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Abstract

The Schumpeterian view on Business cycles treats recessions as a cleansing mechanism and a state where firms can regroup and innovate. Firms need to access finance externally in order to compensate declining cash flow in recessions. Due to financial frictions, the literature proposes that firms need to post collateral in order to mitigate problems of information asymmetries. In this paper I view knowledge within a firm as a prerequisite for it to be innovative.

Combining financial frictions and firm knowledge intensity the overall hypothesis of this paper is: Firms which have collateral can retain its knowledge intensity when cash flow declines. This enables firms with collateral to benefit from recessions like Schumpeter proposed.

In this paper I explore the impact of firm collateral on the cyclicality of knowledge intensity. This is conducted through using firm level data on 14,500 Swedish manufacturing firms over the period 1997-2004. The main results are: (i) the knowledge intensity of a firm without collateral is pro-cyclical. I.e. its share of highly educated employees is positively correlated with sales variation; (ii) on the other hand, the knowledge intensity of firms with collateral is counter-cyclical.

Through retaining their knowledge intensity even as sales drops firms with collateral can benefit from recessions as Schumpeter proposed.

JEL Classification: D52, D82, E32, O16, O31

Keywords: Incomplete markets, asymmetric information, business fluctuations; cycles, corporate finance, innovation.

I Introduction

In this paper I explore smaller firms which do not have an R&D department and therefore do not formally conduct intangible investment. The purpose of this paper is to analyze firms that are otherwise omitted from an analysis which proxy intangible investment with firm R&D expenditure. This is done through analyzing firm knowledge intensity.

When smaller firms hire highly educated employees they choose a more expensive type of input as compared to the less educated employee. The reason behind hiring the more expensive input is the belief that it will generate excess future revenue as compared to the less educated employee. The premium which a firm pays for the highly educated employee in terms of a higher wage is associated with uncertainty. In that sense hiring a highly educated employee represents an intangible investment. Therefore this paper explores smaller firm's (median employment of 1-99) knowledge intensity through an investment perspective. Based on data on the education level of employees a firm's knowledge intensity is defined as the ratio of employees with a university education exceeding three years.

Literature on intangible investment is predominantly based on R&D investment, see e.g. Aghion et al (2007), Bond et al (2003), Hall (2002), Himmelberg & Petersen (1994) etc. A large portion of a firm's R&D budget is spent on wages to the R&D personnel. Within an R&D context the outcome of the R&D projects are highly stochastic. The stochastic outcome is the common denominator of R&D spending and the hiring of highly educated employees. A highly educated employee needs to generate more value to the firm than his or her less educated counterpart in order to make sense financially to the firm. Because of the uncertainty attached to intangible investments most firms choose internally generated financing. This makes the knowledge intensity of firms dependent on internally generated cash flow.

I argue that firms wish to keep their knowledge intensity stable across time. Since internally generated cash flow is cyclical firms need to either hold excess liquidity or being able to access external finance in order to retain its knowledge intensity over the business cycle. In this paper I focus on firm's access to external finance and how that affects the stability of firm knowledge intensity.

Based on credit market access literature and small firm literature I focus on to what extent a small firm can post collateral in order to access external credit (see e.g. Bernanke et al (1996) and Kiyotaki & Moore (1997), Almeida & Campello (2006) for discussions on collateral and investment).

Binks & Ennew (1996) discuss collateral from a small firm perspective. They argue that smaller firms either need to develop a close relationship to their bank or post collateral in order to loan externally. According to Binks & Ennew (1996) banks prefer private collateral over firm collateral since the former mitigates moral hazard problems through increasing the debtors incentives. They highlight that many small firm owners are reluctant to post privately held assets as collateral. Further, plant equipment is in many cases viewed to be too illiquid to serve as collateral. These factors make many small firms credit constrained.

The lack of information on both bank relationships and private collateral is a potential weakness of this paper. Instead I use balance sheet-data on the book value which each firm has in real estate and/or land assets. Even if firm collateral is not the primary source of collateral I argue that comparing two firms, all else equal, one with real estate and/or land assets and one without, a bank would prefer the former in terms of lending.

The assumption that, in order for firms to retain its knowledge intensity over time it needs to access external finance, builds on the results of Aghion et al (2007). They propose that firms that are not credit constrained have a counter-cyclical share of R&D investment out of total investment. The counter-cyclicality is important in a larger context. Namely, Aghion et al (2007) argue that non-constrained firms can take advantage of the benefits of recessions proposed by Schumpeter. The Schumpeterian view on business cycles treats recessions as a cleansing mechanism for the economy and are times when firms can regroup and innovate (Schumpeter (1942))[2]. Therefore it is crucial for firms to be able to retain its knowledge intensity even when business conditions deteriorate. It is expected that firms which can access external finance at lower costs (i.e. firms with collateralizable assets) can retain its knowledge intensity even if sales drops.

The empirical results of this paper are based on a sample of about 15,000 Swedish manufacturing firms. This sample is drawn from a firm-level database provided by Statistics Sweden comprising all Swedish firms between 1997 and 2004.

[2] Aghion et al (2007), p. 2

The main empirical results can be summarized as follows; the knowledge intensity of firms with collateral is negatively correlated (counter-cyclical behavior) with sales variation whereas it is positively correlated (pro-cyclical behavior) for firms without collateral.[3] The results are emphasized when controlling for leverage and external finance dependence.

Based on the empirical findings of this paper firms with collateral are more likely to be able to draw advantage of recessions like Schumpeter proposed and regroup and innovate. Firms having pro-cyclical knowledge intensity disrupt the mechanism proposed by Schumpeter.

This paper contributes to a body of literature which emphasizes the link between long term economic performance such as the innovativeness of firms and short term economic activity such as business cyclicality and credit market access, e.g. Aghion et al (2005, 2007). My results corroborate with the findings of Aghion et al (2007) and shed additional light on the negative impact of firm credit constraints.

The remainder of this paper is organized as follows. Section II provides with a background discussion on previous research and presents the theoretical underpinnings. Section III presents the data and variables. Section IV specifies the empirical model and present results from the first estimation. Section V provide with robustness checks. Section VI concludes.

[3] Both Aghion & Saint-Paul (1998) and Aghion et al (2005) provide with discussions regarding the opportunity cost effect of investments and how short-term investment is pro-cyclical and long-term investment is counter-cyclical when firms can borrow freely.

II Background and Theory

A. Financial frictions and collateral in the literature

The topic of this paper assumes that there exist financial frictions. The field of financial frictions is vast and is covered from many perspectives in the literature.[4] In order to place the story of this paper into context a brief description of the literature is presented.

In their seminal work Modigliani & Miller (1958) refer to the capital structure of firms as irrelevant to its market value. Amongst many[5], Myers (1984) opposes the proposition of the irrelevance of the capital structure decision with his formulation of the pecking order theory. The pecking order theory implies that firms prefer internal over external financing due to it being cheaper. External finance is the least preferred source of financing for firms due to the premium, as compared to internal finance, which the lender demands. The premium is a result of information asymmetries. In brief, the worse scenario for both parties, in terms of external borrowing, is the risk of default. Therefore the lender demands a risk premium; the premium is basically an increasing function of the ex-ante probability of the borrower defaulting.

Bernanke (1983) argues that the US financial collapse of the 1930s amplified the ongoing deterioration of the real economy which took place during the depression. There are many papers which have added to the knowledge of financial frictions and business cycles, e.g. Greenwald & Stiglitz (1993), Hubbard (1998), and Sharpe (1994).

Bernanke & Gertler (1989) suggest that financial market imperfections cause transitory shocks to firm net worth (collateral) which make external borrowing more expensive. In Bernanke et al (1997) the notion of Bernanke & Gertler (1989) leads to credit market frictions being endogenized in a model of the business cycle. In Bernanke et al (1997) they emphasize collateral as the mean for firms to lower the premium on external finance. [6] Bernanke et al (1996) describe the theoretical properties of collateralizable assets and its impact on firm spending. In section A.1 the properties of collateralizable assets and its connection to firm spending is presented.

[4] Financial frictions or imperfectly functioning credit markets are central in different adjacent research fields such as; Corporate Governance and financial contracting (e.g. Jensen & Meckling (1976), Williamson (1988), Grossman & Hart (1986), and Aghion & Bolton (1992)); financial constraints and the cash flow effect on investment (e.g. Fazzari et al (1988), Gertler & Hubbard (1989), Gomes (2001), and Kaplan & Zingales (1997)).

[5] Other influential papers are Myers & Majluf (1984), Stiglitz & Weiss (1981).

[6] The role of collateral as to lower the cost of external capital is presented in Kiyotaki & Moore (1997), Almeida & Campello (2006), Benmelech & Bergman (2008), Goodfriend & McCallum (2007) etc.

A.1 External finance and collateral

The assumptions which the constraint of Bernanke et al (1996)[7], BGG hereon, rests upon are; unless external finance is fully collateralized it is more expensive than internal finance (collateral serves as to mitigate the negative impact of information asymmetries); the external finance premium varies inversely with the firm's net worth; and if the firm's net worth falls through a rise in the external finance premium the spending and subsequently the production of the firm is reduced.

The constraint incorporates an entrepreneur who faces two periods, 0 and 1. She faces a technology in period 0 and demand input in order to produce output at time 1. The entrepreneur has two inputs, a fixed factor *K* and a variable input x_1

- $x_1 = a_0 f(x_0) + b_1 - r_0 b_0$ (1)

The term $a_0 f(x_0)$, a_0 being the technology parameter, represents cash-flow originated in period 0. The term $r_0 b_0$ is composed by the gross interest rate and debt in period 0 respectively, and b_1 captures borrowing in period 1.

In order to include the part of information asymmetries and the external finance premium the model need to be extended to include some sort of factor so that the entrepreneur can signal to its lenders that even if I default you will not stand to lose the entire loan amount. Therefore the model incorporates so ownership of the fixed factor *K* can be transferred over to the lender if the entrepreneur defaults on the loan, i.e. *K* serve as collateral.

- $b_1 \leq (q_1 / r_1) * K$ (2)

Inequality (2) states that borrowing in period 1(b_1) can never exceed the value of the firm's collateral. The market price, q_1 and the gross real interest rate of period 1 determine the value of the fixed asset *K*. This constraint state that the entrepreneur can only loan as much as the discounted

[7] Bernanke et al (1996) pp 2-4

market value of her fixed factor, i.e. only secured lending is allowed in the model. By substituting (2) into (1) the following constraint is derived:

- $x_1 \leq a_0 f(x_0) + (q_1/r_1)K - r_0 b_0$ (3)

The right hand side is the net worth of the entrepreneur and thus her collateral in terms of borrowing, therefore constraint (3) states that spending in period 1 cannot exceed the net worth of the entrepreneur.

The implications of this simple composition in terms of business cycle dynamics further enhance its applicability in the context of this paper. In a recession, demand decreases which lower sales and subsequently the firm's cash flow and reduces the firm's ability to finance the variable input internally.

B. Financial frictions and the Schumpeterian view on Business cycles

B connects financial frictions to innovation. In B.1 the most influential work for this paper, Aghion et al (2007), is presented. In B.2 knowledge intensity and innovation is briefly discussed.

B.1 Brief summary of Aghion et al (2007)

The paper by Aghion et al (2007) is the first paper to my knowledge which explores credit constraints and intangible investment for not just publicly traded large firms. Aghion et al (2007) has therefore influenced the design and research question of this paper.

Aghion et al (2007) explore the Schumpeterian view on business cycles both theoretically and empirically. They introduce financial frictions through the assumption that firms which have defaulted on bank loans are credit constrained. In order for the mechanisms connected to recessions proposed by Schumpeter to function it is vital for firms to be able to access external funds in order to innovate in recessions. In their empirical part they proxy a firm's innovative operations by its R&D investment. Based on a theoretical derivation they argue that firms which are not credit constrained should have a counter-cyclical share of R&D investment out of total investment. Introducing credit constraints should thus reverse the cyclicality of a firm's R&D investment.

Their empirical estimation basically consists of comparing the behavior of credit constrained and non-constrained firms through the following specification (Aghion et al (2007) p. 17)[8]:

- $$\frac{R\&D_{i,t}}{I_{i,t}+R\&D_{i,t}} = \alpha_0 + \beta_1 \cdot \Delta S_{i,t} + \theta \cdot PI_{i,t-1} + \gamma_1 \cdot \Delta S_{i,t} * PI_{i,t-1} + \mu_t + \upsilon_i + \varepsilon_{i,t}$$

The PI-variable is a binary variable assigning 1 if the firm is credit constrained and 0 otherwise. This specification tests the notion of credit constraints through assuming that the slope associated with the sales variable for non-constrained and credit constrained firms differ.

The Aghion et al (2007) paper shows empirically that the share of R&D investment over total investment is counter-cyclical for non-constrained firms. Credit constrained firms on the other hand are shown to have a pro-cyclical response to sales variation. Thus their empirical results corroborate with their theoretical propositions.

Their results imply that non-constrained firms can innovate and regroup in recessions to a larger extent than credit constrained firms. They further test and conclude that counter-cyclical R&D investments are positive for economic growth.

B.2 Knowledge as an investment

It is intrinsically difficult to capture a firm's intangible investments. Almeida & Carneiro (2006) point to that the study of physical investment is more developed than the study of firm investments in human capital. They further argue that in modern economics the latter may be at least as important to study. Their paper is one of few which introduce the information asymmetry aspect of human capital investment. Blundell et al (1999) address the difficulty in measuring the return of human capital investment. As I discussed in the introduction the outcome of an intangible investment is highly stochastic. Black & Lynch (1996) and Chang & Wang (1996) also emphasize human capital through the investment lens.

It is difficult for the individual firm and subsequently difficult for economic researchers to measure the return of human capital investment. In this paper firm investment in human capital is

[8] They include more lags which are not presented here. $\Delta S_{i,t} = \log(Sales_{i,t}) - \log(Sales_{i,t-1})$. The denominator comprises total investment with $I_{i,t}$ comprising physical investment.

measured as its ratio of highly educated employees. I do not attempt to evaluate the return of human capital investments I simply assume that human capital investment is the prerequisite for firms to absorb knowledge and to be innovative.

Thus connecting the above discussion on human capital investment with the Schumpeterian view on business cycles motivates this paper.

C. Theoretical propositions

- Firms with better access to credit compared to other firms are expected to show a less pro-cyclical or even counter-cyclical behavior of its knowledge intensity.

- Collateralizable assets mitigate the problems associated with information asymmetries and thus lower the premium on external finance.

- Collateralizable assets dampen the negative impact which irregular or deteriorating cash flow has on the cost of external finance. This makes firms with collateralizable assets, all else equal, less vulnerable to cyclicality.

III Data

The sample of this paper is collected from two datasets supplied by Statistics Sweden, both ranging from 1997-2004. The required firm characteristics for this paper are compiled from the firm level database (FS). The dataset on firm characteristics are merged with a dataset containing information on the education level of each employee compiled from the Swedish firm-level employment database (RAMS).

Each firm is identified as a legal entity in both datasets which enables the merge of the two datasets.

A. Knowledge intensity

This is the key variable of the empirical estimation procedure of section IV and V. Due to the detailed information of the RAMS-database I am able to identify the number of employees of each firm with a university education exceeding three years. The variable is constructed in the following manor:

- $\text{Knowledge intensity}_{i,t} = \dfrac{\sum \text{Employees with a university education exceeding 3 years}_{i,t}}{\sum \text{Employment}_{i,t}}$

B. Collateralizable assets

The use of firm collateral over private collateral is strictly a question of data availability. For instance, as discussed in the introduction, Binks & Ennew (1996), and also Reid & Jacobsen (1988), argue that private collateral provided by the owner to be perhaps the more important sort of collateral for smaller firms.

Firm collateral is measured as the sum of a firm's real estate and land assets. As it turns out about half of the firms in the sample has this type of collateral.

- $\text{Collateral}_{i,t} = \begin{cases} 1, \text{if Firm}_{i,t} \text{ have collateral} > 0 \\ 0, \text{otherwise} \end{cases}$

The conversion of the collateral variable into a binary variable is made due to the purpose is to compare firms with collateral to firms without collateral. The binary variable conversion approach is further validated in IV.A when the empirical estimation procedure is explained.

C. Sample description

The sample selection criteria are; (i) It has to be a manufacturing firm; (ii) the industry of the firm must constitute at least one percent of average annual sales of the manufacturing sector; [9] (iii) the median employment over the time period must be at least one, but may not exceed 100; and (iv) the firm must have had at least one employee with a university education exceeding three years.[10]

The reason for restricting the analysis to manufacturing firms is twofold. First, the literature has almost exclusively explored manufacturing firms. Second, if services firms would be included the results would bias toward the more capital intensive manufacturing sector.

The second criterion of the sample selection is simply put there in order to focus on the main industries.

The third criterion limits the empirical analysis to small and medium size firms.[11] This is because the purpose of the paper is to focus on firms which do not have an R&D department. Larger firms are more likely to be included in a study on R&D expenditure compared to firms with less than 100 employees.

The choice to eliminate larger firms is also based on the financial frictions literature. In Gertler & Gilchrist (1994) they compare small firms to large firms and conclude that small firms are to a far larger extent hit by credit constraints. This means that they are constrained in terms of external borrowing to a larger extent than larger firms. Bernanke et al (1996) argue that large firms have a much wider variety of financing sources than small firms. Large firms have the ability to issue bonds, and different types of securities whereas small firms are restricted to internal equity (retained earnings) and external debt (bank loans).

[9] The industries excluded due to not passing the 1 percent sales limit are: Textile, Leather, Petroleum Refineries and Nonferrous metals. The excluded industries constitute approximately ten percent of the manufacturing firms and four percent of aggregate sales and investment.
[10] The sample is also examined for odd numbers and outliers both in an economic and statistical sense.
[11] I do not directly point to what makes a firm small or medium since it is irrelevant to the research question. A firm with more than 100 employees is considered large and a firm median employment below 1 is considered a micro firm.

Hall et al (2000) for instance also restrict their attention to small and medium size firms. They argue that the capital structure trade off of debt versus equity is more pronounced for these firms.

Finally a firm must have had at least one employee with a university education exceeding three years during the time period. This is to avoid too many zeros at the dependent variable which would restrict the estimation to certain estimation procedures such as logit or probit.[12]

[Table 1 about here]

The sample is split based on if the firm has had a median value of collateralizable assets above zero. The assignation of 0 and 1 is based on firm-year observations implying that firms which are apart of the collateralizable assets sample still can be assigned zero-values during the sample period.

There is a size dimension of the sample division. The variables entering the estimation are the sales variation[13] variable and the knowledge intensity variable. Both samples have median sales variation of 0.04 so the size dimension should not distort the implications of the estimation results.

The sample which enters the empirical estimations includes about 14,500 manufacturing firms and a total of about 80,000 observations.

[12] This is replicated from the Aghion et al (2007) paper.
[13] Sales variation is defined as the logged difference of sales, which controls for size.

IV Empirical specification

In this section the theoretical propositions of section II are tested. I show that; (i) knowledge intensity is pro-cyclical for firms without collateralizable assets; (ii) for firms with collateralizable assets the effect turns counter-cyclical. The next section conducts robustness checks of the results obtained in this section.

A. Specification

The specification which is presented here is similar to the specification of II.B1 originally from Aghion et al (2007).

$$\text{Knowledge intensity}_{i,t} = \alpha_0 + \beta \cdot \Delta\ln(\text{Sales})_{i,t} + \theta \cdot \text{Collateral}_{i,t} + \gamma \cdot \Delta\ln(\text{Sales})_{i,t} * \text{Collateral}_{i,t} + \nu_i + \mu_t + \varepsilon_{i,t}$$

The specification above falls directly inline with the purpose of the empirical investigation. Statistically I wish to test the correlation between the log difference of sales and firm knowledge intensity. Additionally I wish to test if the sample division presented in III.C is statistically significant. The specification above tests if the difference between the sub-samples is present through a different mean (θ) of knowledge intensity, or if the difference is present through a different response to sales variation (γ). I.e. the intercept and slope of the two sub-samples are tested. This is conducted by applying standard statistical procedures.

The collateral variable is a binary variable assigning 1 if the firm has collateralizable assets and 0 otherwise. This turns the sub-sample of firms without collateralizable assets into the benchmark population which the results of the collateral variable will be compared to.

This specification is in a way a sophisticated t-test. My interest is focused on the significance of the interaction term between sales variation and collateral (γ). Also, the specification above enables me to control for potentially disturbing properties. The default estimation is run with firm fixed effects (FE) and within estimation. FE controls for firm specific effects which are constant over time, i.e. the FE procedure assigns unique intercept-terms to each firm. The FE convention also controls for industry specific aspects. In order to capture unique aspects which are varying over time a full set

of time-dummies are included. The estimation is run with robust standard errors which controls for heteroscedasticity. All these control tools enables firm heterogeneity to be captured.

The specification is also run with random effects (RE) with generalized least squares (GLS) estimation including size and industry dummies in order to serve as robustness checks of the results from the FE results. Further, a specification including an autoregressive term is run to check for autocorrelation related problems (i.e. the persistence of the level of firm knowledge intensity across the sample period).

The intention of estimating the specification with different methods is to check the robustness and validity of the results.

There are ever present problems with econometric estimation such as endogeneity, simultaneity and omitted variable biases. The major problem arising from these biases is that it makes the parameter-estimates non-consistent. In this paper focus is on the difference of two sub-samples. I do not intend to draw any conclusions of the parameter-estimates in an absolute sense. Therefore I argue that even if the results are upward biased for instance they are probably similarly biased which would leave the potential difference of the two sub-samples qualitatively unchanged. The within estimator is sensitive to explanatory variables not being strongly exogenous. The similarity to the Aghion et al (2007) specification is also used as robustness validation. Their results are run with within estimation and compared to generalized method of moments (GMM) estimation.[14] Their within and GMM estimation results were similar and they based their results on the within estimation results.

Based on the theoretical discussion of section II the response of firms without collateralizable assets is assumed to be a positively correlated relationship between knowledge intensity and sales variation, i.e. a pro-cyclical relationship. That implies that I am expecting $\beta > 0$.

I am expecting firms with collateralizable assets to have a significantly different slope, i.e. $\gamma \neq \beta$. Further the ability to mitigate information asymmetries through collateral implies that $\gamma < \beta$ which subsequently implies that $\gamma < 0$. The sales variation correlation for the sample of firms with collateral is interpreted as $(\beta + \gamma)$.

Regarding the θ estimate, which represents the collateral sample's deviation to the intercept, it is harder to be as clear. In a way the FE convention controls for deviations to the mean. In the RE

[14] GMM is preferred when the right-hand side variables are suspected to violate the strict exogeneity assumption.

specification both size and industry dummies are included which also control for deviations to the mean.

B. Results

Column 1, 2 and 3 report the results from the within estimation.

[Table 2 about here]

By first estimating sales variation on firm knowledge intensity an estimate of 0.0024 is reported, implying that a sales increase of ten percent yields a 0.02 percentage point increase of firm knowledge intensity. The result is significant at below five percent. The estimate is unchanged when introducing the proposition of a different mean of the two sub-samples. The insignificance of that estimate is not surprising since the FE convention captures most of the mean deviations.[15] The expected results are obtained when introducing the interaction of sales variation and collateralizable assets. The β-estimate increases in size to 0.0036 and also in significance, now significant at below one percent. The γ-estimate, which is estimated at -0.0059, is significant at below one percent. These results imply that a drop of sales by ten percent for firms with collateralizable assets yield an increase of 0.023 (0.036-0.059) percentage points of knowledge intensity. The implications and interpretations of these results are explored further in section V.

The RE-estimation yield almost identical results. I also estimate the specification with an AR (1) term to test for persistence. The size of the parameter-estimates become smaller but the difference, $(\beta+\gamma)$ is the still the same.[16]

The initial results obtained here present interesting interpretations. Firms with collateralizable assets can access external credit in order to retain its knowledge intensity during periods of declining sales. These results points to the existence of financial frictions which disrupt the possibilities for firms to regroup and innovate in recessions as proposed by Schumpeter.

In the next section I present further exploration of the results obtained in this section.

[15] As a comparison, the results from the RE estimations of columns 4 to 6 provide with significant mean deviations based on firm collateral even after controlling for size and industry mean deviations.
[16] The results of the AR (1) specification are a rather imprecise investigation of persistence, therefore the results are not presented. The AR (1) specification was run using XTREGAR of STATA.

V Robustness checks

In A the knowledge intensity variable is decomposed and explored. In B and C leverage and industry external finance dependence is controlled for.

A. Decomposition of the knowledge intensity variable

Before drawing final conclusions of the correlations of section IV further exploration is needed. The denominator of knowledge intensity comprises total employment. In order to gain information of how to interpret the results of section IV the relationship of less educated employees and sales variation need to be investigated:

- Less Educated employees = Total employment – employees with a university education exceeding three years

This procedure enables me to view knowledge intensity as (H stands for highly educated employees and L for less educated employees):

- $\text{Knowledge intensity}_{i,t} = \frac{H_{i,t}}{H_{i,t} + L_{i,t}}$

Through applying the same specification regarding the right-hand side as the specification of IV.A the behavior of L is explored:

- $$\frac{(L_{i,t} - L_{i,t-1})}{L_{i,t}} = \omega_0 + \varphi \cdot \Delta\ln(\text{Sales}_{i,t}) + \delta \cdot \text{Collateral}_{i,t} + \kappa \cdot \Delta\ln(\text{Sales}_{i,t}) * \text{Collateral}_{i,t} + \nu_i + \mu_t + \varepsilon_{i,t}$$

[Table 3 about here]

Table 3 shows that firms' stock of less educated employees is uniformly affected by sales variation regardless of collateralizable assets, i.e. κ is non-significant. The correlation is as expected positive.

Since L is pro-cyclical it is now possible to interpret the economic meaning of the correlations from section IV.

It is only the stock of highly educated employees which differ between the sub-samples. Firms without collateral discharge highly educated employees at a slightly higher rate than their less educated employees when sales decline. Firms with collateral on the other hand adjust their less educated employees more in a downswing compared to their highly educated employees, thus the negative correlation presented in table 2.

In order to further strengthen the results the robustness checks continue by controlling for financial features such as leverage and industry external finance dependence.

B. Control for leverage

The correlations obtained thus far may still have arisen as a result of omitted variable bias. Leverage is controlled for through identifying the median firm leverage and splitting the sample in two.[17] In the above median sub-sample the firms are assumed to have good credit market access and in the below median sub-sample the firms are considered credit constrained. I assume here that firms with high leverage are less affected of having collateral or not. Therefore the correlations reported in table 2 are expected to be altered here.

In the sub-sample above the median the alteration of the slope difference is expected to be[18] $|\beta_{IV.B} + \gamma_{IV.B}| > |\beta_{V.B} + \gamma_{V.B}|$.

In the below median sub-sample the results are expected to have a reversed alteration $|\beta_{IV.B} + \gamma_{IV.B}| < |\beta_{V.B} + \gamma_{V.B}|$.

[Table 4 about here]

In table 4 columns 2 (within) and 5 (GLS) the results of the sub-sample of firms above the median in terms of leverage are reported. The results are inline with expectations, suggesting that for firms which already have good credit market access collateralizable assets do not matter within the context presented in this paper, i.e. γ is non-significant.

[17] Leverage is defined as in Rajan & Zingales (1995). Leverage = (Short-term debt + long-term debt)/ Total assets.
[18] The subscript IV.B stands for the results of the whole sample presented in section IV.B and V.B stands for the results obtained here and presented in table 4

In columns 3 and 6 the below median sub-sample results are reported and they also fall inline with expectations. The sales correlation for firms without collateral is similar to the whole sample but the difference, $|\beta + \gamma|$ is amplified.

Again, it is not the absolute value of the parameter-estimates which are of interest. It is the behavior of $|\beta + \gamma|$ which is considered. B provides with further evidence of how credit market access affects the cyclicality of knowledge intensity.

C. Control for industry external finance dependence

In C I draw advantage of a paper by Rajan & Zingales (1998) on financial dependence.[19] They calculate the dependence on external finance of US manufacturing industries. Each industry's dependence is calculated by taking (capital expenditures-net cash flow from operations)/capital expenditures. This is conducted for each firm and year over the period 1980-1990. Then they take the average for each firm and present the median firm average as the industry's dependence on external finance.

The reason why I utilize the Rajan & Zingales (1998) measure is to explore industry specific properties. Some industries are intrinsically cyclical and then it is possible that the proposed relationship of this paper fails to hold. This paper argues that a firm needs to be able to access external finance in order to retain its knowledge intensity. But if sales and employment is too cyclical perhaps there are other factors than collateral which is needed in order for the knowledge intensity to be retained.

I divide the industries of my sample based on the Rajan & Zingales (1998) measure.[20] The sub-sample of firms belonging to an industry highly dependent on external finance could either see a pronounced need for collateralizable assets in order to access the sufficient amounts of external funds. Or, it is possible that both firms with and without collateralizable assets share the same response to sales variation.

[19] This paper is widely cited and used as measures of controlling for industry's external finance dependence; see e.g. Aghion et al (2007), Fisman & Love (2004), and Ciccone & Papaioannou (2005).

[20] Industries above the median, i.e. highly dependent on external finance (the Rajan & Zingales measure is within parenthesis); Wood products (0.28), transportation equipment (0.31), machinery (0.45), other industries (0.47), electric machinery (0.77) and pharmaceuticals (1.49). Industries below the median; Food products (0.14), printing & publishing (0.20), other chemicals (0.22), rubber products (0.23) and metal products (0.24).

Firms belonging to an industry less dependent on external finance should be able to maintain a counter-cyclical response, and perhaps even a pronunciation of the counter-cyclical correlations established in IV.B. The expectations for the less dependent sub-sample are $|\beta_{IV.B} + \gamma_{IV.B}| < |\beta_{V.C} + \gamma_{V.C}|$.

[Table 5 about here]

In columns 2 (within) and 5 (GLS) the results of the regression run on the sample of highly dependent firms are reported. Firms belonging to industries highly dependent on external finance are uniformly affected by sales variation in terms of knowledge intensity, i.e. γ non-significant.

The less dependent firms, results in columns 3 and 6, thus corroborate with expectations with an amplified difference of $|\beta + \gamma|$.

D. Summary

This section shows that the correlations obtained in section IV holds for different sub-sample divisions. It is of course difficult to claim that the empirically discovered relationship of this paper captures exactly what it sets out to do. Nevertheless the relationship is robust to different sub-sample divisions. The parameter-size and signs have been consistent throughout the entire estimation procedure which is desirable.

VI Discussion and conclusions

In this section the implications of the results are discussed. In A I explore the relationships of this paper intuitively on firm size. By explicitly analyzing small firms the correlations reported in table 2 are pronounced. In B I discuss the wider implications of the results of this paper and to the extension of the results presented in A below.

A. The effect of firm size

The purpose of this paper has been to investigate the impact of collateral for smaller firms in order to access external credit. Smaller firms have implied firms with a median employment below 100 over the sample period. In other words firms under investigation have been all but large firms.

In this I split the sample into one sub-sample of small firms (firms with median employment of 1-9) and one with firms which could vaguely be called medium size firms (median employment of 10-99). The same specification as in IV.A is applied here. As it turns out the sample of medium size firms do not provide with a statistically significant different effect whether firms have collateral or not. The medium size sample is a rather heterogeneous group but further decomposition of that group would yield too small samples. Instead I wish to separately explore the more homogenous small firm sample.

[Table 6 about here]

About 47,000 out of the initial 80,000 observations correspond to firms with median employment of 1-9. The relationship presented in the paper of a counter-cyclical relationship between knowledge intensity and sales variation for firms with collateral holds for the small firms group. The difference for the whole sample presented in table 2 of $0.0023\ |0.0036-0.0059|$ is amplified for the smaller firms. For the small firm sample the difference is, $0.0029|0.0040-0.0069|$.

Even though this paper has not had the intention to fully explore the effect of firm size, this rather arbitrary sample division provides evidence of the results of this paper being pronounced for smaller firms. In other words the impact of firm collateral on the cyclicality of knowledge intensity is negatively associated with firm size.

B. Implications

I intend to put the results of this paper into a broader context. Ramey & Ramey (1995) show empirically that volatility of GDP per capita is negatively associated with average GDP per capita growth. Their results intensify the need to prevent business cyclicality from being too volatile. The results of my paper are even more important within the context of Ramey & Ramey (1995)'s results. If business cyclicality was to be very volatile and the subsequent peaks and lows were to be amplified the Schumpeterian argument regarding recessions may not hold.

Much attention has been directed to firms accessing collateral or not. But the need for collateral, within the framework of this paper, originates from sales variation. If business conditions were to be very volatile that would lead to sales varying much more. That would make it more difficult for firms to retain its knowledge intensity and in the longer run stay innovative. In VI.A it is suggested that it is particularly small firms which would suffer from excess volatility.

Even though the discussion here is rather intuitive I argue that combining the results of my paper with the results of Ramey & Ramey (1995) suggest the importance of stabilization policies.

References

[1] Aghion, P. & Bolton, P. (1992). "An Incomplete Contracts Approach to Financial Contracting", Review of Economic Studies, Vol. 59, pp. 473-494.

[2] Aghion, P. & Saint-Paul, G. (1998). "On the Virtue of Bad Times: An analysis of the Interaction between Productivity Growth and Economic Fluctuations", Macroeconomic Dynamics, Vol. 2, No 3, pp. 322-344.

[3] Aghion, P., Angeletos, G-M., Banerjee, A. & Manova, K. (2005). "Volatility and Growth: Credit Constraints and Productivity-Enhancing Investment", NBER Working Papers 11349.

[4] Aghion, P., Askenazy, P., Berman, N., Cette, G. & Eymard, L. (2007). "Credit Constraints and the Cyclicality of R&D Investment: Evidence from France", http://www.economics.harvard.edu/faculty/aghion/

[5] Almeida, H. & Campello, M. (2006). "Financial Constraints, Asset Tangibility, and Corporate Investment", NBER Working Papers 12087.

[6] Almeida, R. & Carneiro, P. (2006). "The Return to Firm Investment in Human Capital", World Bank Policy Research Working Paper 3851.

[7] Benmelech, E. & Bergman, N. (2008). "Collateral Pricing", NBER Working Papers 13874.

[8] Bernanke, B. (1983). "Nonmonetary Effects of the financial crisis in the Propagation of the Great Depression", American Economic Review, Vol. 73, No 1, pp. 257-276.

[9] Bernanke, B. & Gertler, M. (1989). "Agency Costs, Net Worth, and Business Fluctuations", American Economic Review, No. 79, pp. 14-31.

[10] Bernanke, B., Gertler, M. & Gilchrist, S. (1996). "The Financial Accelerator and the Flight to Quality", Review of Economics and Statistics, No. 78, pp. 1-15.

[11] Bernanke, B., Gertler, M. & Gilchrist, S. (1997). "The Financial Accelerator in a Quantitative Business Cycle Framework", NBER Working Papers 6455.

[12] Binks, M. R. & Ennew, C. T. (1996). ”Growing Firms and the Credit Constraint”, Small Business Economics, Vol. 8, pp. 17-25.

[13] Black, S.E. & Lynch, L.M. (1996). “Human-Capital Investments and Productivity”, American Economic Review, Vol. 86, No 2, pp. 263-267.

[14] Blundell, R., Dearden, L., Meghir, C. & Sianesi, B. (1999). ”Human Capital Investment: The Returns from Education and Training to the Individual, the Firm and the Economy”, Fiscal Studies, Vol. 20, No 1, pp. 1-23.

[15] Bond, S. Harhoff, D. & Van Reenen, J. (2003). “Investment, R&D and financial constraints in Britain and Germany”, LSE Research Online, http://eprints.lse.ac.uk/771/.

[16] Chang, C. & Wang, Y. (1996). “Human Capital Investment and Asymmetric Information: The Pigovian Conjecture Revisited”, Journal of Labor Economics, Vol. 14, No 3, pp. 505-519.

[17] Ciccone, A. & Papaioannou, E. (2005). “Human Capital, the Structure of Production, and Growth”, ECB Working Paper Series, No 623.

[18] Fazzari, S. R., Hubbard, R. G. & Petersen, B. (1988). ”Financing Constraints and Corporate Investment”, Brookings Paper on Economic Activity, No 1, pp. 141-206.

[19] Fisman, R. & Love, I. (2004). “Financial Development and Growth in the Short and Long run”, NBER Working Papers 10236.

[20] Gertler, M. & Hubbard, R. G. (1989). ”Financial Factors in Business Fluctuations”, NBER Working Papers 2758.

[21] Gertler, M. & Gilchrist, S. (1994). “Monetary Policy, Business Cycles, and the Behavior of Small Manufacturing Firms”, Quarterly Journal of Economics, Vol. 59, pp. 309-340.

[22] Gomes, J. F. (2001). “Financing Investment”, American Economic Review, Vol. 91, No 5, pp. 1263-1285.

[23] Goodfriend, M. & McCallum, B. T. (2007). “Banking and Interest Rates in Monetary Policy Analysis: A Quantitative Exploration”, NBER Working Papers 13207.

[24] Greenwald, B. C. & Stiglitz, J. E. (1993). “Financial Market Imperfections and Business Cycles”, Quarterly Journal of Economics, Vol. 108, No 1, pp. 77-114.

[25] Grossman, S. J. & Hart, O. D. (1986). “The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration”, Journal of Political Economy, Vol. 94, No 4, pp. 691-719.

[26] Hall, B. H. (2002). “The Financing of Research and Development”, http://elsa.berkeley.edu/~bhhall/bhpapers.html

[27] Hall, G., Hutchinson, P. & Michaelas, N. (2000). “Industry Effects on the Determinants of Unquoted SMEs’ Capital Structure”, International Journal of the Economics of Business, Vol. 7, No 3, pp. 297-312.

[28] Himmelberg, C. P. & Petersen, B. C. (1994). ”R&D and Internal Finance: A Panel Study of Small Firms in High-Tech Industries”, Review of Economics and Statistics, Vol. 76, No 1, pp. 38-51.

[29] Hubbard, R. G. (1998). “Capital Market Imperfections and Investment”, Journal of Economic Literature, Vol. 36, pp. 193-225.

[30] Jensen, M. C. & Meckling, W. (1976). ”Theory of the Firm: Managerial Behavior, Agency Costs, and Ownership Structure”, Journal of Financial Economics”, Vol. 3, No 4, pp. 305-360.

[31] Kaplan, S. N. & Zingales, L. (1997). ”Do Investment-Cash Flow Sensitivities provide useful measures of Financing Constraints?”, Quarterly Journal of Economics, Vol. 112, No 1, pp. 169-215.

[32] Kiyotaki, N. & Moore, J. (1997). "Credit Cycles", Journal of Political Economy, Vol. 105, No 2, pp. 211-248.

[33] Modigliani F. & Miller, M. (1958). "The Cost of Capital, Corporation Finance and the Theory of Investment", American Economic Review, Vol. 48, pp. 216-297.

[34] Myers, S. (1984). "The Capital Structure Puzzle", Journal of Finance, Vol. 39, pp. 575-592.

[35] Myers, S. & Majluf, N. S. (1984). "Corporate Financing and Investment Decisions when Firms have Information that Investors do not Have", Journal of Financial Economics, Vol. 13, pp. 187-221.

[36] Rajan, R. G. & Zingales, L. (1995). "What do We Know about Capital Structure? Some Evidence from International Data", Journal of Finance, Vol. 50, No 5, pp. 1421-1460.

[37] Rajan, R. G. & Zingales, L. (1998). "Financial Dependence and Growth", American Economic Review, Vol. 88, No 3, pp. 559-586.

[38] Ramey, G. & Ramey, V.A. (1995). "Cross-Country Evidence on the Link between Volatility and Growth", American Economic Review, Vol. 85, No 5, pp. 1138-1151.

[39] Reid, G. C. & Jacobsen, L. R. (1988). *The Small Entrepreneurial Firm*. Aberdeen: The David Hume Institute, Aberdeen University Press, 1988.

[40] Schumpeter, J. A. (1942). *Capitalism, Socialism, and Democracy*, New York: Harper and Brothers. (Harper Colophon edition, 1976).

[41] Sharpe, S. A. (1994). "Financial Market Imperfections, Firm Leverage, and the Cyclicality of Employment", American Economic Review, Vol. 84, No 4, pp. 1060-1074.

[42] Stiglitz, J. E. & Weiss, A. (1981). "Credit Rationing in Markets with Imperfect Information", American Economic Review, Vol. 71, No 3, pp. 393-410.

[43] Williamson, O. E. (1988). “Corporate Finance and Corporate Governance”, Journal of Finance, Vol. 43, No 3, pp. 567-591.

Table 1 – Descriptive Statistics

Variable	Mean	Q1	Median	Q3	Min	Max
Whole Sample (Observations=80,764)						
No Employees	13.46	3.00	7.00	17.00	0	99
Sales (1)	18,049	2,658	7,399	20,255	1	851,370
Variation in Sales (2)	0.04	-0.11	0.04	0.19	-9.70	8.34
Knowledge Int. (3)	0.08	0	0	0.06	0	1
Firms with collateral (Observations=32,947) (4)						
No Employees	18.43	5.00	12.00	25.00	1	99
Sales	25,116	4,942	12,815	31,064	2	851,370
Variation in Sales	0.05	-0.08	0.04	0.17	-6.45	6.79
Knowledge Int.	0.05	0	0	0.05	0	1
Firms without collateral (Observations=47,817) (5)						
No Employees	10.03	2.00	5.00	12.00	0	99
Sales	13,180	1,896	5,033	13,767	1	667,100
Variation in Sales	0.03	-0.13	0.04	0.22	-9.70	8.34
Knowledge Int.	0.10	0	0	0.08	0	1

Note: (1) In thousand SEK; (2) Variation in sales= $\ln(S_{i,t}) - \ln(S_{i,t-1}) = \ln(S_{i,t}/S_{i,t-1})$ (3) Knowledge intensity: Employees with a university education exceeding three years / Total employment (4) If the firm has had real estate and/or land assets during the time period; (5) If the firm has not had real estate and/or land assets during the time period

Table 2 – Firm collateral and the cyclicality of Knowledge Intensity

Dependent variable:	Knowledge Intensity					
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta Sales_{i,t}$	.0024[b]	.0024[b]	.0036[a]	.0028[a]	.0029[a]	.0042[a]
$Collateral_{i,t}$		.0025	.0028		−.0084[a]	−.0081[a]
$\Delta Sales_{i,t} * Collateral_{i,t}$			−.0059[a]			−.0062[a]
No Observations	80,764	80,764	80,764	80,764	80,764	80,764
No Firms	14,581	14,581	14,581	14,581	14,581	14,581
Estimation	Within	Within	Within	GLS	GLS	GLS

Note: Regressions (1)-(3) are run with firm fixed effects, within estimation, (4)-(6) are run with random effects, GLS-estimation. All regressions are run with time dummies and robust standard errors, a, b, and c significant at 1, 5 and 10 percent. Intercept not reported.

Table 3 – The adjustment to sales variation of employees who do not have a long university education

Dependent variable:	Change in stock of less educated employees [21]					
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta Sales._{i,t}$	.2176[a]	.2171[a]	.2036[a]	.2347[a]	.2346[a]	.2187[a]
$Collateral._{i,t}$		.0616[c]	.0581[c]		.0306[b]	.0268[c]
$\Delta Sales._{i,t} * Collateral._{i,t}$			.0500			.0614
No Observations	75,601	75,601	75,601	75,601	75,601	75,601
No Firms	14,361	14,361	14,361	14,361	14,361	14,361
Estimation	Within	Within	Within	GLS	GLS	GLS

Note: Column Regressions (1)-(3) are run with firm fixed effects, within estimation, (4)-(6) are run with random effects, GLS-estimation. All regressions are run with time dummies and robust standard errors, a, b, and c significant at 1, 5 and 10 percent. Intercept not reported.

Less Educated = Total employment – employees with a university education exceeding three years

[21] Dependent variable => $\frac{(\text{Less Educated}_{i,t} - \text{Less Educated}_{i,t-1})}{\text{Less Educated}_{i,t}}$

Table 4 – Firm collateral and the cyclicality of Knowledge Intensity, split on leverage

Dependent variable:	Knowledge Intensity					
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta Sales_{i,t}$	.0036[a]	.0039[b]	.0036[b]	.0042[a]	.0048[a]	.0042[a]
$Collateral_{i,t}$	.0028	−.0001	.0044	−.0081[a]	−.0011[a]	−.0144[a]
$\Delta Sales_{i,t} * Collateral_{i,t}$	−.0059[a]	−.0031	−.0083[b]	−.0062[a]	−.0039	−.0082[b]
No Observations	80,764	39,226	41,538	80,764	39,226	41,538
No Firms	14,581	7,310	7,271	14,581	7,310	7,271
Estimation	Within	Within	Within	GLS	GLS	GLS

Note: Column (1) and (4) are run on the full sample, column (2) and (5) on the sample containing firms above the median in terms of leverage, and (3) and (6) contains firms below the median in term of leverage. Regressions (1)-(3) are run with firm fixed effects, within estimation, (4)-(6) are run with random effects, GLS-estimation. All regressions are run with time dummies and robust standard errors, a, b, and c significant at 1, 5 and 10 percent. Intercept not reported.

Table 5 – Firm collateral and the cyclicality of Knowledge Intensity, split on external finance dependence

Dependent variable:	Knowledge Intensity					
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta Sales_{i,t}$	.0036[a]	.0041[b]	.0037[b]	.0042[a]	.0046[a]	.0041[a]
$Collateral_{i,t}$	.0028	−.0059	.0097[b]	−.0081[a]	−.0180[a]	−.0003
$\Delta Sales_{i,t} * Collateral_{i,t}$	−.0059[a]	−.0021	−.0092[a]	−.0062[a]	−.0023	−.0096[a]
No Observations	80,764	35,079	45,330	80,764	35,079	45,330
No Firms	14,581	6,487	8,305	14,581	6,487	8,305
Estimation	Within	Within	Within	GLS	GLS	GLS

Note: Column (1) and (4) are run on the full sample, column (2) and (5) on the sample containing firms highly dependent on external finance, and (3) and (6) contains firms less dependent on external finance. Regressions (1)-(3) are run with firm fixed effects, within estimation, (4)-(6) are run with random effects, GLS-estimation. All regressions are run with time dummies and robust standard errors, a, b and c significant at 1, 5 and 10 percent. Intercept not reported.

Table 6 – Firm collateral and the cyclicality of Knowledge Intensity, small firms[22]

Dependent variable:	Knowledge Intensity					
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta Sales_{i,t}$	.0029[b]	.0028[b]	.0040[a]	.0031[b]	.0032[a]	.0045[a]
$Collateral_{i,t}$		.0060	.0063		−.0059[c]	−.0056[c]
$\Delta Sales_{i,t} * Collateral_{i,t}$			−.0069[b]			−.0071[b]
No Observations	46,999	46,999	46,999	46,999	46,999	46,999
No Firms	8,687	8,687	8,687	8,687	8,687	8,687
Estimation	Within	Within	Within	GLS	GLS	GLS

Note: Regressions (1)-(3) are run with firm fixed effects, within estimation, (4)-(6) are run with random effects, GLS-estimation. All regressions are run with time dummies and robust standard errors, a, b, and c significant at 1, 5 and 10 percent. Intercept not reported.

[22] A firm which has had a median employment of between 1 and 9 is considered small.