DISCUSSION PAPERS
Institute of Economics
University of Copenhagen

02-10

Do Financial Market Imperfections Affect the Cyclicality of Employment?

João Ejarque

Studiestræde 6, DK-1455 Copenhagen K., Denmark
Tel. +45 35 32 30 82 - Fax +45 35 32 30 00
http://www.econ.ku.dk

Do Financial Market Imperfections affect the Cyclicality of Employment?

João Ejarque*

October 3, 2002

Abstract

In this paper I show that the idea that firms faced with a liquidity constraint display "excess sensitivity" of employment to shocks is not correct. The employment decision is independent of the financing constraint and artificial data shows that there is no such excess sensitivity.

Keywords: Employment volatility, Investment, Q Theory.

JEL Classification: E22, J63.

*Preliminary, comments wellcome. Institute of Economics, University of Copenhagen. Studiestraede 6, 1455 Copenhagen K, Denmark. Email: Joao.Ejarque@econ.ku.dk.

1 Introduction

A mainstream conclusion of empirical tests of neoclassical investment models of the firm is the existence of financing constraints. One strand of this literature uses labor to come to the same conclusion. The idea is that firms faced with a liquidity constraint will change their employment decisions to help alleviate the constraint on capital investment. This is translated into an "excess sensitivity" of employment to any shocks the constrained firm faces, relative to the unconstrained firm.

In this paper I use a standard model of the investment and employment decisions of the firm to investigate whether the above idea is true. Earlier empirical work - Cantor (1990), Sharpe (1994) - uses largely a non structural empirical specification to test this idea. Here I calibrate an artificial model and study its implications on artificial data.

In the absence of adjustment costs to labor the employment decision is independent of the financing constraint. The artificial data accordingly shows that there is no excess sensitivity of employment to shocks in the presence of the constraint.

If employment is subject to adjustment costs, the employment decision is affected by the constraint, but its effect is to reduce the variability of both labor and capital, since the constraint affects both variables as it is imposed on the total resources of the firm. Again in this model, there is no evidence of excess sensitivity of employment to shocks arising from the inclusion of a financial constraint.

The actual empirical results of Cantor are at odds with the outcome of this paper, and so are many of the ideas underlying the work of Sharpe. This suggests the issue of the excess sensitivity of employment to shocks arising from financial constraints deserves another look.

2 Model

A firm maximizes the expected present value of dividends. Dividends (D) are the remaining flow after subtracting wage costs, investment costs, adjustment costs to capital, and a fixed production cost (ξ) from the total revenue of the firm. The firm may be unable to borrow, and in that case for simplicity I use the extreme form $D \geq 0$ for the financing constraint. An alternative form such as that used in Gomes (2001) will serve the same purposes even though it may deliver different quantitative results. We can write

$$D = R(A, k, l) - wl - I - C(I, k) - \xi$$

where R stands for sales revenue and I denotes investment. Capital depreciates at the rate δ. The evolution of capital follows $k' = (1 - \delta)k + I$. The adjustment cost function for capital is quadratic ($\theta = 2$) following the literature benchmark:[1]

$$C(I,k) = \frac{\gamma}{\theta} k \left[\frac{I}{k} - v \right]^{\theta}$$

where v is a bliss point parameter in adjustment costs.

Technology (A) is random with a stochastic process given by $A_t = \exp(x_t)$, and $x_t = \rho x_{t-1} + \varepsilon_t$, with $\varepsilon_t \sim N(0, \sigma)$. Agents know the current realization of the random variable before they take their decisions. They also know all the structure of the economy.

The revenue function allows for market power and is given by $R = p(y)y = y^{1-\eta}$, $0 < \eta < 1$, where $y_t = A_t (k_t)^{\alpha} (L_t)^{1-\alpha}$, and $0 < \alpha < 1$. The dynamic programming problem, where $V(A,k)$ denotes the value of entering the current period with stock k, and facing shock A, can be written as

$$V(A,k) = \max_{k',l} \{ D(1+\lambda) + \beta EV(A', k') \}$$

where $\beta = \frac{1}{1+r}$ is the discount factor which reflects the required return on equity, and λ is the Lagrange multiplier on the borrowing constraint. It is clear from the statement of the dynamic programming problem that the first order condition for labor will be unaffected by the Lagrange multiplier on the constraint. It is this fact that raises doubts regarding any excess sensitivity of employment to shocks arising from the borrrowing constraint. It is useful now to state the employment policy function arising from the static first order condition for labor ($w = MPL$), since this expression will be used to eliminate labor from the problem.

$$L_t = \left[\left(\frac{(1-\alpha)(1-\eta)}{w} \right)^{\frac{1}{\eta + \alpha(1-\eta)}} \right] \left[A_t^{\frac{(1-\eta)}{\eta+\alpha(1-\eta)}} \right] k_t^{\frac{\alpha(1-\eta)}{\eta+\alpha(1-\eta)}}$$

Now, insierting this expression back in the problem we can rewrite it only in terms of capital with $R - wL = z_t (k_t)^{\tilde{\alpha}}$, where $\tilde{\alpha} = \frac{\alpha(1-\eta)}{\eta+\alpha(1-\eta)}$, and

$$z_t = [\eta + \alpha(1-\eta)] \left[\left(\frac{(1-\alpha)(1-\eta)}{w} \right)^{\frac{(1-\alpha)(1-\eta)}{\eta+\alpha(1-\eta)}} \right] \left[A_t^{\frac{(1-\eta)}{\eta+\alpha(1-\eta)}} \right]$$

Setting the random variable equal to its unconditional expectation we can determine a certainty equivalent steady state, used to center the numerical model.

3 Calibration

The discount factor is set at $\beta = 0.939 = 1/1.065$. The revenue parameters are $\alpha = 0.3$, and $\eta = 0.1$ which deliver a share of labor costs over sales revenue

[1] Gross adjustment costs for capital (those that exist even if $\Delta k = 0$) can arise when delivery of the new machine takes time, or when learning about the new machine takes time.

(wL/R) equal to $(1-\alpha)(1-\eta) = 0.63$, and a value for $\tilde{\alpha} = 0.729(729)$. This value of $\tilde{\alpha}$ is close to the estimates of Cooper and Ejarque (2001), and the partition between labor and capital is close to the standard in the literature.[2]

Whited (1992) suggests the value of $v = 0$, and this is the benchmark.[3] Gilchrist and Himmelberg (1995) have $\delta = I/k = 0.18$, and set the price of capital at 1, which is also the case here. Gomes (2001) uses $\delta = 0.12$. Here I use the intermediate value of $\delta = 0.15$. From Abel and Eberly (1995) adjustment costs to capital are around 12% of total investment costs, $\frac{ack}{ack+pI} = z = 0.12$, and this produces a value of $\gamma = 1.81$.[4]

$$z = \frac{\frac{\gamma}{\theta}k\left[\delta - v\right]^{\theta}}{\frac{\gamma}{\theta}k\left[\delta - v\right]^{\theta} + \delta k} = \frac{\gamma}{\gamma + \theta\delta\left[\delta - v\right]^{-\theta}} \Rightarrow \gamma = \frac{\theta\delta}{\left[\delta - v\right]^{\theta}}\frac{z}{1-z} = 1.81$$

Adjustment costs will then be a fraction of revenue equal to

$$\frac{AC}{R} = \frac{\frac{\gamma}{\theta}\left[\delta - v\right]^{\theta}}{R/k} = \frac{\frac{\gamma}{\theta}\left[\delta - v\right]^{\theta}\alpha(1-\eta)}{r + \delta + r\gamma\left(\delta - v\right)^{\theta-1} + \frac{\gamma}{\theta}\left(\delta - v\right)^{\theta}} = 0.0217$$

The values above determine a steady state fraction of investment expenditure over sales revenue equal to $\frac{I}{R} = 0.16007$. Finally, the wage is so far a free parameter as it simply scales labor since we fixed the labor share. It so happens that for numerical purposes it is convenient to set the wage at the value

$$w = (1-\alpha)(1-\eta)\left[\eta + \alpha(1-\eta)\right]^{\frac{\eta+\alpha(1-\eta)}{(1-\alpha)(1-\eta)}}$$

The fixed cost ξ is set such that the firm is less profitable, and such that the borrowing constraint will bind significant at low levels of capital when the firm will want to grow. This must be set such that at the lowest capital stock contained in the state space the firm will be able to just break even if it remains with the same capital stock or at best grows very little. The state space starts above zero, implying that in order for a firm to exist at all, it must be able to finance this initial capital stock out of private equity (this of course when the constraint is imposed). When the constraint is not imposed, the fixed cost is irrelevant. Finally, the persistence of the shock is set high such that optimal decision varies with the state A. With shocks close to iid, the decision function becomes $k_{t+1}(A_t, k_t) \approx k_{t+1}(k_t)$, fairly independent of A.

Summarizing, the benchmark parameterization is

α	η	γ	θ	δ	w	r	v	ρ	σ
0.3	0.1	1.81	2	0.15	0.35	0.065	0	0.85	0.04

[2] Gomes (2001) uses $\alpha_k + \alpha_l = 0.95$, with $\alpha_k = 0.3$ and $\alpha_l = 0.65$.

[3] Another significant benchmark is to set $v = \delta$, implying there are no adjustment costs in steady state.

[4] I should note that this number is very different from the value estimated by Cooper and Ejarque (2001), which is one order of magnitude smaller (0.15)

3.0.1 Discussion

This calibration is taken from the literature. A reasonable number of sources use the same data, namely the COMPUSTAT, and therefore these numbers should roughly match well together. In any case, the exact parameterization is immaterial for the result. The values used for the fixed cost were set to reduce the profitability of the firm. Even with the fixed cost the firm is still very profitable. However, the calibration achieves the purpose of generating a segment where the firm is constrained (at low levels of capital) which is associated in the experiments below to the stage when a firm is young, and therefore interpreted to be more constrained from empirical experiments. Finally, the stochastic process is discretized using Tauchen's method, and as we can see from the experiments below, small changes in the standard deviation induce large changes in the support for capital, reducing numerical accuracy. Therefore, the model has less volatility than that present in the data in Cantor. But again, that is irrelevant for the results below.

I should note that for the data split in Cantor (1990), firms identified as constrained (with high leverage), are about the same size on average as unconstrained firms. In the face of this model that is unlikely, but again this model is standard, so that puzzle is not of concern here. One other interesting fact from Cantor's data is that the constrained subsample which has a higher volatility of employment and investment also has a equivalently higher volatility of sales. This is odd, when associated to the presence of constraints impeding investment: The constraint should limit the movement of all variables in the firm, and not increase all volatilities. Note that while a higher volatility of sales will make it more likely for the firm to hit the constraint this is a second order effect. The key factor making the firm hit the constraint is having a very low capital stock, far below where the firm will normally be on average. This is what happens in the young firms experiment below.

4 Experiments

The first experiment is to run the model with and without the borrowing constraint and examine the differences. I run both the unconstrained (U) and the constrained (C) model and compute the following statistics from a ten thousand long artificial time series.[5]

σ	$\sigma^2\left(\frac{\Delta L}{L}\right)$	$\sigma^2\left(\frac{I}{k}\right)$	$\sigma^2\left(\frac{R}{k}\right)$	$\sigma^2\left(\frac{D}{k}\right)$	Δk^*	
0.02	0.0523	0.0200	0.0716	0.0267	$29-87$	U
0.04	0.1046	0.0398	0.1413	0.0396	$16-154$	U
0.02	0.0513	0.0199	0.0711	0.0264	$29-87$	C
0.04	0.1045	0.0395	0.1417	0.0399	$16-54$	C

[5]Note that using a time series without imposing size constraints is consistent with the sample split in Cantor, since high and low leverage firms have similar average sizes.

and also

σ	$\frac{k}{L}$	$\frac{R}{k}$	$\frac{cf}{k}$	$\frac{D}{R}$	$\frac{I}{R}$	$\frac{AC}{R}$	$\frac{\xi}{R}$	$D<0$	
0.04	0.614	0.929	0.275	0.114	0.160	0.022	0.073	0.001	U
0.04	0.610	0.935	0.277	0.116	0.159	0.022	0.073	0	C

This experiment shows us a few things. First, labor growth is more volatile than the investment to capital ratio as we see in the data. Second, if we match the volatility of $\frac{\Delta L}{L}$, negative dividends still virtually do not happen in the unconstrained model.[6] It looks like we need more variance. But higher variance will increase the support of the state space and reduce numerical accuracy. Fortunately, the next experiment will allow examination of the behaviour of a constrained firm without such large movements in the firm, and the accuracy problems that brings.

The second experiment is to see whether a panel division (where here picking constrained firms will be necessarily picking the smaller younger ones) will generate the results. That is: whether looking only at the policy function segment where a firm is constrained implies very different behaviour. To this purpose I generate a panel of 1000 firms, each with a time series of 17 periods - as in Cantor's data - and each of them starting at the initial capital stock in the state space of the program, which is well below the lowest conditional steady state.[7] The initial technology state is a random draw, and can be any of the elements in the shock space - in this case 7 elements. For each firm I compute the statistics in the table below, and show the cross section minimum, maximum, median, mean and standard deviation across the 1000 firms, for each statistic. First the results for the panel where no firm is constrained,

U $\sigma = 0.04$	$\sigma^2\left(\frac{\Delta L}{L}\right)$	$\sigma^2\left(\frac{I}{k}\right)$	$\frac{\sigma^2\left(\frac{\Delta L}{L}\right)}{\sigma^2\left(\frac{I}{k}\right)}$	$mean\left(\frac{D}{R}\right)$	$\min(D)$	$\max(D)$	$\%D<0$
min	0.0400	0.0262	0.566	-0.0499	-8.32	0.60	0.250
max	0.2229	0.1644	3.555	$+0.0271$	-2.43	13.1	0.812
med	0.1217	0.0896	1.385	-0.0160	-4.90	4.72	0.437
mean	**0.1233**	**0.0907**	1.482	-0.0153	-5.30	5.00	0.442
std	0.0248	0.0289	0.494	0.0142	1.81	2.43	0.106

and here we see that these 1000 firms spend on average around 44% of the time (out of 17 years) with negative dividends. This implies the constraint will

[6] One feature of this model calibration is that labor is too volatile relative to the I/K ratio. There are two ways to correct this. To try to increase the volatility of the I/K ratio, or to reduce the volatility of labor. The first approach adds noise to the investment process and looking into stochastic capital embodied technological process and measurement error falls into this category. The second has a simple solution which is to introduce adjustment costs to labor. However - even though this will make the borrowing constraint bind in more interesting ways, the prior is that this will limit the ability of employment to adjust to shocks rather than the opposite.

[7] This is the point where the lowest policy function crosses the 45 degree line, that is, the point k^*_{low}, defined by $k^*_{low} = k'\left(A_{low}, k^*_{low}\right)$.

be strongly binding once introduced. What then happens to the volatility of employment and investment once the constraint is introduced?

C $\sigma = 0.04$	$\sigma^2\left(\frac{\Delta L}{L}\right)$	$\sigma^2\left(\frac{I}{k}\right)$	$\frac{\sigma^2\left(\frac{\Delta L}{L}\right)}{\sigma^2\left(\frac{I}{k}\right)}$	$mean\left(\frac{D}{R}\right)$	$\min(D)$	$\max(D)$	$\%D < 0$
min	0.0455	0.0048	1.109	0.0019	0.0001	0.1009	0
max	0.1758	0.0495	17.05	0.0132	0.0479	4.9446	0
med	0.1059	0.0189	5.577	0.0037	0.0071	0.1845	0
mean	**0.1066**	**0.0205**	6.141	0.0040	0.0072	0.3226	0
std	0.0217	0.0091	3.014	0.0013	0.0070	0.5127	0

Both the standard deviations of $\frac{\Delta L}{L}$, and $\frac{I}{k}$ fall.[8] And interestingly, the variance of labor does not change that much, but the volatility of the investment ratio drops abruptly. So, if labor seems relatively more volatile for constrained firms it is not because it is suddenly more sensitive to shocks. To drive the point home, if we run a cross section regression of the standard deviation of employment against a constant and the standard deviation of the investment ratio, the R squared of such a regression is the same in the constrained (0.1762) and unconstrained (0.1700) cases. Which implies the remaining factor explaining the variance, namely the technology shock, explains exactly the same in both cases.[9] So: no excess sensitivity from the constraint.

At this stage, two comments are in order. First, one must be concerned about how general the borrowing constraint is and whether that affects the excess sensitivity idea. In its favor are the fact that this constraint is an extreme case, and is therefore most likely to cause a strong reduction in employment and investment fluctuations in the problem, and also the fact that this condition is familiar from the literature.[10] The second one is adressed in the next section.

5 Adjustment costs to labor.

The second issue to address from the model is the absence of adjustment costs to labor, which makes employment a static decision. [11] In fact Sharpe (1994) directly associates the excess sensitivity result to the existence of adjustment costs to labor:

[8] One factor worth mentioning is that in Cantor's experiments, the dummy for high leverage has the same sign for both employment and investment. But the statement of the excess sensitivity idea suggests the sign of the dummy should be opposite between the two variables.

[9] Regression results for the unconstrained case: beta=[0.0901 0.3544], tstats=[37.59 14.29], rsqr= 0.1700. Regression results for the constrained case: beta=[0.0999 0.3346], tstats=[57.63 4.23], rsqr= 0.176.

[10] Here it serves the purpose of restricting any borrowing, since there is no difference between new equity issues and debt.

[11] Most investment literature ignores - however wrongly - adjustment costs to labor. Labor search literature would take a strong view on this, back to - for example - Mortensen and Pissarides (1994). An aggregate objection is contained for example in Andolfatto (1996).

> "A broad microeconomic interpretation of these findings is that there are costs of adjusting a firm's labor force ... Generally the presence of such costs ought to induce the firm to dampen fluctuations in its labor force relative to the cyclical fluctuations in demand for its output...However, firms that experience relatively high opportunity costs of capital during cyclical downturns (smaller and more highly leveraged firms) are prone to do less labor hoarding *so as* to conserve their working capital at such times."[Sharpe (1994), page 1060, italics added][12]

But this argument is inconclusive and the causal implication of this statement is misleading. It is not obvious what the relative impact of the borrowing constraint on the different variables is, since for example, if the firm has a lot of labor and suddenly is hit with a negative shock and it cannot fire workers, then it is capital which must take the burden of adjusting to the excess labor wage costs, in order to make dividends positive. I will go one step further: the notion that labor will adjust in any special way because of the constraint makes little sense. The constraint is imposed on income and **both** variables will adjust to it, and adjustment will imply less variability, rather than the opposite. Both inputs are now assets, and preserving both stocks is now valuable.[13] Finally, there is the issue of whether investment and employment become more sensitive to the shock in the presence of the constraint.

In order to see if adjustment costs, by eliminating the static nature of the employment decision, change the outcome of the previous model, I construct a version with quadratic adjustment costs to labor in a symmetric way to capital.[14] The two Euler equations of this new model are

$$\begin{aligned} 1+\gamma\left(\frac{I}{k}\right)^{\theta-1} &= \beta\left(\frac{1+\lambda'}{1+\lambda'}\right)\left[R_{k'}+(1-\delta)-\frac{\gamma}{\theta}\left(\frac{I'}{k'}\right)^{\theta}+\gamma\left(\frac{I'}{k'}\right)^{\theta-1}\frac{k''}{k'}\right] \\ \phi\left(\frac{m}{L}\right)^{\theta-1} &= \beta\left(\frac{1+\lambda'}{1+\lambda'}\right)\left[R_{L'}-w-\frac{\phi}{\theta}\left(\frac{m'}{L'}\right)^{\theta}+\phi\left(\frac{m'}{L'}\right)^{\theta-1}\frac{L''}{L'}\right] \end{aligned}$$

We can see that the constraint affects both variables in the same way, via the term containing the Lagrange multipliers, $\left(\frac{1+\lambda'}{1+\lambda'}\right)$. It is unclear a priori whether labor will suddenly be more sensitive to the technology shock relative

[12] The findings are of "a statistically and economically significant relationship between a firm's financial leverage and the cyclicality of its labor force" [Sharpe (1994), page 1060]. Basically, firms with higher leverage have more volatile labor forces.

[13] In fact, there is a dilemma here. The more dynamic and subject to adjustment costs labor is, the less this variable can be "used" to accomodate others. The less dynamic and the smaller the adjustment costs, the less the labor decision changes by the imposition of the constraint.

[14] Symmetry is just for convenience. Hamermesh and Pfann (1996), and also Pfann and Palm (1993), discuss evidence of asymmetry in adjustment costs. Curiously, Lazear (1990) suggests firing costs only matter under imperfect capital markets (from the worker's perspective). Galeotti and Schiantarelli (1991) have a model with adjustment costs to laboir and capital but do not investigate the issues in this paper.

to capital (or at all) than before. We can however see one thing immediately, and that is that if adjustment costs to labor are small, the main trade-off in the choice of employment will still be a static one between $R_{L'}$ and w. So, unless there is evidence that these adjustment costs are sizeable, we should have much the previous case. Finally, the timing could be important, in that we assume usually a time to build of one period for capital, but labor turnover is probably much faster so that the model is mispecified in that way. But a faster turnover for labor approaches it to the static labor decision case and so some of it could be contained in the wage term. Therefore that may not be a problem since the bias is likely to go in the direction of exagerating the (intertemporal) extent of adjustment costs to labor.

Calibration

I calibrate the model to be as similar to the previous model as possible. All common parameters have the same values, and here there is a job destruction rate which serves the role of depreciation on the labor stock. This separation rate is set at $\delta_L = 0.1$, following losely numbers from Davis, Haltiwanger and Schuh (1996). Labor then obeys $L' = (1 - \delta_L) L + m$. Summarizing, the benchmark parameterization is

α	η	γ	θ	δ_k	w	r	v	ρ	σ	δ_L	ϕ
0.3	0.1	1.81	2	0.15	0.35	0.065	0	0.85	0.04	0.1	1.81

Moments

This model has the following moments in the unconstrained model, computed from a 10.000 long time series:[15]

	$\frac{\Delta L}{L}$	$\frac{I}{k}$	$\frac{R-wL}{k}$	$\frac{D}{R}$	$\frac{I}{R}$	$\frac{wL}{R}$	$\frac{ACK}{R}$	$\frac{ACL}{R}$
mean	0.15	0.10	0.38	0.20	0.16	0.60	0.022	0.016
std	0.026	0.026	0.056	0.031	0.024	0.036	0.007	0.008

Young firms

I again run the young firms panel experiment from the previous model.

It is adequate to mention here Sharpe's view of his results on asymetric behaviour in recessions and expansions:

> "suggest that the leverage and size effects are almost entirely attributable to their influence on firm behaviour during recessions" [Sharpe, page 1072].

However, the present model suggests that financial constraints are binding when firms are expanding their inputs. It is clear that during a recession firms will be cautious in their contraction because they may face binding constraints in a future expansion, but nevertheless this effect is bound to be of second order, relative to the effect of the constraint on an expanding firm.

[15] The moments for the constrained model taken in this way are the same because the constraint normally almost never binds. It is in the experiment for young firms that the constraint is active.

The results for the unconstrained model are:

U	$\sigma^2\left(\frac{\Delta L}{L}\right)$	$\sigma^2\left(\frac{I}{k}\right)$	$\frac{\sigma^2\left(\frac{\Delta L}{L}\right)}{\sigma^2\left(\frac{I}{k}\right)}$	$mean\left(\frac{D}{R}\right)$	$\min(D)$	$\max(D)$	$\%D<0$
min	0.0768	0.0690	0.9805	−0.0314	−1.8896	1.2942	**0.2353**
max	0.1715	0.1582	1.1666	0.0327	−0.9821	9.1314	**0.5294**
med	0.1261	0.1170	1.0858	0.0047	−1.4368	3.6929	**0.3529**
mean	**0.1240**	**0.1145**	**1.0833**	**0.0043**	**−1.4594**	**4.1878**	**0.3286**
std	0.0204	0.0190	0.0334	0.0112	0.2503	1.3531	**0.0512**

where we see that these firms have on average 33% of the time negative dividends.[16] For the constrained model we get

C	$\sigma^2\left(\frac{\Delta L}{L}\right)$	$\sigma^2\left(\frac{I}{k}\right)$	$\frac{\sigma^2\left(\frac{\Delta L}{L}\right)}{\sigma^2\left(\frac{I}{k}\right)}$	$\%D<0$
min	0.0421	0.0269	1.0812	0
max	0.1139	0.0907	2.0388	0
med	0.0728	0.0554	1.2916	0
mean	**0.0746**	**0.0566**	**1.3495**	**0**
std	0.0164	0.0152	0.1953	0

This experiment shows that introducing the constraint once again **reduces** the volatilities of both employment and investment. This time the volatility of employment falls more substantially because the constraint affects employment also. The volatility of employment once again falls less, so that their ratio rises from 1.08 to 1.30 on average. But this increase is much smaller than in the model above without adjustment costs. But do these statistics contain evidence of a disproportional reaction of employment to shocks?

Excess sensitivity

To evaluate whether employment becomes more sensitive to shocks under the constraint I run a cross section regression of the volatility of employment growth and of investment against the standard deviation of the shock for the constrained and unconstrained cases, and I compare the respective R squared. I do not need proxies because I have the true data so I run by OLS

$$\begin{aligned} \sigma\left(\frac{M}{L}\right)_i &= \alpha_0^L + \alpha_1^L \sigma(A)_i + \epsilon_i \\ \sigma\left(\frac{I}{K}\right)_i &= \alpha_0^k + \alpha_1^k \sigma(A)_i + \epsilon_i \end{aligned}$$

Each regression has 100 observations (100 firms), either all constrained or all unconstrained. Each moment for each firm is computed off a time series of

[16] I eliminated the fixed production cost (which reduces profits and thus makes dividends negative more often) because it creates numerical problems, and in this version of the model with the very large state space, it is very costly to experiment.

17 observations. Each firm starts life with the same capital stock and then is hit with an independent series of shocks.

Then each regression is performed 100 times, each time with a new panel draw of 100 firms. Then a distribution of the coefficients, their standard deviations, and the R squared is obtained. Here is a summary of this experiment:[17]

$nk = 81$		α_1^L	T_1^L	R_L^2	α_1^k	T_1^k	R_k^2
mean	U	0.158	1.21	**0.031**	0.132	1.09	**0.028**
std		0.178	1.36	0.042	0.163	1.35	0.040
mean	C	0.141	1.43	**0.033**	0.181	1.90	**0.046**
std		0.116	1.19	0.035	0.107	1.16	0.043

We can see that despite being quite small the R squared is higher for both variables under the constraint, and capital displays a slightly higher sensitivity to the shock, as measured by the increase in size and significance of the respective coefficient.[18]

However, these results are not necessarily meaningfull. There is nothing that makes this the "right" regression to run, and I run it only in the spirit of the literature. An alternative way to go about it is to think of the policy functions, $K_{t+1}(K_t, L_t, A_t)$ and $L_{t+1}(K_t, L_t, A_t)$. I then run the following regressions by OLS

$$\begin{aligned}\frac{M_t}{L_t} &= \alpha_0^L + \alpha_1^L K_t + \alpha_2^L L_t + \alpha_3^L A_t + \epsilon_t \\ \frac{I_t}{K_t} &= \alpha_0^k + \alpha_1^k K_t + \alpha_2^k L_t + \alpha_3^k A_t + \epsilon_t\end{aligned}$$

and this time I run it for each firm, on a panel of 200 firms, and take statistics of the distribution of the results. What I am interested in is the R squared, and the coefficient on A. A larger absolute value of the coefficient on A, under the constraint is interpreted as an increase in sensitivity to the shock.[19] The first (second) two rows give us the mean and standard deviation of the distribution of results for the 200 firms, when all the 200 firms are unconstrained (constrained):[20]

[17]The state space for shocks has 9 points here and in the next experiment below.

[18]Also, in order to see if these outcomes are significantly altered by changing the relative weight of the adjustment costs I ran the model with $\gamma = 0.181$, which leads to a share of adjustment costs to capital over revenues of only 0.27%, while the same share for adjustment costs to labor is still 1.69%. The outcome of the this experiment was roughly the same, with the only difference that now the coefficients in the labor regression increased more in value. The R squared and the statistical significance of the volatility of A still increased more in the capital regression.

[19]Note that the true policy function is not necessarily linear, so that the regression is also mispecified.

[20]Again all firms have a time series of 17 periods, and start with the same very low capital and labor stocks, such that when the constraint is introduced it binds.

$nk = 81$		α_3^L	T_3^L	R_L^2	α_3^k	T_3^k	R_k^2
mean	U	**0.71**	2.29	0.90	**1.13**	2.34	0.86
std		0.55	1.94	0.06	0.85	1.87	0.08
mean	C	**0.57**	3.56	0.90	**0.67**	4.36	0.88
std		0.25	2.06	0.06	0.24	2.39	0.08

The results are that the absolute value of the coefficients on A is reduced in the presence of the constraint, but on the other hand their T statistics increase. The R squared does not change significantly by the the introduction of the constraint. This is hard to interpret as an increase in sensitivity arising from the presence of financial constraints, because A must always be significant, since it is a state variable of the problem. Therefore it seems that inference should be based on the sign and magnitude of the coefficient.

Cantor regressions

To evaluate the impact of the constraint I run the same regressions as Cantor.[21] First I run by OLS the cross section

$$\sigma\left(\frac{I}{K}\right)_i = \alpha_0 + \alpha_1 DM_i + \alpha_2 \bar{K}_i + \alpha_3 \sigma\left(\frac{R}{K}\right)_i + \epsilon_i$$

and then I run, also by OLS

$$\sigma\left(\frac{I}{K}\right)_i = \alpha_0 + \alpha_1 DM_i + \alpha_2 \bar{K}_i + \alpha_3 \sigma\left(\frac{R}{K}\right)_i + \alpha_4 \left[DM_i * \sigma\left(\frac{R}{K}\right)_i\right] + \epsilon_i$$

and do the same for labor using

$$\begin{aligned} \sigma\left(\frac{M}{L}\right)_i &= \alpha_0 + \alpha_1 DM_i + \alpha_2 \bar{K}_i + \alpha_3 \sigma\left(\frac{R}{L}\right)_i + \epsilon_i \\ \sigma\left(\frac{M}{L}\right)_i &= \alpha_0 + \alpha_1 DM_i + \alpha_2 \bar{K}_i + \alpha_3 \sigma\left(\frac{R}{L}\right)_i + \alpha_4 \left[DM_i * \sigma\left(\frac{R}{L}\right)_i\right] + \epsilon_i \end{aligned}$$

[21]The dummy has the value of zero when the firm is unconstrained, and the value of one when it is constrained. A constrained firm is a firm that faces a constraint at some point in the sample. Each firm has a time series of 17 periods and starts with a very low capital so that when the constraint is imposed it always binds in the beggining. So, there are 118 constrained firms and 468 unconstrained ones. The results shown here are from one run, but while the exact values of coefficients and T statistics (in parenthesis in absolute value) may change, the qualitative results of the significance and sign of the dummy coefficients has never changed in many runs.

and the results regarding the dummy variable are that all dummies are significant and *negative*.

	α_0	α_1	α_2	α_3	α_4	R^2
I/K	0.034 (16)	-0.056 (63)	0.003 (17)	0.42 (49)		0.9497
I/K	0.029 (16)	-0.036 (18)	0.003 (19)	0.47 (53)	-0.180 (11)	0.9588
M/L	0.04 (25)	-0.039 (58)	0.001 (15)	0.86 (63)		0.9557
M/L	0.04 (24)	-0.028 (16)	0.001 (16)	0.90 (63)	-0.199 (7)	0.9589

This of course contrasts with the results from Cantor. Since the standard deviation of both cash flow and sales are present on the right hand side of his regressions, he controls for extra variance in one of the groups and the results here suggest that the dummies should be negative if we were facing borrowing constraints.

6 Conclusion

In this paper I challenge the conclusion that firms with a highly volatile labor force are likely to be financially constrained. I use artificial data from calibrated models to study the effect on the volatilities of investment and employment - and their sensitivity to the underlying shock - of introducing a financial constraint.

I show first that in a model without adjustment costs to labor, the introduction of a financial constraint does not affect the employment rule. I find that the introduction of the constraint has a small impact on the volatility of employment and a large impact on the volatility of investment, and that it acts to *reduce* the volatility of both variables. Finally, I find no excess sensitivity of employment to shocks, when there is a constraint. The fraction of the variance of employment explained by the variance of the shock is the same in both cases, as one would expect from the theoretical model.

I then argue that even in the presence of adjustment costs to labor, the introduction of such a constraint does not obviously increase the relative volatility of employment due to the fact that this constraint affects both the investment and employment decision in similar ways. Artificial data from this model again shows that the volatilities of both employment and investment are reduced by the presence of the constraint.

I believe this reflects a basic trade-off: the more dynamic and more subject to adjustment costs labor is, the less this variable can be "used" to accomodate others, and the less dynamic and the smaller these adjustment costs are, the less the labor decision changes by the imposition of the constraint.

Finally, there is no significant evidence of an increase in sensitivity to shocks, arising from the introduction of financial constraints.

An obvious critique of the experiments developed in this paper is that these results could conceivably be reversed under more general constraint, shock process, and adjustment costs specifications. I do not believe that other specifications for the financial constraint or for the adjustment cost of labor will change this result. I do believe that some other generalization of the model such as firm heterogeneity (in ways that include one or more shock processes) can reproduce the results in the empirical literature in the absence of finacial constraints. None of this changes the conclusion of this paper that more care must be taken in interpreting empirical results of employment volatility as evidence of the presence of financial constraints.

References

[1] Abel, A. and Eberly, J. (1994), A unified model of investment under uncertainty, American Economic Review, 84, 1369-84

[2] Andolfatto, D. (1996), Business Cycles and Labor Market search, American Economic Review 86, vol. 1, 112-32

[3] Barnett, S. and Sakellaris, P. (1999). A New Look at Firm Market Value, Investment and Adjustement Costs. The Review of Economics and Statistics 81(2), 250-260.

[4] Caballero, R. and Leahy, J. (1996). Fixed Costs: the Demise of Marginal q. NBER working paper 5508

[5] Cantor, R. (1990). Effects of leverage on coporate investment and hiring decisions. Federal Reserve Bank of New York Quarterly Review 15, 31-41.

[6] Cooper, R. and Ejarque, J. (2001), Exhuming Q. NBER Working Paper 8182

[7] Davis, S., Haltiwanger, J. and Schuh, S. (1996), Job Creation and Destruction, MIT Press

[8] Fazzari, S., Hubbard, R., and B. Petersen, "Financing Constraints and Corporate Investment," *Brookings Papers on Economic Activity*, 1 (1988), 141-95

[9] Galeotti, M. and Schiantarelli, F. (1991), Generalized Q models for Investment, The Review of Economics and Statistics, Vol. LXXIII, Number 3, 383-392.

[10] Gilchrist, S. and Himmelberg, C. (1995), Evidence on the role of cash flow for Investment, Journal of Monetary Economics, 36, 541-72

[11] Gilchrist, S. and Himmelberg, C. (1998), Investment, Fundamentals and Finance, NBER working paper 6652

[12] Gomes, J. (2001), Financing Investment, American Economic Review 91-5, 1263-1285

[13] Hamermesh, D. and Pfann, G. (1996). Adjustment Costs in Factor Demand. Journal of Economic Literature 34, 1264-1292

[14] Hayashi, F. (1982), Tobin's marginal and average Q: A neoclassical interpretation, Econometrica, 50, 215-24

[15] Hayashi, F. and Inoue, T. (1991), The relationship between firm growth and Q with multiple capital goods, Econometrica 59, 731-753

[16] Lazear, E. (1990), Job Security Provisions and Employment. Quarterly Journal of Economics, 105-3, 699-726.

[17] Mortensen, D. and Pissarides, C. (1994), Job Creation and Job Destruction in the Theory of Unemployment, The Review of Economic Studies 61, 397-415

[18] Pfann, G. and Palm, F. (1993). Asymetric Adjustment Costs in Non-Linear Labour Demand Models for the Netherlands and U.K. Manufacturing Sectors, Review of Economic Studies 60, 397-412

[19] Sharpe, S. (1994). Financial Market Imperfections, Firm Leverage, and the Cyclicality of Employment. American Economic Review 84, 1060-1074.

[20] Whited, T. (1992), Debt, Liquidity Constraints, and Corporate Investment. The Journal of Finance, 1425-1460