_w \Delta w_{i,t} + \tilde{\beta} X_{i,t} + \epsilon_{i,t}. \tag{2}$$

However, against the backdrop of the previous discussion, we allow the coefficient $\tilde{\gamma}_y$ to vary with the presence of financial tightness (defined more clearly below). To gain a complete picture of the channels through which financial tightness works, we distinguish between external financial tightness and internal financial tightness. External financial tightness (Ext_i) hinders firms in obtaining funds from outside investors and lenders, while internal financial tightness (Int_i) reduces internal funds that could be used to finance labour hoarding. Both Ext_i and Int_i enter the model with a lag of one year; i.e., they reflect the financial situation of the firm before the period of observation in output and employment.

Thus, the response of employment to changes in demand in Eq. (2), γ_y, is a linear combination of our measures of financial tightness, $\tilde{\gamma}_y = \gamma_y + \gamma_{y,ext} Ext_{i,t-1} + \gamma_{y,int} Int_{i,t-1}$. Combining this linear function of $\tilde{\gamma}_y$ with Eq. (2), we obtain the following baseline estimation equation:

$$\begin{aligned} \Delta e_{i,t} = {} & \tilde{\gamma}_n \Delta e_{i,t-1} + \gamma_y \Delta y_{i,t} + \gamma_{y,int} Int_{i,t-1} \Delta y_{i,t} + \gamma_{y,ext} Ext_{i,t-1} \Delta y_{i,t} \\ & + \gamma_{int} Int_{i,t-1} + \gamma_{ext} Ext_{i,t-1} + \tilde{\gamma}_w \Delta w_{i,t-1} + \tilde{\beta} X_{i,t-1} + \epsilon_{i,t}, \end{aligned} \tag{3}$$

where Δe_{ti} is the log-change in employment, $\Delta y_{i,t}$ is the log-change in output (value added), and $\Delta w_{i,t}$ is the average wage in a firm (the total wage payments divided by FTE).[9] Our focus is on the estimates of the coefficients of the interaction terms, $\gamma_{y,ext}$ and $\gamma_{y,int}$, which are estimated simultaneously.

The vector $X_{i,t}$ includes various control variables. In the literature, one finds strong evidence that financial tightness influences investment. If financially tight firms are forced to disinvest, labour-capital complementarities could cause firms to reduce their labour force (Caggese and Cunat, 2008 or Benmelech et al., 2011). To control for this effect, $X_{i,t}$ includes the change in the firm's capital stock.[10] To control for the impact of different levels of capital intensity between firms, $X_{i,t}$ also contains the capital-stock-to-FTE ratio in $t-1$. Changes in firm-level output could be driven by demand and supply shocks. To isolate demand shocks, we control for an important component of supply shocks: changes in productivity.[11] We also include firm-specific fixed effects capturing sustained differences in firm-specific employment growth. Time-fixed effects have also been added to the equation to control for changes in aggregate employment growth.[12] In addition to the baseline model, we estimate three alternative specifications giving a special focus to the symmetry between upturns and downturns, the dependence of the adjustment to the wage level and the transitory feature of labour hoarding.

The exogeneity of our right-hand side variables is a particular concern in our analysis. In Section 5, we therefore implement four adjustments to the baseline model in order to foster the causal interpretation of our estimates. The first two address the identification of demand shocks at the firm level. The other two address the identification of financial tightness

[8] In the original work of Nickell (1986), the coefficient β in the labour demand Eq. (1) is an inverse function of the real interest rate. Even though Nickell does not model financial frictions, the financial frictions literature shows that external finance is more costly for constrained firms than for unconstrained firms Bernanke and Gertler (1995). As a result, future misalignment with equilibrium employment and, therefore, future adjustment costs are discounted with a higher factor, and the concurrent adjustment is more complete ($\tilde{\gamma}_y$ is larger for financially constrained firms than for financially unconstrained firms).

[9] An elasticity of employment with respect to an output of less than unity implies procyclical labour productivity and might indicate that firms hoard labour (Biddle, 2014), even though procyclical labour productivity might also be a result of other mechanisms. Using changes in housing prices to estimate demand shocks, as in Giroud and Mueller (2017), has the advantage over our setup, as the response of employment is more closely tied to changes in demand. Below, we show that changes in output, which are likely to be temporary, yield results similar to our baseline estimates, suggesting that using output as a measure of $\Delta y_{i,t}$ tends to capture temporary changes in demand. Given that both approaches show that financial tightness impedes labour hoarding, the results presented in this paper corroborate the findings in Giroud and Mueller (2017) and show that it also has implications for labour productivity, as discussed in the conclusion.

[10] The capital stock is also part of the labour demand equation derived in the Appendix and used by other studies, e.g., Nickell (1984),Burgess (1988), or Nickell and Nicolitsas (1999).

[11] Productivity shocks are defined as changes in total factor productivity, which are derived from a Cobb-Douglas production function estimated separately for each industry.

[12] In principle, financial tightness could interact with all variables in the model, i.e., with all control variables included in $X_{i,t}$. We checked the robustness of our results for these extended specifications and found only very minor differences (see Section E in the Appendix). Furthermore, it is conceivable that the internal and external financial tightness reinforce each other, motivating that $\tilde{\gamma}_y$ may also depend on the interaction term $\gamma_{y,ext,int} Int_{i,t-1} Ext_{i,t-1}$. However, the estimate of $\gamma_{y,ext,int}$ turned out to be very small and mostly statistically insignificant. We have therefore omitted these further interaction terms in the baseline specification.

Table 1
Sample statistics.

	Observations		*Employment*	*Value added*
	Total	Firms	average per firm	average per firm
Whole sample	104181	20819	173	33464
Industries				
Business Serv. 1	7898	1984	117	38705
Business Serv. 2	3884	1126	201	19034
Construction	9128	1838	138	15309
Education	2035	480	101	10685
Energy	4550	798	89	34846
Entertainment	3088	829	73	11507
Health	5104	1151	100	8369
IT	4549	1017	197	54060
Manuf. Pharma	834	116	638	476091
Manuf. Invest.	17886	2870	173	26561
Manuf. Other	11240	1910	136	20425
Manuf. Watches	4389	718	263	54343
Mining	826	136	44	8568
Rest. Hotels	4702	950	118	9497
Trade	18680	3922	217	42256
Transport	5385	974	352	52201

Notes: Employment is the number of full-time equivalents (FTE). The industries comprise the following: Business Services 1 (Real estate activities, legal, accounting, management, architecture, engineering activities, scientific research and development, other professional, scientific and technical activities); Business Services 2 (Administrative and support service activities); Construction: Education (not including public schools); Energy (Energy supply, water supply, waste management); Entertainment (Arts, entertainment, recreation and other services); Health (Human health and social work activities); IT (Information and communication); Manufacturing of pharmaceutical goods; Manufacturing of investment and intermediate goods; Manufacturing of watches (Watches, computer, electronic and optical products); Manufacturing of other goods; Mining (Mining and quarrying); Restaurants and Hotels (Accommodation and food service activities); Trade (Retail and wholesale trade, repair of motor vehicles and motorcycles); and Transport (Transportation and storage).

at the firm level. First, we use industry-level instead of firm-level output to identify demand shocks. Second, we look at the cross-sectional variation of employment during the Great Recession and the recovery. Third, we use industry-level measures of financial tightness. Fourth, we use a measure of exogenous variation of firms' financial tightness that is available for a subset of firms.

In the following section, we provide firm-level measures of financial tightness and describe how these measures are incorporated into Eq. (2).

3. Data description

We use a large panel of firm-level balance-sheet and income-statement data stretching from 1998 to 2016 and placed at our disposal by the SFSO (Swiss Federal Statistical Office). GDP data and other national account statistics are based on this high quality dataset. It comprises 104, 181 observations at an annual frequency and includes 20, 819 firms. The data are collected at the firm level and not, as is often the case, at the plant level. It is an unbalanced panel; that is, we do not observe every firm for all 19 years. However, the sample is a comprehensive draw from the population of Swiss firms, including all industries of the economy, except the financial and public sectors. The SFSO collects data for all large firms on an annual basis. From time to time, smaller firms might be replaced in the sample by firms from the same industry and similar characteristics. The dataset has an advantage over more-frequently used datasets, such as Compustat, in that it contains both privately held and publicly listed firms as well as both large and very small firms, which do not have to publish their balance sheets or income statements. This is important, as the latter are likely to be particularly prone to limitations in external sources of financing. The limitation of the dataset is that while it includes many small firms, large and medium-sized firms are overrepresented, and the data does not cover the full universe of firms.

Employment is defined in full-time equivalent (FTE) units in logs denoted by $e_{i,t}$. Output is measured by subtracting intermediate goods expenditure from total sales; the formulation is the official calculation used by the SFSO for value added.[13] Our dataset also includes a measure of average wages, $w_{i,t}$, which are measured as total wage expenditures divided by employment. It also includes physical capital, which we measure by its book value in the balance sheet. Table 1 lists the number of observations, the number of firms, the average full-time employment and the average output per firm for each industry, all of which are the key variables in our empirical section.

[13] Note that even if a firm operates across borders, the data excludes all foreign activities. Thus, output, labour costs, numbers of employees, costs for intermediate goods etc. all relate to Swiss activities.

Table 2
Measures of financial tightness.

	Liquidity		*Profitability*		*Collateral*		*Bal.Sheet*	
	Md	Sd	Md	Sd	Md	Sd	Md	Sd
Whole sample	2.69	24.63	0.11	0.29	0.47	3.90	13533	1447207
Within industries								
Business Serv. 1	1.70	8.25	0.11	0.27	0.17	4.67	12698	1288788
Business Serv. 2	1.56	4.07	0.06	0.15	0.12	2.73	4319	130207
Construction	2.26	1.56	0.07	0.14	0.35	0.62	11223	66971
Education	1.28	0.98	0.04	0.87	0.38	1.96	6935	35571
Energy	6.19	25.70	0.28	0.21	1.37	18.47	31224	787500
Entertainment	1.89	2.29	0.07	0.18	0.50	1.31	5572	134120
Health	1.27	0.82	0.04	0.16	0.83	3.44	5895	28063
IT	2.20	8.68	0.09	0.19	0.15	0.82	11242	960334
Manuf. Pharma	3.63	12.74	0.25	0.94	0.64	1.22	61806	8082120
Manuf. Invest.	2.91	3.42	0.13	0.38	0.56	1.04	19343	228398
Manuf. Other	3.00	2.73	0.10	0.16	0.64	0.98	11963	156181
Manuf. Watches	2.76	5.75	0.15	0.26	0.42	0.84	22955	1008085
Mining	3.70	2.77	0.19	0.20	0.97	1.76	13687	29463
Rest. Hotels	2.19	0.82	0.09	0.17	0.90	1.23	7090	51853
Trade	5.80	54.88	0.17	0.24	0.29	0.71	18146	1674860
Transport	2.46	9.21	0.08	0.17	0.78	1.65	16398	3885619
Between industries								
Industr.-means	2.36	1.45	0.10	0.07	0.53	0.34	12331	14095

Notes: This table reports summary statistics for the financial tightness variables. Md denotes the median, and sd denotes the standard deviation. Firms are classified into industries according to the SFSO definition. Figs. 3,4,5,6,7,8,9,10 in the appendix show distributions of these variables.

Furthermore, the dataset contains information that can be used to construct firm-specific measures of external and internal financial tightness. External financial tightness hinders firms from obtaining funds from outside investors and lenders. A firm faces internal financial tightness if it is more difficult to bridge a drop in demand by using internal funds.

In the spirit of Kaplan and Zingales (1997), we classify situations of financial tightness based on indicators constructed from the firms' balance sheets. We use several measures of financial tightness of a firm, as described in the next paragraph. To do so, we first define a firm as being in a financially tight situation if its value for a given financial situation indicator is above (below) the median value of that indicator. We then define a dummy variable with the value 1 if the firm is below the median and with the value 0 if it is above the median.[14] This value is defined for each firm-year observation such that a firm can be defined as being above the median in one period but below in another.

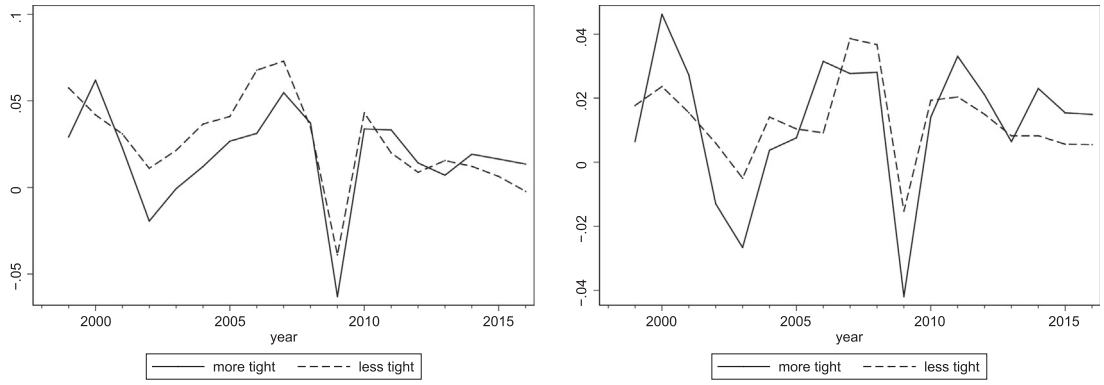
First, we look at two measures defining the external financial situation of a firm. For our first measure, we use the size of a firm's balance sheet (Bernanke et al., 1996; Gertler and Gilchrist, 1994; Caggese and Cunat, 2008). The idea behind using the balance sheet size as a measure for the financial situation is related to the costs of asymmetric information. Firms with a small balance sheet tend to have had little experience in the credit market, and there is limited available information on their creditworthiness. In contrast, information on firms with large balance sheets is much more available. Our second measure is the amount of collateral a firm owns. We define collateral as the sum of a firm's structures (buildings and land) and machines per unit of outstanding debt. Because it is riskier to lend to firms with low collateral, firms with low collateral have limited or more-costly access to external finance.

Second, we derive two different indicators for a firm's internal financial tightness. The data come from the firms' income statements. Our first measure is liquidity, which is defined as the ratio of sales to labour costs, following Aghion et al. (2015). Because profits are usually regarded as the main source of internal funding for investment, including the investment in labour hoarding, our second measure is the level of profits; we define profit as EBIT (earnings before interest rates and taxes) per unit of output, which is a measure of a firm's profitability.

The medians and the standard deviations of our financial tightness indicators are listed in Table 2. The first row shows statistics for all observations, and the rows below show statistics for the 16 industries. These figures show that the heterogeneity within industries can be very large. The last row shows the between-industry variation, i.e., the medians and standard deviations of the 16 industry-medians. The between-industry variation is low compared to the variation within industries. This indicates clearly that to capture the whole scope of heterogeneity within an economy, it is useful to employ firm-level data.

To illustrate the aggregate dynamics of the key variables, that is, the changes in output and the changes in employment, we show the average growth in employment and in output of our sample over time. We distinguish between firms in more and less tighter financial situations (In Fig. 1, the solid lines reflect the growth for firms that are classified as those in a financially tighter situation, and the dashed lines reflect the growth of firms in a financially less tight situation). Taking the example of liquidity tightness, we illustrate the aggregate dynamics. While the fluctuations in output growth are similar for both

[14] In Section C.3 in the Appendix, we look at a finer grid, not just above and below median.



(a) Output (b) Employment

Fig. 1. Average growth in employment and output for firms in a financially more and less tight situation (1999–2016). *Notes*: The panel on the left shows average output growth for more liquidity-tight firms (solid line) and for less liquidity-tight firms (dashed line). The right panel shows average employment growth. The averages are built by using firm-level growth rates weighted by the number of full-time equivalents.

groups of firms, growth in employment fluctuates markedly more for financially tighter firms. Moreover, there is a clear difference in the decline in employment during the Great Recession, in which firms that are financially less tight reduce employment by only 1.5%, while financially tighter firms reduce employment by 4.2%, thus reducing employment more than twice as much as firms that are financially less tight. This figure motivates our analysis of the impact of financial tightness on the intertwinement of employment and output.

4. Empirical analysis and results

This section reports estimates of the employment elasticity and differences depending on whether a firm is financially tight or not. We address the potential endogeneity of output more thoroughly in Section 5. In SubSection 4.1, we report the baseline regressions. Then, shedding light on specific aspects of labour hoarding, we show three refinements of the baseline equation. First, in SubSection 4.2, we distinguish between firms with decreases and firms with increases in output. The results are very similar. This similarity shows that financial constraints have a symmetric impact on labour hoarding. Second, in SubSection 4.3, we show that firms that pay high wages tend to hoard more labour if they are financially unconstrained. Third, in SubSection 4.4, we show that our findings are similar if we focus only on a temporary change in output, i.e., a change consistent with a cyclical shock to demand.

4.1. Baseline specification

Based on using Eq. (12), the impact of a one percent decrease in output on employment is displayed in Table 3. The upper panel 1 shows the estimated results of $\tilde{\gamma}_y$ for the four different combinations of financial tightness indicators. The direct impact of a one percent decline in output is given by γ_y on the first line. $\gamma_{y,int}$ is the marginal effect of facing internal financial tightness, and $\gamma_{y,ext}$ the marginal effect of facing external financial tightness.

Column (1) shows the results for estimates including liquidity as a measure of internal financial tightness and collateral as a measure of external financial tightness. Firms that are not financially tight reduce employment by only 0.17% in response to a one percent decline in output, with an elasticity significantly below one, which suggests that these firms hoard labour.[15] If a firm faces liquidity tightness, this elasticity almost doubles, compared to the firms with no liquidity tightness. If the firm is short of collateral, the firm lays off 0.04 percentage points more employment than other firms, implying that firms with collateral shortages decrease their employment by approximately one-fourth more than firms with no collateral shortages.

All alternative measures of internal and external tightness show that firms that are in a financially strained situation hoard less labour than other firms. Columns (2), (3) and (4) report the results for other measures and combinations of financial tightness indicators, including profitability as an internal tightness indicator and the size of the balance sheet as an external tightness indicator. The estimates of $\gamma_{y,int}$ and $\gamma_{y,ext}$ indicate that all four measures of financial tightness, taken alone,

[15] Note that a coefficient below one may not necessarily be evidence only for labour hoarding. This under-reaction to changes in demand could also come from the presence of convex adjustment costs. However, as the coefficient is very small, it seems implausible that convex adjustment costs alone could explain the small size of this coefficient. Moreover, the finding that the coefficient is larger for financially constrained firms suggests that the small coefficient is (at least partially) due to labour hoarding, as there is no obvious reason why convex adjustment costs should interact with financial constraints (while it is quite plausible that labour hoarding should).

Table 3
Employment elasticities and financial tightness.

1) Employment elasticity for not tight firms and marginal effects of financial tightness				
Specification	(1)	(2)	(3)	(4)
Measure of internal tightness	Liquidity	Profitability	Liquidity	Profitability
Measure of external tightness	Collateral	Collateral	Balance sheet	Balance sheet
γ_y	0.170***	0.194***	0.172***	0.186***
	(0.008)	(0.008)	(0.006)	(0.006)
$\gamma_{y,int}$	0.151***	0.128***	0.114***	0.094***
	(0.010)	(0.010)	(0.010)	(0.010)
$\gamma_{y,ext}$	0.044***	0.033***	0.113***	0.127***
	(0.009)	(0.009)	(0.010)	(0.011)
R^2	0.373	0.379	0.378	0.388
2) Implied employment elasticity $\tilde{\gamma}_y$ depending on financial tightness				
No tightness	0.170	0.194	0.172	0.186
Only internal	0.320	0.322	0.286	0.281
Only external	0.213	0.227	0.286	0.314
Internal and external	0.364	0.355	0.400	0.408
3) Number of observations				
No tightness	19,799	20,896	27,182	26,854
Only internal	20,538	19,441	14,780	15,108
Only external	20,298	19,258	12,928	13,311
Internal and external	18,537	19,577	24,297	23,914

Notes: The first panel 1) on the top shows the response in employment to a one percent change in output, depending on whether a firm faced financial tightness in the previous period. The direct impact of a one percent decline in output is given by γ_y on the first line. $\gamma_{y,int}$ is the marginal effect of facing internal financial tightness, and $\gamma_{y,ext}$ is the marginal effect of facing external financial tightness. Robust standard errors are in parentheses; $^{***}p < 0.01$, $^{**}p < 0.05$, and $^{*}p < 0.1$. Panel 2) reports the sum of the interaction coefficients (the standard deviations have been excluded; all are significant at the one percent level). The last panel shows the number of observations for each specification.

have a detrimental impact on the employment adjustment. While the impact of low collateral is somewhat lower, the other indicators have a substantial impact.

The estimates above are based on regressions including both the external and the internal financial tightness indicators. They thus have a conditional interpretation; that is, the coefficient on the internal financial tightness indicator is for a firm that experiences no external financially tight situation. Firms might be financially tight in both dimensions, internally and externally. To give a simple illustration of the elasticities for more and less financially tight firms, in panel 2, we report the coefficient for the firms with no financial tightness in the first row, which is identical to the coefficient γ_y in panel 1). The second row shows the elasticity for a firm that faces only an internal financial tightness (the sum of γ_y and $\gamma_{y,int}$); the third, the elasticity of a firm that faces only external financial tightness (the sum of γ_y and $\gamma_{y,ext}$); and the last row shows the coefficient of a firm, which is faced with financial tightness in both dimensions.

Panel 2 shows that a firm's employment elasticity is between 0.17% and 0.19% if both of its financial tightness indicators are zero (first row). Internally and externally tight situations lead to a marked rise in this elasticity (second and third rows), as discussed above. The strongest impact, however, is observed when internal and external tightness occurs jointly. In that case, firms lay off twice more employees than do other firms. Panel 3 shows that the share of firms experiencing tightness in both dimensions, internally and externally, is not negligible. Depending on the specification, the share of firms for which both tightness indicators suggest a financially strained situation accounts for 23% - 31% of the observations.

In the following subsections, we refine our results. We first test if the results change depending upon whether a firms output is increasing or decreasing. Next, we quantify the impact of the wage level on fluctuations in employment. Next, we test the transitory feature of labour hoarding. In the Appendix, we conduct various robustness test, and we look at the effect of financial tightness at different levels of its distribution.

4.2. Symmetry

Do firms react symmetrically to changes in output? Alternatively, is the impact of financial tightness asymmetric, that is, stronger during the recession than in the following upturn? To analyse this, we estimate our model to include separately observations with a negative change in output and observations with a positive change in output. Table 4 reports the results for decreases in output.[16]

[16] We have tested the results when an downturn (upturn) is defined relative to growth at the economy-level. For this analysis, the firms are divided into a downturn bin if their change in value added lies below the nominal GDP growth level and into an upturn bin if their change in value added lies above this aggregate growth level. The results are similar to the baseline specification and are reported in the appendix (Tables 18 and 19).

Table 4
Employment elasticities and financial tightness in downturns.

1) Employment elasticity for not tight firms and marginal effects of financial tightness				
Specification	(1)	(2)	(3)	(4)
Measure of internal tightness	Liquidity	Profitability	Liquidity	Profitability
Measure of external tightness	Collateral	Collateral	Balance sheet	Balance sheet
γ_y	0.166***	0.197***	0.171***	0.190***
	(0.014)	(0.013)	(0.012)	(0.011)
$\gamma_{y,int}$	0.168***	0.151***	0.133***	0.116***
	(0.018)	(0.019)	(0.018)	(0.020)
$\gamma_{y,ext}$	0.041**	0.031*	0.111***	0.126***
	(0.016)	(0.017)	(0.020)	(0.020)
R^2	0.338	0.354	0.341	0.358
2) Implied employment elasticity $\bar{\gamma}_y$ depending on financial tightness				
No tightness	0.166	0.197	0.171	0.190
Only internal	0.334	0.348	0.303	0.305
Only external	0.207	0.228	0.282	0.316
Internal and external	0.376	0.379	0.414	0.432
3) Number of observations				
No tightness	8852	9882	12178	12623
Only internal	8468	7438	6037	5592
Only external	9119	9176	5801	6443
Internal and external	7562	7505	9994	9352

Notes: The first panel 1) on the top shows the response in employment to a one percent change in output, depending on whether a firm faced financial tightness in the previous period. The direct impact of a one percent decline in output is given by γ_y on the first line. $\gamma_{y,int}$ is the marginal effect of facing internal financial tightness, and $\gamma_{y,ext}$ is the marginal effect of facing external financial tightness. Robust standard errors are in parentheses; $^{***}p < 0.01$, $^{**}p < 0.05$, and $^{*}p < 0.1$. Panel 2) reports the sum of the interaction coefficients (standard deviations have been excluded; all are significant at the one percent level). The last panel shows the number of observations for each specification.

The elasticities of the firms in a downturn are all very similar to those displayed in Table 3. In a downturn, approximately one fourth of the firms face tightness along both dimension and lay off twice more employees than firms that face no financial tightness.

In an upturn, financial tightness could theoretically have either a dampening or an enhancing impact on employment elasticity. In the first case, the rationale is that financial tightness has a negative impact on employment growth, both in a downturn as well as when demand increases. In this case, the marginal effects of financial tightness is negative, and financially strained firms have lower implied elasticities than other firms, meaning that firms facing financial tightness lay off more labour in a downturn and take on less labour in an upturn.

The second case is based on the idea that labour hoarding is a cyclical phenomenon with an investment character: firms keep on more labour than necessary in a downturn so that they will not have to hire as much new staff in the subsequent upturn. Financially tighter firms, however, are unable to hoard the optimal amount of labour and are forced to lay off more staff than desired in a downturn. In turn, in an upturn, they have to re-hire more labour for each percentage point rise in output. The interaction terms have positive coefficients, and both in a downturn and in an upturn, the implied employment elasticity is higher than that of firms facing no financial tightness.

The results displayed in Table 5 show that the estimates of $\gamma_{y,int}$ and $\gamma_{y,ext}$ are all significantly positive, with elasticities similar to those for downturns. These results indicate that financial tightness amplifies the fluctuations of employment and weakens those of labour productivity. In contrast, when caused by strong labour hoarding, weak cyclicality of employment is a sign of financial health.

Table 17 in the appendix reports the difference between the coefficients estimated for downturns and upturns. The differences are only significant for the marginal effect of internal tightness. The positive sign means that internally financially tighter firms re-hire less labour in an upturn than they laid off in a previous downturn. This feature is, however, economically small.[17]

4.3. Low-wage versus high-wage firms

The wage level is likely to influence labour hoarding behaviour. However, it is a priori unclear whether firms in the high-wage segment hoard more or less labour than firms in the low-wage segment. There are two opposing effects. On the one hand, adjustment costs are probably higher for high-wage jobs, because of two reasons. First, firing costs are set to be higher

[17] We furthermore show in Appendix D that while resulting in relatively small and insignificant coefficients of the financial tightness indicators, estimating an error-correction relationship between employment and output by using a mean group estimator and adding the financial tightness indicators to this equation does not change the short-term adjustment coefficients. However, a caveat is that since we have a small number of time periods, relative to a cross-sectional dimension, the estimator of the long-run equation is not consistent.

Table 5
Employment elasticities and financial tightness in upturns.

1) Employment elasticity for not tight firms and marginal effects of financial tightness				
Specification	(1)	(2)	(3)	(4)
Measure of internal tightness	Liquidity	Profitability	Liquidity	Profitability
Measure of external tightness	Collateral	Collateral	Balance sheet	Balance sheet
γ_y	0.197***	0.223***	0.195***	0.212***
	(0.015)	(0.015)	(0.012)	(0.013)
$\gamma_{y,int}$	0.126***	0.077***	0.081***	0.042**
	(0.020)	(0.018)	(0.020)	(0.018)
$\gamma_{y,ext}$	0.049***	0.040**	0.153***	0.167***
	(0.018)	(0.018)	(0.020)	(0.020)
R^2	0.371	0.378	0.376	0.384
2) Implied employment elasticity $\tilde{\gamma}_y$ depending on financial tightness				
No tightness	0.197	0.223	0.195	0.212
Only internal	0.322	0.300	0.276	0.253
Only external	0.246	0.262	0.348	0.378
Internal and external	0.371	0.339	0.429	0.420
3) Number of observations				
No tightness	10947	11014	15004	14231
Only internal	12070	12003	8743	9516
Only external	11179	12072	7127	6868
Internal and external	10975	10082	14303	14562

Notes: The first panel 1) on the top shows the response in employment to a one percent change in output, depending on whether a firm faced financial tightness in the previous period. The direct impact of a one percent decline in output is given by γ_y on the first line. $\gamma_{y,int}$ is the marginal effect of facing internal financial tightness, and $\gamma_{y,ext}$ is the marginal effect of facing external financial tightness. Robust standard errors are in parentheses; $^{***}p < 0.01$, $^{**}p < 0.05$, and $^{*}p < 0.1$. Panel 2 reports the sum of the interaction coefficients (standard deviations have been excluded; all are significant at the one percent level). The last panel shows the number of observations for each specification.

owing to higher redundancy payments and more-generous dismissal conditions. Second, because the wage level should be determined by a worker's productivity, high-wage jobs will probably require higher hiring costs and higher initial training costs. Hiring costs are especially high when the human capital is scarce or very firm-specific. For example, Blatter et al. (2012) provide evidence that hiring costs as a share of wage costs are higher in occupations with higher skill requirements. This means that the costs of laying off high-wage jobs might be larger than those of laying off low-wage jobs. On the other hand, one could argue that dismissing a worker with a high wage decreases wage expenditures more than dismissing a worker with a low wage. In this case, the costs of laying off workers with high-wage jobs are larger than those of laying off workers with low-wage jobs.

To test which hypothesis dominates, we split our sample at the median firm-level average wage. In our dataset, we do not have wage data per employee; we only the average wage per firm. Therefore, we cannot distinguish between different jobs within the same firm. Thus, the classification by firm-level average wage, which we use for this exercise, is only a proxy. Especially for firms with very heterogeneous remuneration schemes, the average could be misleading. The results in Fig. 2 show that for all specifications, the employment elasticities of high-wage firms (light grey bars) are lower than those for low-wage firms (dark grey bars). This suggests that the first channel dominates; i.e., in the high wage segment, hiring and firing costs tend to be relatively more important than the wage savings. The error bars showing the 95% confidence intervals suggest however that the difference in hoarding behaviour is only significant for firms facing no financial tightness: High-wage firms only hoard more labour when they dispose of sufficient funding opportunities. The elasticity of high-wage, not financially tight firms is a third lower than that of low-wage firms. High-wage firms that face only external financial tightness (i.e., no internal financial tightness) also tend to hoard significantly more labour. However, if a firm faces internal financial tightness, its labour hoarding behaviour does not differ much if they pay high or low wages. The implied elasticity for firms facing internal and external financial tightness is in all specifications very similar.

4.4. Transitory feature of labour hoarding

We have shown that financial tightness can have a substantial influence on employment because it hampers the ability of firms to hoard labour. In this subsection, we focus on the transitory feature of labour hoarding. The expected persistence of a downturn plays a crucial role in the labour hoarding behaviour of firms. If firms believe that the downturn is temporary, downsizing their labour force will entail future re-hiring costs; therefore, the incentives to hoard labour are high. If, however, firms associate the change in demand with permanent developments, they will have an incentive to more or less completely adjust their labour force to the lower level of output.[18]

[18] For example, Baily et al. (2001) analyse the cyclicality of labour productivity, focusing on the impact of a transitory demand shock. They measure the transitory shocks as the deviation of downstream demand from the linear trend.

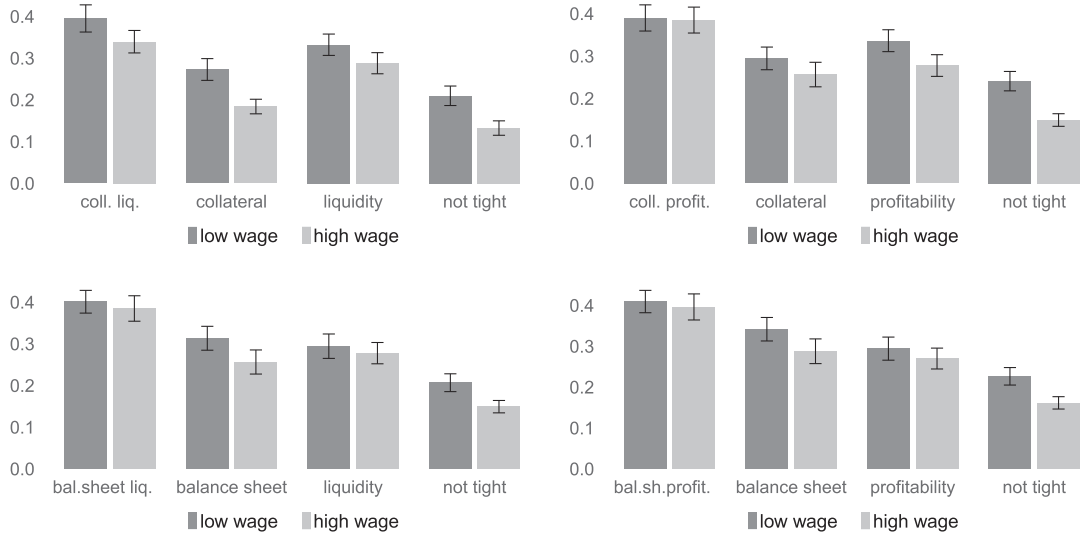


Fig. 2. Employment elasticities and financial tightness by wage level. *Notes:* The light grey bars represent the high-wage firms and the dark grey bars the low-wage firms. The two bars in the first column represent the implied labour elasticity for firms with both an internal and an external financially tight situation, as measured by $\gamma_y + \gamma_{y.int} + \gamma_{y.ext}$. The two bars in the second column represent externally tight firms, as measured by $\gamma_y + \gamma_{y.ext}$; the two bars in the third column represent internally tight firms, as measured by $\gamma_y + \gamma_{y.int}$, and the two bars in the fourth column represent the labour elasticity for firms with no financial tightness, as measured by γ_y. The error bars represent the 95% confidence intervals.

We test whether the results previously obtained above are influenced by firms that adjust their employment to permanent changes in demand. To do this, we re-estimate the baseline equation by using only those observations for which we have an indication that the change in demand is temporary. We use the sum a firm spends on temporary work to capture the cyclical movement of employment: because temporary work is quickly available and easily reversible, it will be used by firms as a buffer to regulate their labour force when they assume the fluctuations in demand will be temporary. In contrast, it would be inefficient for employers to take on temporary work for a permanent job because the retention level is generally low and the fixed costs of work-related training are therefore less worthwhile (Booth et al., 2002). Thus, if firms assume that an increase in demand is permanent, they will hire permanent workers, while if an upturn is seen to be temporary, it will be more attractive to take on temporary workers.[19] Accordingly, if firms expect a downturn to be temporary, they will try to keep as much as possible of their permanent labour force and diminish their costs by reducing temporary work with no redundancy pay (Dolado et al., 2002).

We assume, therefore, that when an upturn (decline) in output occurs together with a rise (decline) in temporary work, the firm believes that the fluctuations in demand are temporary. We proceed by looking at the sample sub-set, in which changes in output occur together with a change in temporary work and the two move in the same direction. Because the expenditures for temporary work only amount to 2.0% of total labour costs on average (see Table 13 in the Appendix), it is fair to claim that the total change in employment is not influenced in a meaningful way by changes in the costs for temporary work. As not all firms employ temporary work, this exercise reduces the sample to approximately 29,084 observations. Roughly half of them change output in the same direction as temporary work, as shown in the summary statistics for this sample (Table 14 in the Appendix).[20]

Table 6 displays the results for a one percent decrease in output. The results are very similar to the results shown in Table 3. This suggests that the influence of financial tightness on employment applies to the cyclical component of a labour adjustment.

5. Identification

A causal interpretation of our estimates requires that the right hand side variables are exogenous. This is certainly a concern in our estimation reported above. We therefore go step-by-step through each potential source of endogeneity: the endogeneity of the lagged firm-level output and the endogeneity of the financial tightness indicators. We address the potential endogeneity of output with two alternative strategies. First, we instrument firm-specific output with output at the sec-

[19] While firms will eventually react with an adjustment of the permanent workforce to permanent shocks, we cannot exclude that they to some extent first adjust their temporary workforce.

[20] Around one fourth of the firms in the total sample use temporary labour. The firms in this sample are approximately 30% larger on average (both in terms of employment and in terms of value added) than the firms for the whole sample, suggesting that larger firms tend to use temporary labour more intensively. The constraint variables for this sample have similar medians as the full sample and in most sectors have a lower dispersion (see Table 15 in the Appendix).

Table 6
Employment elasticities and financial tightness for temporary employment.

1) Employment elasticity for not tight firms and marginal effects of financial tightness				
Specification	(1)	(2)	(3)	(4)
Measure of internal tightness	Liquidity	Profitability	Liquidity	Profitability
Measure of external tightness	Collateral	Collateral	Balance sheet	Balance sheet
γ_y	0.214***	0.236***	0.224***	0.238***
	(0.017)	(0.017)	(0.014)	(0.014)
$\gamma_{y,int}$	0.134***	0.109***	0.091***	0.070***
	(0.023)	(0.023)	(0.024)	(0.023)
$\gamma_{y,ext}$	0.045**	0.036*	0.140***	0.151***
	(0.020)	(0.021)	(0.024)	(0.023)
R^2	0.384	0.393	0.393	0.405
2) Implied employment elasticity $\tilde{\gamma}_y$ depending on financial tightness				
No tightness	0.214	0.236	0.224	0.238
Only internal	0.348	0.345	0.314	0.308
Only external	0.259	0.273	0.364	0.389
Internal and external	0.393	0.382	0.455	0.459

Notes: The first panel 1) on the top shows the response in employment to a one percent change in output, depending on whether a firm faced financial tightness in the previous period. The direct impact of a one percent decline in output is given by γ_y on the first line. $\gamma_{y,int}$ is the marginal effect of facing internal financial tightness, and $\gamma_{y,ext}$ is the marginal effect of facing external financial tightness. Robust standard errors are in parentheses; $^{***}p < 0.01$, $^{**}p < 0.05$, and $^{*}p < 0.1$. Panel 2) reports the sum of the interaction coefficients (the standard deviations have been excluded; all are significant at the one percent level).

toral level. Second, we focus on an episode, the Great Recession, which is widely recognized as an exogenous shock to foreign demand for Swiss output. To foster our causal interpretation of the effect of financial tightness, we also pursue two alternative strategies. First, we replace firm-specific financial tightness indicators with financial tightness indicators defined at the industry level. Second, we estimate the effect of changes in revenue from financial assets, which are arguably exogenous to shocks to firm-specific employment, on labour hoarding.

5.1. Variation of output at the sectoral level

In Section 4, firm-level variation in output is used as an explanatory variable to proxy for demand shocks. One concern in that specification is that shocks to firm-specific employment could affect the firms' output. We test whether our baseline results are affected by this potential endogeneity problem by using changes in industry-level output as an instrument for firm-level output. Aghion et al. (2015) argue that the use of output at the higher level of aggregation can reduce the scope for reverse causality because the changes in employment of an individual firm will not influence the characteristics of a whole industry. We therefore estimate Eq. 12 employing 2SLS and instrument log-changes in firm-level output $\Delta y_{i,t}$ by log-changes in industry-level output $\Delta y_{j,t}$, where firm i is part of industry j.

The results of the 2SLS estimation is displayed in Table 7. The F-tests suggest that the first stage is strong. The standard errors are clustered at the industry level to take into account the fact that the instrument varies at the level of industries but not across firms within the same industry. Most elasticity estimates remain significant except for those of the collateral tightness indicator, which was also economically small in the main specification. These results suggest that the effect of collateral tightness is not robust and therefore not significantly different from zero. The other three tightness indicators are robust to the use of industry-level output as an instrument for firm-level output. The coefficients of the interaction terms, $\gamma_{y,int}$ and $\gamma_{y,ext}$, are slightly lower than those in the baseline specification shown in Table 3. Meanwhile, the direct impact of output variation on employment is somewhat larger but does not alter our main interpretation.

5.2. Variation in 2009 and 2010

In addition to the estimation in Section 5.1, we estimate the effect of financial tightness on labour hoarding, as specified in Eq. (12), by looking at the cross-sectional variation in the firms' financial conditions when the firms entered the Great Recession period.

In Switzerland, the Great Recession led to a large and broad-based decline in output (as also shown in Fig. 1) that we assume to have been driven by an exogenous negative demand shock.[21] The Great Trade Collapse, which followed the Great Recession in the US in the second half of 2008, hit European countries suddenly, synchronically and severely (Baldwin, 2009).

[21] The share of firms in our sample that experienced a decline in output in 2009 was much higher than that in 2008 (56% compared to 37%). Moreover, the average growth in the output of all firms was clearly negative, with an average firm growth rate of −5.9% in 2009 (compared to 3.0% in 2008). Average employment growth fell from 1.9% in 2008 to −2.3% in 2009.

Table 7
2SLS: employment elasticities with industry-level value-added.

1) Employment elasticity for not tight firms and marginal effects of financial tightness

Specification	(1)	(2)	(3)	(4)
Measure of internal tightness	Liquidity	Profitability	Liquidity	Profitability
Measure of external tightness	Collateral	Collateral	Balance sheet	Balance sheet
γ_y	0.300***	0.312***	0.307***	0.310***
	(0.087)	(0.082)	(0.081)	(0.075)
$\gamma_{y,int}$	0.122**	0.120***	0.095**	0.090**
	(0.049)	(0.044)	(0.046)	(0.038)
$\gamma_{y,ext}$	0.023	0.009	0.097**	0.106***
	(0.035)	(0.034)	(0.038)	(0.037)
$F\ \Delta y_{i,t}$	197.8	243.5	158.4	205.5
$F\ Int_{i,t-1}\Delta y_{i,t}$	17.0	147.4	17.9	153.5
$F\ Ext_{i,t-1}\Delta y_{i,t}$	82.2	86.2	27.8	26.6

(2) Implied employment elasticity $\tilde{\gamma}_y$ depending on financial tightness

No tightness	0.300	0.312	0.307	0.310
Only internal	0.422	0.432	0.401	0.399
Only external	0.323	0.321	0.404	0.416
Internally and external	0.444	0.441	0.499	0.505

Notes: The first panel 1) on the top shows the response in employment to a one percent change in output, depending on whether a firm faced financial tightness in the previous period. The direct impact of a one percent decline in output is given by γ_y on the first line. $\gamma_{y,int}$ is the marginal effect of facing internal financial tightness, and $\gamma_{y,ext}$ is the marginal effect of facing external financial tightness. The standard errors are in parentheses (clustered at the industry level); $^{***}p < 0.01$, $^{**}p < 0.05$, and $^{*}p < 0.1$. $F\ \Delta y_{i,t}$, $F\ Int_{i,t-1}\Delta y_{i,t}$ and $F\ Ext_{i,t-1}\Delta y_{i,t}$ are the F-statistics of the first-stage regressions for the change in output and the two interaction terms. Panel 2 reports the sum of the interaction coefficients (standard errors have been excluded; all are significant at the 1% level).

Thus, the spillovers to a small open European economy such as that of Switzerland were arguably exogenous to a large part of the Swiss firms.[22]

If the change in Swiss output during the recession year 2009 was driven by a exogenous negative demand shock, we can use this shock to identify a causality between the change in output and the change in employment.[23] The estimates of the Eq. (12) for the recession year 2009 are displayed in Table 8.

Column (1) shows the results for estimates including liquidity as a measure of internal tightness and collateral as a measure of external tightness. Firms that do not face financial tightness reduced employment by only 0.26% in response to a one percent decline in output, with an elasticity significantly below one, which suggests that they hoarded labour. If a firm was low in liquidity in 2008, it laid off 0.17 percentage points more employment during the recession than a firm with high liquidity, implying that low-liquidity firms decreased their employment substantially more than other firms. Meanwhile, collateral tightness did not increase the elasticity significantly.

Columns (2), (3) and (4) report the results for other measures and combinations of tightness indicators, including profitability as a measure of internal financial tightness and the size of the balance sheet as a measure of external financial tightness. While the impact of low collateral is not significant, the other indicators of tightness all have a substantial impact.

Panel 2 shows that during the Great Recession, while a firm's employment elasticity was between 0.25% and 0.29% if it was not facing financial tightness (first row), internal and external tightness led to a marked rise in this elasticity (second and third rows), as discussed above. Firms with both internal and external financial tightness reduced labour the most. Panel 3 shows that the share of firms that were internally as well as externally financially strained was not negligible. Depending on the specification, the share of firms that were financially strained according to both indicators (internal and external) accounted for 21% to 25% of all observations.

[22] For example, in the first quarter of 2009, the Swiss National Bank wrote in its quarterly bulletin (Swiss National Bank, 2009): "In the fourth quarter of 2008, real GDP dropped by 1.2% in annualised terms. While the contraction in economic activity appeared to be less pronounced in Switzerland than in the major European countries, this figure nevertheless obscures the extent of the collapse in global demand, in particular in the manufacturing industry, with the concomitant sharp drop in exports." Later, in the second quarter of 2009, they stated: "Initially, the crisis mainly affected exports and the financial industry, but in recent months it also had a noticeable impact on the domestic economy. However, there were still striking differences. Businesses in the export industry continued to fare markedly worse than firms that cater to domestic demand." (Swiss National Bank, 2009). These statements are consistent with the view that from the perspective of the Swiss economy, the great recession in 2009 was mainly an external demand shock. Unfortunately, in the dataset, we do not have any direct information on the export share in output per firm, nor can we match the data to any trade databases that would allow more specific information about the export structure of each firm, which is information that would be necessary to define similar instruments as Berman et al. (2015). However, Bäurle and Steiner (2015) show that the Swiss economy reacts strongly to foreign demand shocks. The elasticity of Swiss GDP to foreign GDP is approximately 0.4. As the domestic oriented public sector is omitted in our data, this relation is presumably even stronger when using our dataset.

[23] Such an identification strategy has also been used by Greenstone et al. (2020), who look at the Great Recession to estimate the effects of financial constraints on the real economy. Similarly, Siemer (2019),Popov and Rocholl (2015), and Duygan-Bump et al. (2015) use this period to quantify the effect of financial constraints on employment and unemployment.

Table 8
Impact of 1% change in output on employment during the recession of 2009.

(1) Employment elasticity for not tight firms and marginal effects of financial tightness				
Specification	(1)	(2)	(3)	(4)
Measure of internal tightness	Liquidity	Profitability	Liquidity	Profitability
Measure of external tightness	Collateral	Collateral	Balance sheet	Balance sheet
γ_y	0.260***	0.300***	0.253***	0.272***
	(0.029)	(0.028)	(0.023)	(0.023)
$\gamma_{y,int}$	0.165***	0.093***	0.136***	0.067**
	(0.030)	(0.031)	(0.031)	(0.032)
$\gamma_{y,ext}$	0.018	−0.006	0.086***	0.112***
	(0.029)	(0.030)	(0.030)	(0.032)
R^2	0.528	0.523	0.531	0.529
(2) Implied employment elasticity $\bar{\gamma}_y$ depending on financial tightness				
No tightness	0.260	0.300	0.253	0.272
Only internal	0.425	0.394	0.389	0.338
Only external	0.278	0.294	0.339	0.383
Internal and external	0.443	0.387	0.475	0.450
(3) Number of observations				
No tightness	713	734	1068	1075
Only internal	655	634	577	570
Only external	736	702	381	361
Internally and external	575	609	653	673

Notes: The first panel 1) on the top shows the response in employment to a one percent change in output, depending on whether a firm faced financial tightness in the previous period. The direct impact of a one percent decline in output is given by γ_y on the first line. $\gamma_{y,int}$ is the marginal effect of facing internal financial tightness, and $\gamma_{y,ext}$ is the marginal effect of facing external financial tightness. Robust standard errors are in parentheses; $^{***}p < 0.01$, $^{**}p < 0.05$, and $^{*}p < 0.1$. Panel 2) reports the sum of the interaction coefficients (the standard deviations have been excluded; all are significant at the one percent level). The last panel shows the number of observations for each specification.

The findings above for the period of the Great Recession show that firms in a tight financial situation were less able to hoard labour than firms in a better financial situation. To corroborate the results from the recession, we test if the negative impact of financial tightness on employment during the 2009 recession will be reversed in a positive impact during the subsequent upturn in 2010.[24]

The data confirms this hypothesis. The results are displayed in Table 9. The estimates of $\gamma_{y,int}$ and $\gamma_{y,ext}$ are significantly positive for internal liquidity tightness and external balance sheet tightness, with elasticities similar to those during the recession of 2009. Even though internal profitability tightness and external collateral tightness are not significantly different from zero, they are not negative. This implies that it was the financially strained firms that triggered the labour market upturn that occurred in the aftermath of the Great Recession.

5.3. Variation in financial tightness at the sectoral level

Another source of a potential identification issue is the firm-level definition of financial tightness, which might be correlated with other firm-level primitives, which might also shape the response of employment and output. In our baseline specification, financial tightness enters the model with a lag of one year; i.e., it reflects the financial situation of the firm *before* the period of observation in output and employment. This reduces the role of contemporaneous changes in output or employment on financial tightness measures. Furthermore, firm-fixed effects are included in our panel data estimation. This implies that time-invariant firm-specific features, which may influence employment or output, are not driving the results. It is, however, possible that time-variant, firm-endogenous characteristics play a role. We therefore consider two further specifications. In this subsection, we define tightness indicators at the industry level. In the following subsection, we use an exogenous variation to the firms' financial tightness indicator and show that the main correlation reported above remains valid.

Industry-level tightness indicators are calculated similarly to the tightness indicators at the firm level; i.e., the average per year of all firms' tightness indicators in a given sector is calculated. An industry is defined as facing financial tightness if its industry average is below the median of all industries for a given year. The industries are again defined at the 4-digit NOGA level. We then replace the firm-level tightness indicator by the industry-level tightness indicator in Eq. 12 and re-estimate the equation. Again, we cluster standard errors at the industry level to take into account that the indicators now vary at the level of the industry.

[24] Again, there is no evidence that financial tightness has an asymmetric effect in upturns and downturns (Table 20 in the appendix.

Table 9
Impact of 1% change in output on employment during the upturn of 2010.

1) Employment elasticity for not tight firms and marginal effects of financial tightness				
Specification	(1)	(2)	(3)	(4)
Measure of internal tightness	Liquidity	Profitability	Liquidity	Profitability
Measure of external tightness	Collateral	Collateral	Balance sheet	Balance sheet
γ_y	0.161***	0.193***	0.160***	0.176***
	(0.030)	(0.030)	(0.021)	(0.022)
$\gamma_{y,int}$	0.130***	0.047	0.088**	0.013
	(0.040)	(0.038)	(0.043)	(0.040)
$\gamma_{y,ext}$	0.034	0.013	0.136***	0.161***
	(0.035)	(0.035)	(0.037)	(0.035)
R^2	0.356	0.348	0.365	0.361
2) Implied employment elasticity $\tilde{\gamma}_y$ depending on financial tightness				
No tightness	0.161	0.193	0.160	0.176
Only internal	0.292	0.240	0.249	0.189
Only external	0.195	0.206	0.297	0.337
Internal and external	0.326	0.253	0.385	0.350
3) Number of observations				
No tightness	650	671	987	999
Only internal	562	541	530	515
Only external	643	628	306	300
Internal and external	506	521	538	544

Notes: The first panel 1) on the top shows the response in employment to a one percent change in output, depending on whether a firm faced financial tightness in the previous period. The direct impact of a one percent decline in output is given by γ_y on the first line. $\gamma_{y,int}$ is the marginal effect of facing internal financial tightness, and $\gamma_{y,ext}$ is the marginal effect of facing external financial tightness. Robust standard errors are in parentheses; $^{***}p < 0.01$, $^{**}p < 0.05$, and $^{*}p < 0.1$. Panel 2) reports the sum of the interaction coefficients (the standard deviations have been excluded; all t are significant at the one percent level). The last panel shows the number of observations for each specification.

Table 10 reports our results. The coefficients are similar to those in the baseline table. While low collateral combined with low liquidity is not significant and therefore not robust, all other tightness indicators have a similar impact as in the baseline specification.

5.4. Variation of financial tightness due to financial profits

We analyse the impact of the possible endogeneity of the financial tightness indicators by using a measure of exogenous variation to the firms' profits. Some firms hold financial assets, and in our database, these firms report their revenue stemming from these assets. We test if an exogenous change in profits stemming from a change in financial profits impacts

Table 10
Employment elasticities with financial tightness measured at the industry-level.

1) Employment elasticity for not tight firms and marginal effects of financial tightness				
Specification	(1)	(2)	(3)	(4)
Measure of internal tightness	Liquidity	Profitability	Liquidity	Profitability
Measure of external tightness	Collateral	Collateral	Balance sheet	Balance sheet
γ_y	0.183***	0.179***	0.188***	0.195***
	(0.020)	(0.021)	(0.014)	(0.015)
$\gamma_{y,int}$	0.118***	0.117***	0.093***	0.084***
	(0.028)	(0.024)	(0.024)	(0.022)
$\gamma_{y,ext}$	0.029	0.043*	0.050**	0.052**
	(0.023)	(0.024)	(0.021)	(0.021)
R^2	0.364	0.363	0.364	0.363
2) Implied employment elasticity $\tilde{\gamma}_y$ depending on financial tightness				
No tightness	0.183	0.179	0.188	0.195
Only internal	0.300	0.297	0.282	0.279
Only external	0.212	0.223	0.239	0.247
Internal and external	0.330	0.340	0.332	0.330

Notes: The first panel 1) on the top shows the response in employment to a one percent change in output, depending on whether a firm faced financial tightness in the previous period. The direct impact of a one percent decline in output is given by γ_y on the first line. $\gamma_{y,int}$ is the marginal effect of facing internal financial tightness, and $\gamma_{y,ext}$ is the marginal effect of facing external financial tightness. Robust standard errors are in parentheses; $^{***}p < 0.01$, $^{**}p < 0.05$, and $^{*}p < 0.1$. Panel 2) reports the sum of the interaction coefficients (the standard deviations have been excluded; all are significant at the one percent level).

Table 11
Employment elasticities with exogenous variations in profitability.

γ_y	0.247***
	(0.027)
$\gamma_{y,fin}$	-0.333***
	(0.075)
$\gamma_{y,op}$	-0.272***
	(0.072)

Notes: Estimated effect of internal tightness measured by financial profits ($\gamma_{y,fin}$) and operating profits ($\gamma_{y,op}$) separately. Financial profits are only components of the balance sheet and are exogenous to a firm's productivity or idiosyncratic shocks. Robust standard errors in parentheses; $^{***}p < 0.01$, $^{**}p < 0.05$, and $^{*}p < 0.1$.

employment in the same way as operative profits do. Financial revenue and write-downs occur when firms hold financial assets that gain or lose in value or when the firm receives a dividend payment on their financial assets. According to Swiss accounting standards, these include only profits or losses with variable returns, which are arguably unpredictable. Fixed interest payments or interest income have a separate position on the balance sheet and are not included in net financial revenue. The underlying assumption is that variations in financial profits in period $t-1$ reflect changes in profits that are orthogonal to firms' shocks that drive both output and employment in period t.

We implement this idea by estimating Eq. 2 with $\tilde{\gamma}_y$ specified as follows:

$$\tilde{\gamma}_y = \gamma_y + \gamma_{y,fin} ProfFin_{i,t-1} + \gamma_{y,op} ProfOp_{i,t-1}, \tag{4}$$

where profitability is divided in two variables: financial profitability, $ProfFin_{i,t-1}$, is the part of the financial tightness indicator due to low profitability, which is driven by the revenue from holding financial assets minus the losses due to firms' write-downs on financial assets, while operative profitability $ProfOp_{i,t-1}$ is calculated as the difference between total profitability and financial profitability.

Note that we do not use a binary classification of profitability as in the baseline case but use the level variable directly. The reason is that the share of financial profits in total profits is usually small and that therefore, financial profits are not a decisive factor behind a firm's classification in the bin with high and low financial tightness. Our analysis in Section C.3 in the Appendix suggests, however, that small changes only have an effect in the upper half of the distribution, in which financial tightness has a monotonic impact on employment (see Fig. 11). Thus, we reduce our sample to the upper half of the distribution, in which we can expect a monotonic effect of financial tightness. Because of this and because not all firms have financial income or write-downs, the sample is reduced to 10,120 observations in this analysis.

Table 11 shows the estimated coefficients, confirming that firms with larger financial or operating profitability (less tight) adjust employment less than firms facing financial tightness. The coefficients of the two interaction terms for financial and operating profitability are not significantly different from each other. Thus, a one percent decline in financial profitability has a qualitatively similar effect on labour hoarding as a one percent decline in operating profitability, suggesting that the internal financial tightness that hinders labour hoarding is not solely a result of unobservable idiosyncratic factors, which might influence both profitability and employment. Together with the fact that net financial profits are arguably exogenous to a firm's idiosyncratic shocks, as argued above, we interpret this as evidence that the financial situation causally impacts labour hoarding behaviour.

6. Macroeconomic implications

Our final application is to estimate how large the macroeconomic impact of financial tightness is on employment growth. We take our firm-level findings to the macro level by means of a counterfactual analysis. We estimate a counterfactual aggregate employment growth series excluding the impact of financial tightness on the labour hoarding behaviour of firms. First, at the firm level, we exclude the impact of financial tightness by deducting the interaction terms combining financial tightness and output growth, as in Eq. (4), from actual employment. Then, these firm-level counterfactual growth rates are weighted with the number of employees of each firm and added up to an aggregate counterfactual growth series.

The results of this exercise show that the effect of financial tightness on labour hoarding is quantitatively important for aggregate employment. Table 12 shows the percentage reduction in the variance of the counterfactual compared to actual aggregate employment.[25] Depending on the specification, the variance of the aggregate employment growth would be 15.6% to 26.7% lower if internal and external financial tightness had not influenced the scope of the firms' labour hoarding. As seen in all previous estimates, the impact is smaller when only a single tightness indicator is taken into account.

[25] Fig. 12 in the Appendix illustrates the counterfactual reported in column (1) for all time periods. Note that the effect looks slightly smaller than suggested by the reduction in the variance because this graphical representation illustrates a reduction in the standard deviation. As expected from a labour hoarding perspective, the effect is rather small during more tranquil periods, while it is quite substantial during the recession in 2009 or the recovery in 2010.

Table 12
Reduction in variance of the counterfactual compared to actual aggregate employment.

Specification	(1)	(2)	(3)	(4)
Measure of internal tightness	Liquidity	Profitability	Liquidity	Profitability
Measure of external tightness	Collateral	Collateral	Balance sheet	Balance sheet
Excluding impact of only internal tightness	−21.73	−13.19	−17.79	−11.09
Excluding impact of only external tightness	−10.40	−9.01	−8.96	−9.49
Excluding impact of internal and external tightness	−26.71	−17.19	−21.65	−15.62

The Great Recession is a good example, with which one can illustrate the impact of financial tightness on employment growth: aggregate employment of the firms included in our sample increased by 3.3% in 2008, when the economy was still growing dynamically in a period shortly before the recession set in. In 2009, aggregate employment decreased by 2.7% and rose by 1.7% in 2010.[26] The fluctuations in employment would have been smaller if the firms had faced no financial strains in liquidity and collateral. The counterfactual would have increased by 3.0% in 2008, decreased by 2.3% in 2009, and would have increased again by 0.9% in 2010. Thus, while aggregate employment growth decreased by 6.0% from peak to trough, our counterfactual only decreased by 5.3%. During the upturn in 2010, employment growth increased by 4.4%, while the counterfactual only increased by 3.2%. For the other combinations of financial tightness measures, the change in employment growth lies in the same range.

This example describes well the impact of the firms' financial tightness on the labour hoarding behaviour: financial tightness is not the cause of employment cycles, but it influences the extent of employment fluctuations.

7. Conclusions

This paper documents the role of financial tightness on employment adjustment by using firm-level data from balance sheets and income statements, including firm-level employment statistics. The data are a sample from the universe of Swiss firms, including all industries of the economy, except the financial and public sectors. Also included are very small firms, which typically do not publish their economic figures. We find that the adjustment of the firms' employment to changes in output depends on their financial situation. Firms with limited funding availability resize their labour force more strongly than firms that have abundant funding availability. Firms that are not in a financially tight situation are able to hoard more labour.

More specifically, we show not only that limited external financing is an important factor but also that the availability of internal funding, in particular, has a large influence. The strongest effect is observed if internal and external financial tightness occur jointly. Furthermore, the impact of financial tightness is generally lower for firms paying high wages. This result suggests that it is particularly costly to lay off workers with higher wages, who tend to be more-skilled workers.

The amplifying effects of financial tightness is quite similar in upturns and downturns. Firms in a strained financial situation not only decrease their employment more when output decreases but also increase their employment more strongly when output increases. Our results are therefore consistent with the view that financial tightness impedes the labour hoarding behaviour of firms, because firms that hoard labour during a downturn do not hire as much labour in an upturn. We furthermore show that this effect is relevant for aggregate employment, suggesting that employment would have declined by around two thirds of its actual decline during the Great Recession if financial tightness would not have hindered labour hoarding. This implies that financially tighter firms amplify the co-movement between employment and output. In contrast, a weak cyclicality of employment, caused by strong labour hoarding, is largely driven by financially healthy firms.

These results complement the large body of literature on the role of financial constraints on investment; in this literature, financial constraints are typically found to increase the sensitivity of investment to shocks. Through this channel, financial frictions are found to amplify the propagation of shocks to the macroeconomy. Our results suggest that a similar mechanism works through the labour market and that the depth of financial frictions is potentially important to understand labour hoarding, confirming and extending the findings in Giroud and Mueller (2017). As we look at the response of employment to changes in output, our results have implications for the cyclicality of labour productivity. In particular, an economy with more financially healthy firms would be characterized by more cyclical labour productivity. An interesting avenue for future research would be to examine the strong increase in the cyclicality of labour productivity documented in Fernald and Wang (2016) and to evaluate the role of firms' improved financial health and reduction in financial tightness.

CRediT authorship contribution statement

Gregor BÄurle: Conceptualization, Data curation, Formal analysis, Methodology, Project administration, Visualization, Writing - original draft, Writing - review & editing. **Sarah M. Lein:** Conceptualization, Methodology, Project administration,

[26] These figures do not coincide exactly with the official labour statistics (the payroll survey and the labour force survey) because the source is different and some sectors such as public administration and financial services are not included in our dataset. However, the overall development is similar.

Resources, Visualization, Writing - original draft, Writing - review & editing. **Elizabeth Steiner:** Conceptualization, Data curation, Formal analysis, Methodology, Project administration, Visualization, Writing - original draft, Writing - review & editing.

Appendix A. An empirical model of labour demand

In our empirical section, we estimate a labour demand equation. This equation can be derived from a partial equilibrium model, largely following Nickell (1986) and Nickell and Nicolitsas (1999). Even though we do not explicitly derive the financial tightness indicators from a microfoundation, this short sketch of a model is helpful for understanding the empirical estimation equation in the main text. Note that we refer here to financial constraints, not financially tight situations, because the former is the standard term used in most of the literature.

We assume a simple production function, which is identical for all firms. Firms produce output y by using labour n and capital k according to the production function (lowercase letters are all in logs):

$$y_t = a_t + \alpha n_t + (1-\alpha)k_t, \tag{5}$$

where a denotes productivity.

Firms maximise profits and take an iso-elastic demand curve with demand elasticity ε as given. The equilibrium level of labour is therefore given by the following first order condition:

$$n_t^* = \tilde{a_0} - w_t + y_t + a_t, \tag{6}$$

where $\tilde{a_o} \equiv -1/(\alpha-1)ln(\varepsilon\alpha)$ is a constant and w_t is the log real wage.

Adjusting labour is costly, and adjustment costs are denoted by the quadratic function $C_t = W_t \frac{b}{2}(\Delta N_t)$. The firm maximises the present discounted value of the firm as follows:[27]

$$max\sum_{k=0}^{\infty} E_t[\beta^{t+k}(P_{t+k} * Y_{t+k} - W_{t+k}N_{t+k} - C_{t+k})], \tag{7}$$

where β is the discount factor defined as an inverse function of the real interest rate $\beta = \frac{1}{1-r}$. Nickell (1986) shows that log-linearizing the first order condition yields the following:

$$n_t = \mu n_{t-1} + (1-\mu)(1-\mu\beta)\sum_{k=0}^{\infty}(\mu\beta)^k n_{t+k}^*., \tag{8}$$

where μ is the stable root of the Euler equation.

Plugging (6) into (8) and assuming that real wages, output, and productivity follow AR(1) processes, [28] we obtain the following:

$$n_t = \mu n_{t-1} + a_0 + a_1 y_t + a_2 a_t + a_3 w_t + \varepsilon_t, \tag{9}$$

where $a_0 \equiv \tilde{a_o}(1-\mu), a_1 \equiv \frac{(1-\mu)(1-\mu\beta)}{1-\mu\beta\rho_y}, a_2 \equiv \frac{(1-\mu)(1-\mu\beta)}{1-\mu\beta\rho_a}$, and $a_3 \equiv \frac{(1-\mu)(1-\mu\beta)}{1-\mu\beta\rho_w}$.

Following a large literature based on Bernanke et al. (1996), we assume that if firms are financially constrained, it becomes more expensive for them to obtain external finance.[29] Therefore, financing hoarded labour becomes more expensive, especially for firms with internal funds, such as cashflows or retained earnings, that are insufficient. If this is the case, then a_1 is a positive function of the financial constraint, and firms that are financially constrained are expected to have a larger a_1 than financially unconstrained firms.[30] Denote the indicator for a financially constrained firm i as $I(constrained) = 1$ and zero otherwise; then, the estimation equation is given by the following:

$$n_{i,t} = \mu n_{i,t-1} + a_{i0} + a_1^{unconstr} y_{i,t} + a_1^{constr} I(constrained)_i \times y_{i,t} + a_2 a_{i,t} + a_3 w_{i,t} + \varepsilon_{i,t}; \tag{10}$$

Thus, employment depends on lagged employment, a firm fixed effect, output and output interacted with the financial constraint, productivity, and real wages.

Appendix B. Descriptive statistics

Figs. 3–10.
Tables 13–15.

[27] To simplify, we assume that the aggregate price level is equal to one in all periods.

[28] The AR(1) processes are specified as $w_t = \rho_w w_{t-1} - p + \varepsilon_t^w, y_t = \rho_y y_{t-1} + \varepsilon_t^y$, and $a_t = \rho_a a_{t-1} + \varepsilon_t^a$, where all $E_t\varepsilon_{t+1} = 0$are uncorrelated.

[29] Costs, such as agency costs and asymmetric information, lead to an imperfect substitutability between internal and external funds and thereby to a premium on external finance (Bernanke and Gertler, 1995).

[30] In addition, a_2 and a_3 can depend on the financial constraint. We tested this empirically and found these interaction terms to be very close to zero and statistically insignificant. We therefore did not add these interactions to our baseline regressions.

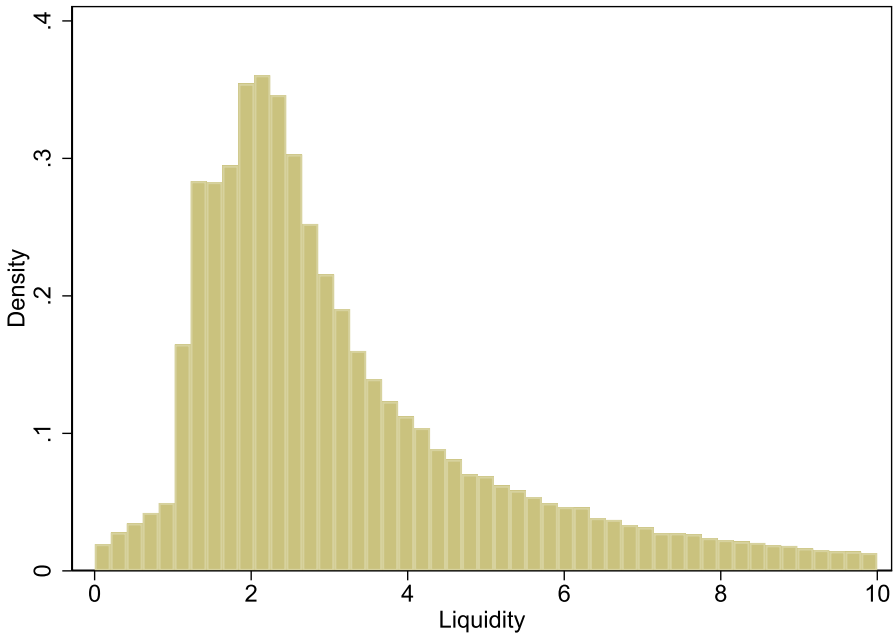


Fig. 3. Liquidity, 1999–2016. *Notes*: Distribution of firms' liquidity (sales to labour costs ratio)

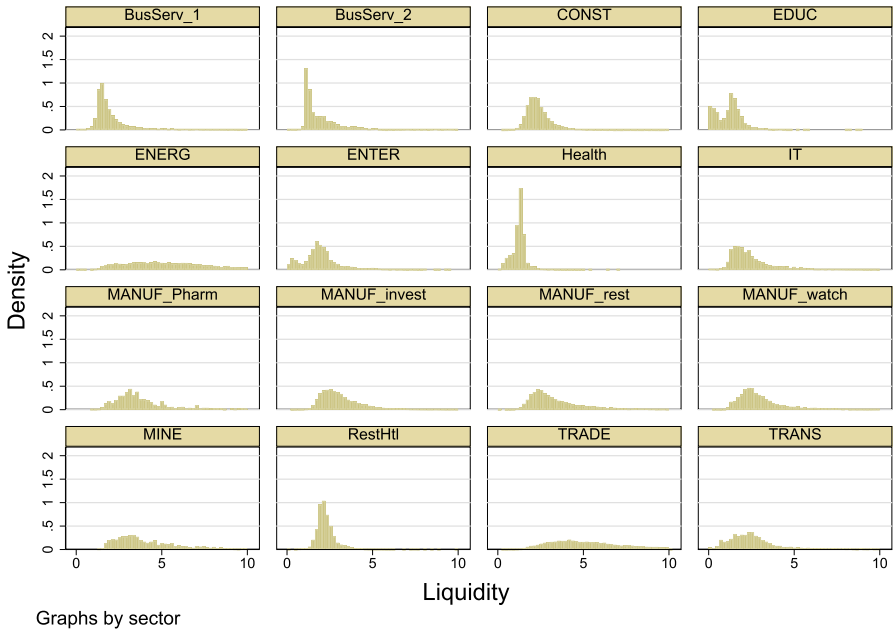


Fig. 4. Liquidity, by industry, 1999–2016.

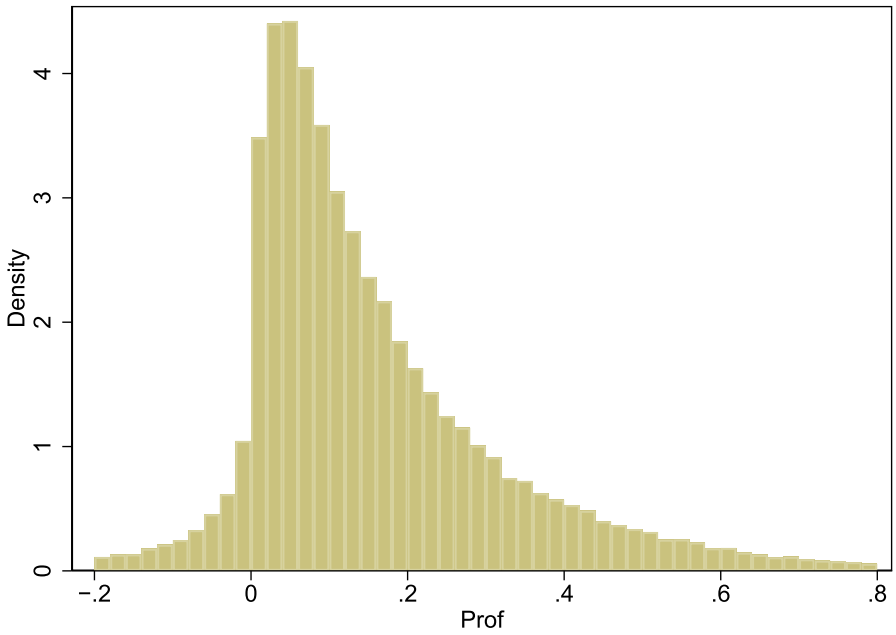


Fig. 5. Profitability, 1999–2016. *Notes*: Distribution of firms' profitability (EBIT to value added ratio)

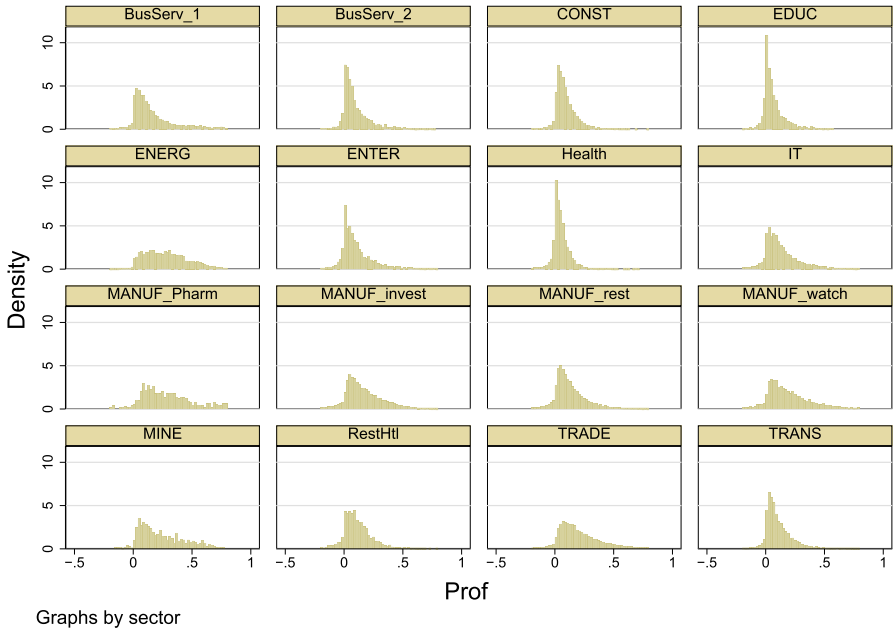


Fig. 6. Profitability, by industry, 1999–2016.

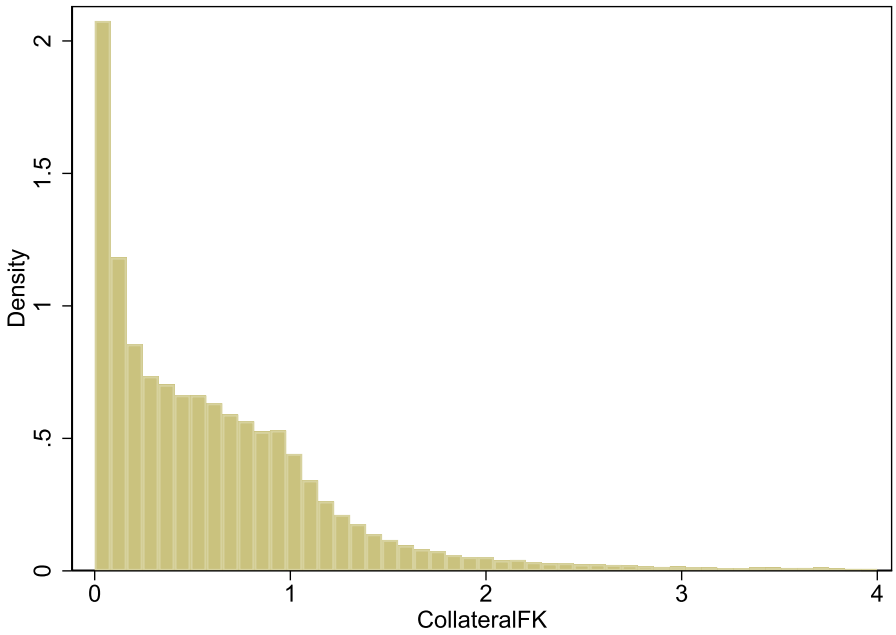


Fig. 7. Collateral, 1999–2016. Notes: Distribution of firms' collateral (sum of a firm's structures (buildings and land) and machines per unit of outstanding debt)

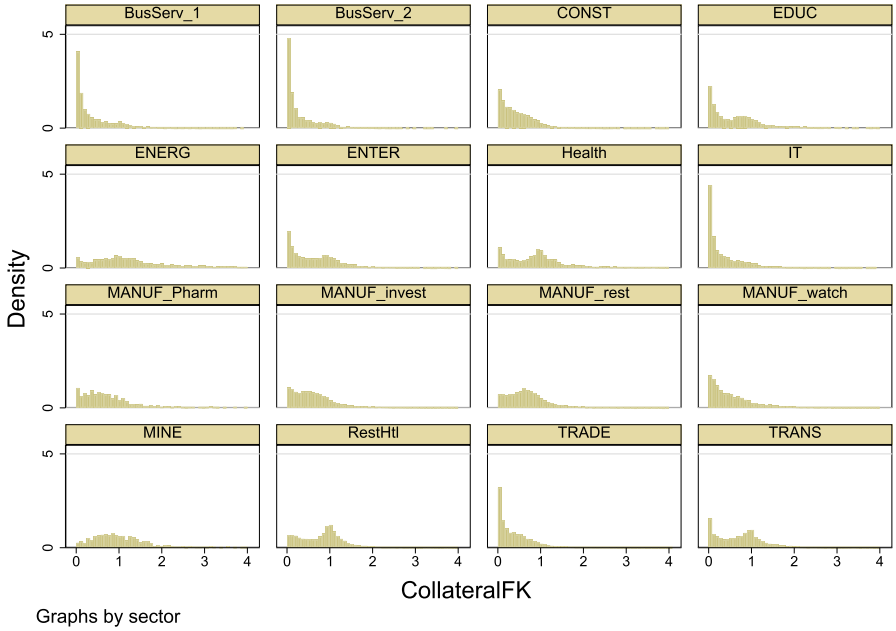


Fig. 8. Collateral, by industry, 1999–2016.

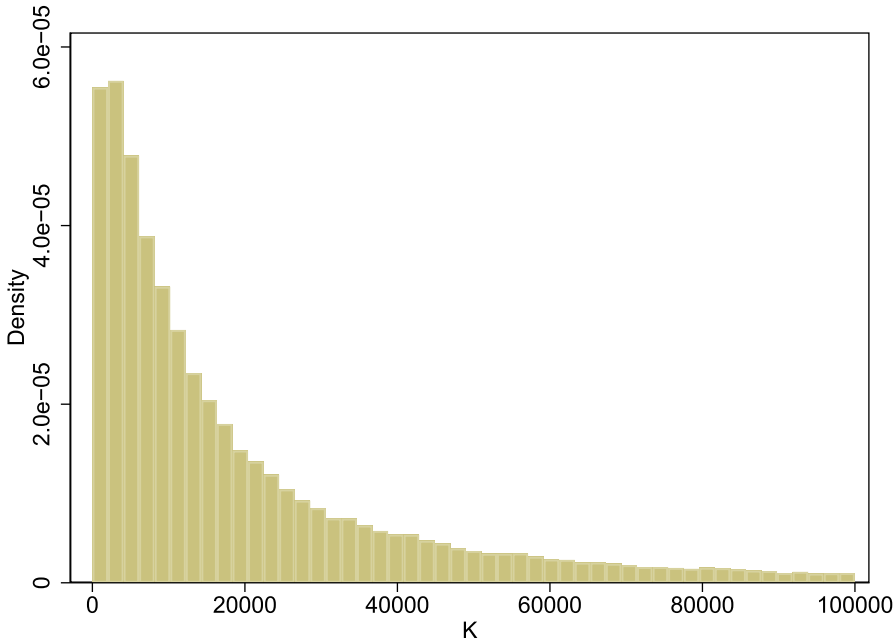


Fig. 9. Size of balance sheet, 1999–2016. *Notes*: Distribution of the size of balance sheet (in 1000 CHF)

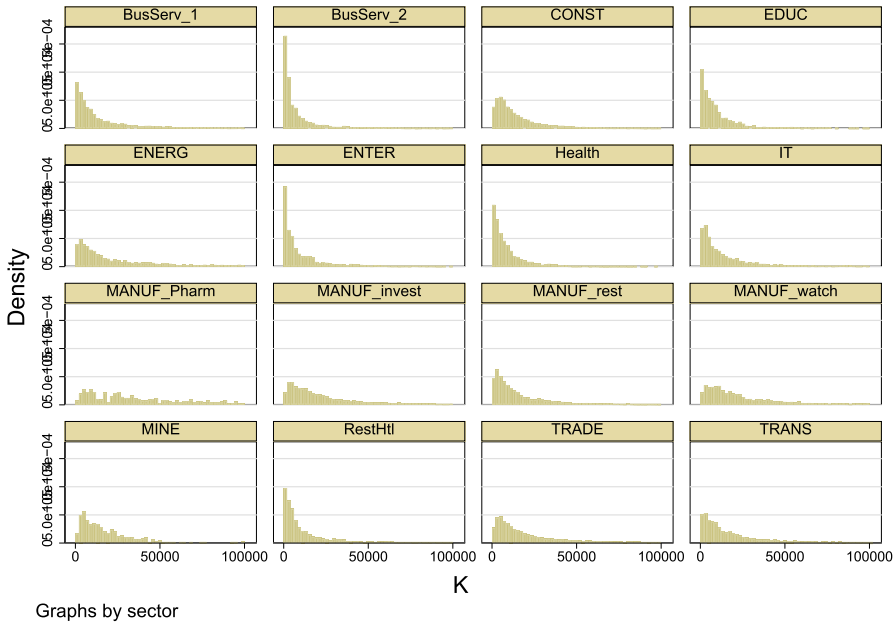


Fig. 10. Size of balance sheet, by industry, 1999–2016.

Table 13
Average share of expenditures for temporary work to total labour costs.

	in%
Aggregate	2.0
Industry	
Business Services 1	1.3
Business Services 2	2.1
Construction	4.6
Education	0.9
Energy	1.8
Entertainment	1.7
Health	1.0
IT	1.9
Manufacturing Pharmaceuticals	1.0
Manufacturing Investment goods	1.8
Manufacturing Watches and electronics	1.9
Manufacturing Other	1.3
Mining	2.8
Restaurants Hotels	1.4
Trade	1.1
Transport	1.4

Table 14
Summary statistics for temporary demand shock sample.

	Observations		*Employment*	*Value added*
	Total	Firms	average per firm	average per firm
Whole sample	15440	5530	243	48783
Industries				
Business Serv. 1	774	318	182	53013
Business Serv. 2	406	195	326	29604
Construction	2534	810	150	17589
Education	112	65	97	12772
Energy	615	204	163	66359
Entertainment	232	107	95	17722
Health	787	381	108	9658
IT	501	205	320	90433
Manuf. Pharma	167	51	994	852151
Manuf. Invest.	3586	1080	225	35384
Manuf. Other	1650	540	185	31176
Manuf. Watches	739	246	233	38721
Mining	112	41	58	12099
Rest. Hotels	370	159	211	16943
Trade	2137	865	300	53990
Transport	718	263	766	117097

Notes: See table 1 in the main text. These summary statistics apply to the sample that is in the definition for temporary demand shocks.

Appendix C. Additional results

C.1. Coefficient estimates for control variables

Table 16.

C.2. Tests for asymmetry and sensitivity to definitions of upturns and downturns

Tables 17–20.

C.3. Marginal effects by extent of financial tightness

In the main specification, we have estimated the impact for a firm facing a financially tight situation compared to that for a firm not facing a financially tight situation. Here, we first analyse the impact of financial tightness on employment for a finer grid, which enables us to provide information on whether the impact of financial tightness on employment is evenly distributed. Thereafter, we estimate the equation by using continuous data. This allows us to gain a more detailed picture of the marginal effects of financial tightness indicators.

Table 15
Summary statistics for the financial tightness variables for temporary demand shock sample.

	Liquidity		*Profitability*		*Collateral*		*Bal.Sheet*	
Whole sample	2.72	19.65	0.11	0.20	0.46	4.17	18886	2365154
Within industries								
Business Serv. 1	1.85	13.67	0.10	0.22	0.15	1.07	21198	577647
Business Serv. 2	1.76	2.19	0.06	0.15	0.18	0.51	8825	109524
Construction	2.26	1.26	0.07	0.09	0.32	0.48	12094	70482
Education	1.35	0.87	0.04	0.12	0.37	0.71	6795	27083
Energy	5.00	8.89	0.24	0.18	1.32	19.80	50128	965420
Entertainment	1.92	2.02	0.06	0.23	0.38	0.83	11420	98573
Health	1.31	0.41	0.04	0.08	0.87	2.19	7363	38123
IT	2.38	4.49	0.12	0.17	0.23	0.56	19900	1726019
Manuf. Pharma	3.87	16.53	0.30	0.27	0.62	0.93	82432	12092312
Manuf. Invest.	2.97	2.34	0.13	0.19	0.53	0.93	25072	280966
Manuf. Other	3.04	2.36	0.10	0.17	0.62	0.84	16065	214073
Manuf. Watches	2.70	1.76	0.15	0.38	0.43	0.85	25055	382069
Mining	3.41	2.87	0.18	0.18	1.32	1.31	18254	32656
Rest. Hotels	2.07	0.47	0.08	0.13	0.65	0.88	9302	40175
Trade	5.76	50.55	0.18	0.23	0.26	0.75	29924	2433298
Transport	2.63	3.37	0.08	0.13	0.76	1.26	24733	7896727
Between industries								
Industr.-means	2.51	1.25	0.10	0.07	0.48	0.36	19077	19252

Notes: See table 2 in the main text. These summary statistics apply to the sample that is in the definition for temporary demand shocks.

Table 16
Impact of a 1% change in output on employment, full regression output.

	Coefficient	Std.Err.	t	p
γ_y	0.170	0.008	22.51	0.00
$\gamma_{y,int}$	0.151	0.010	14.97	0.00
$\gamma_{y,ext}$	0.044	0.009	4.88	0.00
γ_{int}	−0.028	0.002	−15.05	0.00
γ_{ext}	−0.003	0.001	−2.04	0.04
Δe (lag)	0.016	0.001	12.57	0.00
Δw	−0.587	0.011	−55.27	0.00
Δtfp	−0.008	0.003	−2.98	0.03
$\Delta capitalstock$	−0.079	0.006	−13.79	0.00
capital/labour (lag)	0.000	0.000	2.80	0.01
year				
2001	−0.000	0.002	−0.18	0.85
2002	−0.024	0.002	−9.66	0.00
2003	−0.036	0.002	−14.56	0.00
2004	−0.029	0.002	−12.21	0.00
2005	−0.020	0.002	−9.24	0.00
2006	−0.019	0.002	−8.33	0.00
2007	−0.011	0.002	−4.90	0.00
2008	−0.012	0.002	−5.24	0.00
2009	−0.044	0.003	−15.48	0.00
2010	−0.031	0.003	−12.17	0.00
2011	−0.016	0.002	−6.34	0.00
2012	−0.031	0.002	−13.20	0.00
2013	−0.034	0.002	−15.30	0.00
2014	−0.035	0.002	−15.55	0.00
2015	−0.045	0.002	−19.51	0.00
2016	−0.043	0.002	−18.62	0.00
Constant	0.051	0.002	23.36	0.00

Full regression output is shown for Eq. (2), with, in the case of a decrease value added, low liquidity as a measure of internal financial tightness and a low collateral ratio as a measure of external financial tightness. Full regression outputs for the other specifications are available on request.

For the finer breakdown, we construct six equally sized bins. The baseline regression is estimated separately six times (once for each bin) for all eight specifications shown in Fig. 11, resulting thereby in 32 separate estimates.

The upper left chart in Fig. 11 shows the results for the specification in which the liquidity tightness indicator is combined with the collateral tightness indicator. Note that liquidity is divided into six bins, while the collateral tightness remains a binary variable. The first bin contains the lowest sixth of the distribution, i.e., the most liquidity-tight firms, while the sixth

Table 17
Asymmetry between downturn and upturn, panel data estimation.

Specification	(1)	(2)	(3)	(4)
Measure of internal tightness	Liquidity	Profitability	Liquidity	Profitability
Measure of external tightness	Collateral	Collateral	Balance sheet	Balance sheet
γ_y	−0.031	−0.026	−0.024	−0.022
	(0.020)	(0.019)	(0.017)	(0.016)
$\gamma_{y,int}$	0.042	0.074***	0.052*	0.074***
	(0.027)	(0.026)	(0.027)	(0.027)
$\gamma_{y,ext}$	−0.008	−0.009	−0.042	−0.040
	(0.025)	(0.025)	(0.028)	(0.029)

Notes: This table reports the difference between the coefficients for downturns and for upturns, both of which are reported in Tables 4 and 5. We subtract the coefficient for the upturn estimates from that of the downturn estimates. A negative and significant coefficient implies that a firm lays off more staff with a one percent decline in output than it hires with a one percent increase in output (and for a positive coefficient, vice versa). The standard deviation is in parentheses; $^{***}p < 0.01$, $^{**}p < 0.05$, and $^{*}p < 0.1$.

Table 18
Employment elasticities and financial tightness for firms with a negative deviation from aggregate nominal GDP growth.

1) Employment elasticity for not tight firms and marginal effects of financial tightness				
Specification	(1)	(2)	(3)	(4)
Measure of internal tightness	Liquidity	Profitability	Liquidity	Profitability
Measure of external tightness	Collateral	Collateral	Balance sheet	Balance sheet
γ_y	0.169***	0.198***	0.177***	0.194***
	(0.012)	(0.011)	(0.010)	(0.009)
$\gamma_{y,int}$	0.169***	0.167***	0.133***	0.135***
	(0.014)	(0.016)	(0.015)	(0.016)
$\gamma_{y,ext}$	0.051***	0.038***	0.116***	0.123***
	(0.013)	(0.014)	(0.016)	(0.016)
R^2	0.360	0.376	0.364	0.381

Notes: For all firms whose change in value added lies below nominal GDP growth, this table shows the employment response dependent on whether or not a firm was financially strained in the previous period. The direct impact of a one percent decline in output is given by γ_y on the first line. $\gamma_{y,int}$ is the marginal effect of facing internal financial tightness, $\gamma_{y,ext}$ is the marginal effect of facing external financial tightness, and $\gamma_{y,int,ext}$ is the marginal effect of facing both types of financial tightness. The standard deviation is in parentheses; $^{***}p < 0.01$, $^{**}p < 0.05$, and $^{*}p < 0.1$.

Table 19
Employment elasticities and financial tightness indicators for firms with a positive deviation from aggregate nominal GDP growth.

1) Employment elasticity for not tight firms and marginal effects of financial tightness				
Specification	(1)	(2)	(3)	(4)
Measure of internal tightness	Liquidity	Profitability	Liquidity	Profitability
Measure of external tightness	Collateral	Collateral	Balance sheet	Balance sheet
γ_y	0.188***	0.216***	0.192***	0.211***
	(0.015)	(0.015)	(0.012)	(0.013)
$\gamma_{y,int}$	0.131***	0.077***	0.091***	0.046**
	(0.020)	(0.018)	(0.020)	(0.018)
$\gamma_{y,ext}$	0.052***	0.043**	0.152***	0.168***
	(0.018)	(0.018)	(0.020)	(0.021)
R^2	0.375	0.381	0.379	0.386

Notes: For all firms whose change in value added lies above nominal GDP growth, this table shows the employment response dependent upon whether or not a firm was faced by financial tightness in the previous period. The response in employment is shown for a one percent change in output. The direct impact of a one percent decline in output is given by γ_y on the first line. $\gamma_{y,int}$ is the marginal effect of facing internal financial tightness, and $\gamma_{y,ext}$ is the marginal effect of facing external financial tightness. Robust standard errors in parentheses, $^{***}p < 0.01$, $^{**}p < 0.05$, and $^{*}p < 0.1$.

Table 20
Asymmetry between the downturn in 2009 and the upturn in 2010.

Specification	(1)	(2)	(3)	(4)
Measure of internal tightness	Liquidity	Profitability	Liquidity	Profitability
Measure of external tightness	Collateral	Collateral	Balance sheet	Balance sheet
γ_y	0.099**	0.107**	0.093***	0.096***
	(0.042)	(0.041)	(0.032)	(0.032)
$\gamma_{y,int}$	0.035	0.046	0.048	0.054
	(0.050)	(0.049)	(0.053)	(0.051)
$\gamma_{y,ext}$	−0.016	−0.019	−0.05	−0.049
	(0.056)	(0.046)	(0.048)	(0.048)

Notes: This table reports the difference between the coefficients reported in Tables 8 and 9, for the 2009 downturn and for the 2010 upturn; in the table, we subtract the coefficient for the upturn estimates from that of the downturn estimates. A positive and significant coefficient implies that a firm laid off more staff with a one percent decline in output than it subsequently hired with a one percent increase in output (and a negative coefficient vice versa). The standard deviation is in parentheses; $^{***}p < 0.01$, $^{**}p < 0.05$, and $^{*}p < 0.1$.

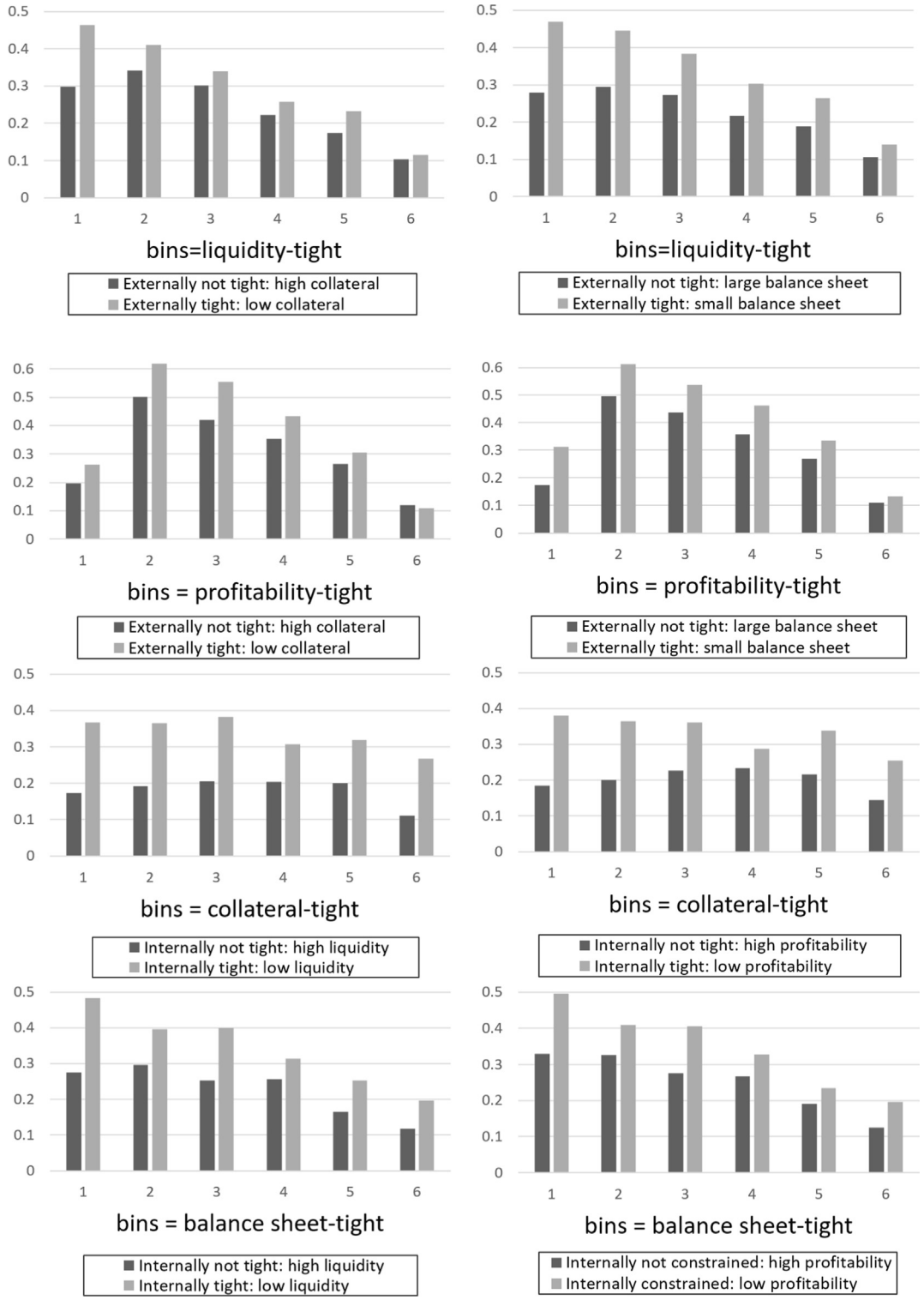


Fig. 11. Employment elasticities during a downturn and providing a finer classification of financial tightness indicators.

bin contains the less liquidity-tight firms, i.e., the firms with the most-abundant liquidity. The black bars represent the impact of a one percent decrease in output for firms that have high collateral, and the grey bars represent the impact for firms that have low collateral, i.e., that face more financial tightness according to our definitions.

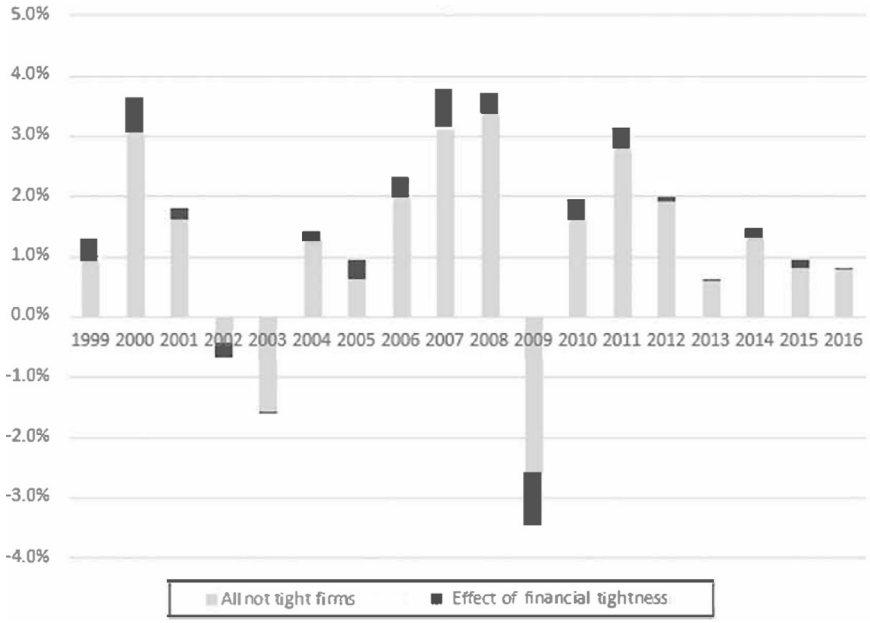


Fig. 12. Employment growth and counterfactual.

All charts in Fig. 11 show that firms lay off more labour if they face tightness along both dimensions (grey bars are larger than the black bars). Thus, the results of the baseline specification are confirmed in this exercise. The bars tend to decrease from the first to the sixth bin. This indicates that the results shown in the body of the paper are not driven by the tails of the distributions.

Moreover, Fig. 11 also shows that financial tightness does not have a linear influence on employment. The decrease is in most cases monotonic only in the upper end of the distribution (bins 4–6). At the lower end, where firms are in financially

Table 21
Employment elasticities in a linear specification.

1) Marginal effects of financial tightness - all firms				
Specification	(1)	(2)	(3)	(4)
Measure of internal tightness	Liquidity	Profitability	Liquidity	Profitability
Measure of external tightness	Collateral	Collateral	Balance sheet	Balance sheet
γ_y	0.250***	0.299***	0.288***	0.331***
	(0.006)	(0.008)	(0.006)	(0.007)
$\gamma_{y,int}$	0.001	0.151***	−0.000	0.068***
	(0.000)	(0.026)	(0.000)	(0.022)
$\gamma_{y,ext}$	0.004***	0.003***	0.053***	0.046***
	(0.001)	(0.001)	(0.003)	(0.003)
2) Firms classified as facing a financially tight situation in the baseline				
γ_y	0.339***	0.387***	0.361***	0.461***
	(0.076)	(0.048)	(0.041)	(0.025)
$\gamma_{y,int}$	0.007	−0.257***	0.003	−0.150**
	(0.013)	(0.044)	(0.011)	(0.067)
$\gamma_{y,ext}$	0.049	0.175***	0.052***	0.048***
	(0.078)	(0.065)	(0.015)	(0.013)
3) Firms classified as not facing a financially tight situation in the baseline				
γ_y	0.176***	0.301***	0.230***	0.307***
	(0.010)	(0.012)	(0.010)	(0.011)
$\gamma_{y,int}$	0.003***	0.433***	−0.000***	0.286***
	(0.001)	(0.041)	(0.000)	(0.033)
$\gamma_{y,ext}$	0.002***	0.002***	0.036***	0.018***
	(0.001)	(0.001)	(0.004)	(0.005)

Notes: This table reports the coefficients of a regression, in which financial tightness indicators are not classified as a zero/one variable, as in our baseline estimates, but instead as a continuous variable. In panel 1, we report the results for all firms, and in panel 2, we report the results for the firms that in our earlier specification are classified as facing financial tightness. In panel 3, we report the ones that are classified as not facing financial tightness in our baseline estimate. The standard deviation is in parentheses; ***$p < 0.01$, **$p < 0.05$, and *$p < 0.1$.

Table 22
Elasticities and financial constraints including Long-term effects.

1) Long-term employment elasticity for not tight firms and marginal effects of financial tightness				
Specification	(1)	(2)	(3)	(4)]
Measure of internal tightness	Liquidity	Profitability	Liquidity	Profitability
Measure of external tightness	Collateral	Collateral	Balance sheet	Balance sheet
γ_{lr}	0.007**	−0.005	0.006*	−0.007**
	(0.003)	(0.003)	(0.003)	(0.003)
$\gamma_{lr,int}$	0.003	0.002	0.004**	0.006***
	(0.002)	(0.001)	(0.002)	(0.001)
$\gamma_{lr,ext}$	−0.002	−0.002	0.002	−0.002
	(0.001)	(0.001)	(0.004)	(0.003)
2) Short-term employment elasticity for not tight firms and marginal effects of financial tightness				
γ_{y}	0.173***	0.192***	0.175***	0.183***
	(0.008)	(0.008)	(0.007)	(0.007)
$\gamma_{y,int}$	0.152***	0.128***	0.116***	0.095***
	(0.010)	(0.010)	(0.010)	(0.010)
$\gamma_{y,ext}$	0.043***	0.032***	0.114***	0.130***
	(0.009)	(0.009)	(0.010)	(0.011)
R^2	0.373	0.379	0.378	0.388

Notes: Panel 1 shows the long-term effects of a change in output on employment. γ_{lr} is the long-term effect on a firm not facing financial tightness. $\gamma_{lr,int}$ and $\gamma_{lr,ext}$ measure the additional long-term effect stemming from internal and external tightness. For a one percent change in output, panel 2 shows the employment response dependent upon whether or not a firm faced financial tightness in the previous period. The direct impact of a one percent decline in output is given by γ_y on the first line. $\gamma_{y,int}$ is the marginal effect of being in an internally tight financial situation, and $\gamma_{y,ext}$ is the marginal effect in an externally tight financial situation. Robust standard errors are in parentheses; $^{***}p < 0.01$, $^{**}p < 0.05$, and $^{*}p < 0.1$.

more tighter situations (bins 1–3), the pattern is not clear-cut. In fact, the firms in bin 1 often have a lower elasticity than the firms in the following bins. This is the case especially for the profitability measure of financial tightness (both charts on the second line). Nonetheless, on average, the impact tends to be higher for financially tighter firms (bins 1–3) than for firms that are less financially tight (bins 4–6). These results indicate that our binary classification with the median as the threshold in the baseline specification is a sound choice. Depending on the point in the distribution, the coefficients of a linear specification would not be robust.

We illustrate this feature with a linear estimation complemented by a piece-wise estimation. Based on a linear specification, the impact of financial tightness on employment is shown in Table 21. The coefficients of the interaction terms, $\gamma_{y,int}$ and $\gamma_{y,ext}$, are significant in most cases and have the correct sign.[31] As a further robustness check, the estimation based on the observations that are classified as being those of firms in a financially tight situation in the baseline regression are shown in panel 2). Similarly, in panel 3, the results are shown for firms that are classified as not facing a financially tight situation). The results for the firms with more intense financial tightness show that there are two negative coefficients, namely, the two coefficients that measure the marginal impact of a change in profitability. This confirms the results discussed above. In these two specifications, external tightness has a positive and significant coefficient. Overall, the results in Section 2 indicate that it is not possible to measure the marginal effects of financial tightness on employment for firms in the lower part of the distribution. In contrast, the coefficients for the less-tight firms are mostly significant and positive, reflecting the monotonicity seen in Fig. 11 for the upper range of the distribution.

Appendix D. Longer-term effects

The baseline specification focuses on the short-term impact of financial tightness indicators on labour hoarding. In the following, we test if the financial situation of a firm has long-term effects. In a first step, we estimate the firms' desired employment $e^*_{i,t}$ by means of the following CD production function:

$$e^*_{i,t} = \frac{1}{\beta} y_{i,t} - \frac{1-\beta}{\beta} k_{i,t} - \frac{1-\beta}{\beta} tfp_{i,t} + \epsilon_{i,t}, \tag{11}$$

where $y_{i,t}$ is output, $k_{i,t}$ is the capital stock, $tfp_{i,t}$ is total factor productivity (all in logs), and β is the CD production function parameter.

In a second step, the baseline regression Eq. (12) is augmented with the residuals from the long-term Eq. (11). The long-run response of employment to a change in output is given by the coefficient γ_{lr}, which measures the part of the deviation from the long-run relationship $\epsilon_{i,t}$ that will dissipate in the following period. $\gamma_{lr,int}$ and $\gamma_{lr,ext}$ measure the additional long-run effect stemming from internal and external financial tightness.

[31] Financial tightness indicators are defined as the deviation of the annual mean from the firm-specific measure of tightness. Therefore, lower liquidity, lower profitability, lower collateral or a smaller balance sheet lead to a rise in the measure of tightness and should, in turn, lead to a larger adjustment in employment. Thus, the coefficient of the interaction terms, $\gamma_{y,int}$ and $\gamma_{y,ext}$, should be positive.

Table 23
Employment elasticities, alternative specifications.

Specification	(1) Baseline	(2) Interaction with industry	(3) Industry-time fixed effects	(4) Industry-fixed effects	(5) GMM-based estimate
Measure of tightness: Collateral and Liquidity					
γ_y	0.170***	0.161***	0.151***	0.158***	0.149***
	(0.008)	(0.008)	(0.015)	(0.013)	(0.049)
$\gamma_{y,int}$	0.151***	0.156***	0.157***	0.168***	0.168***
	(0.010))	(0.020)	(0.020)	(0.018)	(0.027)
$\gamma_{y,ext}$	0.044***	0.047**	0.046**	0.037**	0.070**
	(0.009)	(0.019)	(0.019)	(0.016)	(0.026)
Measure of tightness: Collateral and Profitability					
γ_y	0.194***	0.193***	0.186***	0.187***	0.185***
	(0.008)	(0.015)	(0.015)	(0.013)	(0.047)
$\gamma_{y,int}$	0.128***	0.140***	0.136***	0.163***	0.192***
	(0.010)	(0.022)	(0.022)	(0.019)	(0.027)
$\gamma_{y,ext}$	0.033***	0.033*	0.032	0.024	0.054**
	(0.009)	(0.012)	(0.020)	(0.017)	(0.026)
Measure of tightness: Balance sheet and Liquidity					
γ_y	0.172***	0.167***	0.157***	0.156***	0.160***
	(0.006)	(0.013)	(0.013)	(0.010)	(0.046)
$\gamma_{y,int}$	0.114***	0.120***	0.120***	0.120***	0.122***
	(0.010)	(0.021)	(0.021)	(0.019)	(0.029)
$\gamma_{y,ext}$	0.113***	0.105***	0.106***	0.124***	0.131***
	(0.010)	(0.023)	(0.023)	(0.019)	(0.030)
Measure of tightness: Balance sheet and Profitability					
γ_y	0.186***	0.187***	0.178***	0.170***	0.190***
	(0.006)	(0.012)	(0.012)	(0.011)	(0.045)
$\gamma_{y,int}$	0.094***	0.107***	0.104***	0.124***	0.155***
	(0.010)	(0.023)	(0.023)	(0.019)	(0.029)
$\gamma_{y,ext}$	0.127***	0.116***	0.117***	0.132***	0.125***
	(0.011)	(0.023)	(0.023)	(0.019)	(0.030)

Notes: The first panel on the top shows the response in employment to a one percent change in output, to collateral and liquidity tightness measures for internal and external tightness, respectively. The direct impact of a one percent decline in output is given by γ_y on the first line. $\gamma_{y,int}$ is the marginal effect of being in an internally tight financial situation, and $\gamma_{y,ext}$ is the marginal effect of an externally tight financial situation. The standard deviation is in parentheses; $^{***}p < 0.01$, $^{**}p < 0.05$, and $^{*}p < 0.1$. The panels below repeat the same analysis for different tightness definitions, as indicated in the panel headers. The columns indicate the estimation strategy. In column (1), we repeat our baseline estimates; in column (2), we include industry-fixed effects interacted with the measures of financial tightness indicators; in column (3), we include industry and time fixed effects; in column (4), we include industry fixed effects and omit the firm-fixed effects. In column (5), we use GMM with three lagged values (starting from $t-2$) of the change in employment for the moment conditions.

$$\begin{aligned}\Delta e_{ti} =& \gamma_{lr}\epsilon_{i,t-1} + \gamma_{lr,int}Int_{i,t-1}\epsilon_{i,t-1} + \gamma_{lr,ext}Ext_{i,t-1}\epsilon_{i,t-1} \\ &+\tilde{\gamma}_n\Delta e_{i,t-1} + \gamma_y\Delta y_{i,t} + \gamma_{y,int}Int_{i,t-1}\Delta y_{i,t} + \gamma_{y,ext}Ext_{i,t-1}\Delta y_{i,t} \\ &+\gamma_{int}Int_{i,t-1} + \gamma_{ext}Ext_{i,t-1} + \tilde{\gamma}_w\Delta w_{i,t-1} + \tilde{\beta}X_{i,t-1} + \epsilon_{i,t},\end{aligned} \tag{12}$$

The estimate results are shown in Table 22. The long-term effect of a change in output on employment is shown in panel 1. γ_{lr}, the long-run employment elasticity for firms, is in all cases very small and mostly not significant. γ_{lr} has a negative sign and is significant only in one case. Moreover, $\gamma_{lr,int}$ and $\gamma_{lr,ext}$ are also very small and in most specifications insignificant. The short-term adjustment coefficients reported in panel 2 are quantitatively very similar to those of the baseline regression, indicating that including the long-term does not change the short-term estimates and is not an important mechanism per se. However, we have a rather short time period (T is substantially smaller than N); therefore, the long-run estimates may suffer from small sample problems.

Appendix E. Further robustness tests

In the following, to test the robustness of our results, we conduct several estimates with alternative specifications.

In the baseline specification, equations use firm-fixed effects to control for firm-specific unobserved fixed effects that could be correlated with the regressor. It is therefore redundant to include industry-fixed effects in the regressions. It is however possible that industry-fixed effects interacted with the measures of financial tightness may have an impact on the degree of labour hoarding. The results of this test (column 2 in Table 23) are practically identical to those of the baseline specification, indicating that the inclusion of these interaction terms is not necessary.

Table 24
Employment elasticities when including interaction terms with other variables in the equation.

Specification	(1) Baseline	(2) Interaction with $\Delta e_{i,t-1}$	(3) Interaction with $\Delta w_{i,t}$	(4) Interaction with change in capital stock	(5) Interaction with capital-stock -to-FTE-ratio
Measure of tightness: Collateral and Liquidity					
γ_y	0.170***	0.155***	0.153***	0.163***	0.159***
	(0.008)	(0.020)	(0.015)	(0.015)	(0.015)
$\gamma_{y,int}$	0.151***	0.161***	0.179***	0.155***	0.156***
	(0.010)	(0.015)	(0.021)	(0.020)	(0.020)
$\gamma_{y,ext}$	0.044***	0.048**	0.045**	0.045**	0.050***
	(0.009)	(0.019)	(0.019)	(0.019)	(0.019)
Measure of tightness: Collateral and Profitability					
γ_y	0.194***	0.195***	0.188***	0.196***	0.193***
	(0.008)	(0.015)	(0.015)	(0.015)	(0.015)
$\gamma_{y,int}$	0.128***	0.136***	0.164***	0.136***	0.136***
	(0.010)	(0.022)	(0.0223)	(0.022)	(0.022)
$\gamma_{y,ext}$	0.033***	0.032	0.027	0.030	0.034*
	(0.009)	(0.020)	(0.020)	(0.020)	(0.020)
Measure of tightness: Balance sheet and Liquidity					
γ_y	0.172***	0.167***	0.153***	0.168***	0.168***
	(0.006)	(0.013)	(0.012)	(0.013)	(0.013)
$\gamma_{y,int}$	0.114***	0.120***	0.139***	0.119***	0.119***
	(0.010)	(0.021)	(0.022)	(0.021)	(0.021)
$\gamma_{y,ext}$	0.113***	(0.104***	(0.127***	(0.105***	(0.105***
	(0.010)	(0.023)	(0.024)	(0.023)	(0.023)
Measure of tightness: Balance sheet and Profitability					
γ_y	0.186***	0.167***	***0.153	0.168***	0.168***
	(0.006)	(0.013)	(0.012)	(0.013)	(0.013)
$\gamma_{y,int}$	0.094***	0.120***	0.139***	0.119***	0.119***
	(0.010)	(0.021)	(0.022)	(0.021)	(0.021)
$\gamma_{y,ext}$	0.127***	0.104***	0.127***	0.105***	0.105***
	(0.011)	(0.023)	(0.024)	(0.023)	(0.023)

Notes: The first panel on the top shows the response in employment to a one percent decline in output to collateral and liquidity tightness indicators used as measures for internal and external tightness, respectively. On the first line, the direct impact of a one percent change in output is given by γ_y. $\gamma_{y,int}$ is the marginal effect of being in an internally financially strained situation, and $\gamma_{y,ext}$ is the marginal effect of being in an externally financially strained situation. The standard deviation is in parentheses; ***$p < 0.01$, **$p < 0.05$, and *$p < 0.1$. The panels below repeat the same analysis for different financial tightness definitions, as indicated in the panel headers. The columns indicate the estimation strategy. In column (1), we repeat our baseline estimates. In column (2), we interact the financial tightness indicator with the lagged change in employment; in column (3), with the change in the average wages; in column (4), with the change in the capital stock; and in column (6), with the K/E ratio.

Table 25
Specification tests for GMM estimate.

	Collateral Liquidity	Collateral Profitability	Balance sheet Liquidity	Balance sheet Profitability
Arellano-Bond test for 2nd-order autocorrelation	0.85	0.87	0.79	0.95
Hansen test for overidentifying restrictions	0.69	0.55	0.56	0.44

p-values (Hansen test: based on $\chi^2(90)$ distribution).

Next, we test whether the inclusion of industry-level trends influences the reaction of employment to a change in output. For this purpose, we add industry-time-fixed effects to our baseline equation. The results (column 3) show that industry-time-fixed effects have practically no impact on the marginal effect of financial tightness on employment.

Given we are working with an unbalanced sample of firms in which the industries remain constant over time, while the universe of firms changes from year to year, the unobserved heterogeneity caused by time independent factors may be better controlled for by introducing industry-fixed effects, instead of using firm-fixed effects. The estimate results (column 4) are very similar to the baseline results.

As already discussed, in a dynamic model such as ours, at least the lagged dependent variable might be correlated with the error term. The problem is typically addressed by using a GMM estimate, as proposed by Arellano and Bond (1991) (column 5). The application of this estimator yields a slightly more pronounced effect of the financial tightness indicators. The small difference between the estimates of the coefficients of interest is likely caused by the fact that the autocorrelation of

our dependent variable is quite contained, and with 19 years of data, the time-series dimension of our dataset is reasonably large.[32]

In our baseline specification, to keep the number of coefficients small, we left out several interaction terms. While from a theoretical point of view, financial tightness should interact with all variables in the model, the baseline equation includes only the interaction terms of financial tightness with the demand changes and the industry-fixed effects. We have conducted robustness tests by further including the interaction terms of financial tightness with the following variables: the change in employment in $t-1$ (column 2 in Table 24); the change in wages in t (column 3); the change in capital stock in t (column 4); the capital-stock-to-FTE ratio in $t-1$ (column 5); and finally, the change in total factor productivity in t (not shown in Table 24). These interaction terms are in some specifications significant, but the coefficients are very small, and the impact on labour elasticity is minor.

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[32] We use three lagged values of $\Delta e_{t-1,i}$ as a basis for the moment conditions. We test the validity of instruments using the Hansen statistic, and we test for remaining second-order autocorrelation in the first difference of the error term. Neither test points to misspecification; see Table 25 below.

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