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Knowledge investments in recessions:
- The effects of demand and credit

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by

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CRISIS, RESTRUCTURING AND GROWTH

This working paper is one of a series of papers and reports published by the Institute for Research in Economics and Business Administration (SNF) as part of its research programme "Crisis, Restructuring and Growth". The aim of the programme is to map the causes of the crisis and the subsequent real economic downturn, and to identify and analyze the consequences for restructuring needs and ability as well as the consequences for the long-term economic growth in Norway and other western countries. The programme is part of a major initiative by the NHH environment and is conducted in collaboration with The Norwegian Ministry of Trade and Industry, The Research Council of Norway, The Confederation of Norwegian Enterprise/ABELIA and Sparebanken Vest/Bergen Chamber of Trade and Industry/Stavanger Chamber of Trade and Industry.

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KNOWLEDGE INVESTMENTS IN RECESSIONS:

THE EFFECTS OF DEMAND AND CREDIT

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ABSTRACT

We examine how recessions change firms' knowledge investments. Unlike existing work we split the effects of recessions into demand reductions, and problems with access to credit. Our main findings are that investments in R&D and innovation are more sensitive to problems with access to credit than they are to reductions in demand. For investments in human and organizational capital, the relationship is the opposite, i.e. they are more sensitive to demand reductions than access to credit. Furthermore, we hypothesize and find support for important nonlinearities in the effects of demand changes on investments in human and organizational capital. For mild demand reductions these investments increase, but for strong demand reductions they decrease, and, notably, they also decrease for firms that experience demand increases.

INTRODUCTION

We examine how recessions change firms' knowledge investments. The motivation to do so stems from our view that a) the strategy literature has had surprisingly little to offer in terms of understanding how recessions impact competitive behavior (Agarwal, Barney, Foss, & Klein, 2009), and b) given the almost universally accepted primary importance of knowledge stocks in determining competitive outcomes, understanding changes in such stocks are presumably of special importance.

To get some traction on the link between recession and knowledge investments we split the effects of recessions into demand reductions, and problems with access to credit. Both of these are relevant in most recessions, but firms may experience them in different degrees and different combinations (Tong & Wei, 2008). We separate these two in order to analyze whether their effects (on knowledge investments) differ. We also split knowledge investments into different types of knowledge stocks, specifically investments in R&D, -innovation, -human capital, and investments in organizational capital. We also examine changes in physical asset investments to form a contrast to knowledge assets.

Our data are based on a randomly sampled survey of 1248 Norwegian CEOs conducted late in 2010, merged with accounting data. Our main findings are that investments in R&D and innovation are more sensitive to problems with access to credit than they are to reductions in demand. For investments in human- and organizational capital, the relationship is the opposite. These are more sensitive to demand reductions than they are to access to credit. Furthermore, we hypothesize and find support for important nonlinearities in the effects of demand changes on investments in human and -organizational capital. For mild demand reductions these investments increase, but for strong demand reductions they decrease, and notably, they also decrease for firms that experience increases in demand.

THEORY AND HYPOTHESES

The recession in 2008-9 revealed a major shortcoming in the strategy literature. Given the interest the field of strategy has devoted to understanding competitive behavior - and how competitive behavior is influenced by forces in firms' external environment - the strategy literature would seem a natural place to look for insights into how recessions affect firm behavior. Surprisingly the strategy literature has almost nothing to say on the subject of

recessions and business cycles (Agarwal et al., 2009). Surely we acknowledge that some of the standard theoretical apparatus is relevant for recessions too, but there is also reason to question whether some of the common background assumptions are valid under recessions.

For example, the strategy literature typically assumes that a number of markets are reasonably well functioning, most notably capital markets, so that positive NPV investments will be financed. The business cycle literature in economics and finance provide ample evidence that this assumption is questionable during a recession. For example Gilchrist and Sim (2007) estimate that 50-80% of the drop in investment during a recession is due to financial factors that constrain firms' ability fund investments. So a sizeable share of the problem during a recession is precisely that profitable investments are not financed. The bank channel has been designated as particularly important in depressing investment (Bernanke & Gertler, 1989, 1990), causing firms and industries that are particularly dependent on credit to cut deeper in investments than those that are less dependent (Braun & Larrain, 2005; Campello, 2003). In short, we cannot safely assume that profitable investments will be financed during a recession.

Another common background assumption in the strategy literature is that the ability to finance profitable investments does not vary across different asset types. I.e., while capital markets do assess the risk/return profile of different investments, there is no discrimination for or against tangible assets once this is taken into account. This means that firms are free to allocate their investments so that the expected marginal returns are equal across different asset types. Again, this is not necessarily the case during recessions. If banks need to reduce lending, they will presumably keep the clients that pose the lowest risk of losses (Bernanke, Gertler, & Gilchrist, 1996). Unlike equity investors that have an upside from a profitable investment, banks only have a downside if loans are not repaid. Since intangible assets are typically weaker collateral than physical capital, funding for intangible assets will be particularly difficult for firms that cannot finance these by retained profit (Aghion, Askenazy, Berman, Cette, & Eymard, 2008; Hall, 2010). So the more dependent you are on credit, the more difficult it will be to finance investments in intangibles and the more you will have to cut in such investments. However, there are also investments that become cheaper and more attractive during a recession (Aghion & Saint-Paul, 1991). In particular this applies to investments that rely on the reduced opportunity cost of employees' time during a recession. If employees are less than fully employed producing output, the opportunity costs of forgone production are lower when those employees are diverted to training or participation in change programs (Davis & Haltiwanger,

1990; Hall, 1991). In sum then, recessions may cause serious distortions in both the level and composition of investment, factors that are important to competitive behavior and ultimately competitive outcomes. The effect of recessions on investments should therefore be a natural subject of study for the strategy literature.

As noted we split the effects of recessions into problems with demand shortfalls and problems with access to credit. There are theoretical reasons to expect these two aspects of recessions to have somewhat different impact on investment behavior. We first focus on investments in plant and machinery, which serves as a contrast to the changes in knowledge investments that is our primary interest. Reduced demand and problems with access to credit should both cause reductions in investments in plant and machinery. Obviously, the more demand is reduced, the more a firm is likely to experience excess capacity, and the less attractive investments in physical capacity becomes. If some portion of physical capital is normally financed through credit, reduced credit availability will further reduce physical capital investments. Since the former (demand) has to do with the *incentives* to invest and the latter (credit) with the *ability* to invest, we expect that the effect of reduced demand will be stronger. Put differently, credit constraints are only relevant for firms that have an incentive to invest, so demand should have larger negative effects than credit. This gives us the following hypotheses:

> *H1: Demand reductions and problems with access to credit are both negatively related to investments in physical assets.*
>
> *H2: Demand reductions have a larger negative effect on investments in plant and machinery than problems with access to credit*

Next we turn to investments in R&D and innovation. First of all, investments in R&D and innovation are long term investments that are more difficult to scale up and down than investments in physical capital. If you cut in R&D, you are unlike to be able to scale investments back up quickly (Li, 2011). This inertia will make investments in R&D less sensitive to fluctuations in demand than investments in physical capital.[1] The firms that are most likely to cut R&D are those that face severe financing constraints. Firms that are able to finance R&D from earnings will tend to maintain R&D investments, while firms that are unable to do so must either cut investment or increase borrowing. The firms that cut the most in R&D and innovation are therefore likely to be those that face problems with credit

[1] From this it follows that R&D increases its share of total investments in recessions, as found by Aghion et al. (2008).

availability (Aghion et al., 2008). We therefore expect R&D investments to be more sensitive to problems with access to credit than reductions in demand.

H3: Investments in R&D and innovation are less sensitive to demand reductions than are investments in physical capital

H4: Investments R&D and innovation are more sensitive to credit availability problems than to demand reductions

We now shift focus to a different type of knowledge investments, specifically investments in human and organizational capital. These categories are typically considered to be countercyclical (Aghion & Saint-Paul, 1991). The reason for this is the lowered opportunity costs of taking employees out of their ordinary tasks when capacity utilization is low - as it tends to be during a recession which in turn makes such investments more attractive. Obviously, this point is only relevant if there is some degree of labor hoarding. If firing and (re)hiring was costless, firms would not have economic incentives to hold on to employees with excess capacity beyond what legal restrictions mandate. We can also note that since this effect is driven by excess capacity, and involves investment of time more than cash, it should be more sensitive to demand- than to credit problems.

We also believe that there should be important nonlinearities associated with such investments for the following reasons: While mild increases in excess capacity makes these investments more attractive, at some point the cost of excess capacity becomes too high, and the firm will increasingly turn to layoffs. Put differently; at some point the expected gains from retaining and training employees will be lower than the forgone savings from layoffs. Conversely, even during a recession, some firms will face demand increases. For such firms the opportunity costs of training and investments in organizational capital will have increased, and investments should fall (Bean, 1990).[2] The change in investments in training and organizational capital should therefore be a negative cubic function of demand problems. I.e. if demand increases, investments should fall. If demand is reduced, investments should initially increase, but eventually decrease (for sufficiently large reductions in demand) as firms turn to layoffs instead of labor hoarding. This pattern is what a negative cubic function traces out. Summing up, this gives us the following hypotheses:

[2] For sufficiently large increases the firm will have to start hiring, which will tend to drive the need for training upwards.

H5: Investments in human- and organizational capital are more sensitive to demand reductions than to credit problems

H6: Changes in investments in human- and organizational capital is a negative cubic function of demand problems

DATA AND METHODS

We use data from an extensive questionnaire about the effects of the recent financial crisis and the subsequent recession on Norwegian firms. The survey was distributed to the CEO of 5000 Norwegian firms in November 2010. These firms where randomly drawn from the population of Norwegian firms with the following limitations: Firms had to have a minimum turnover of NOK 10 million ($ 1.7 million) in 2007, and a salary expenses of minimum NOK 3 million ($ 0.5 million), this was done to avoid the large number of small firms that are set up as tax shelters, and have no real operations. We also removed all government owned firms, and members of industries that are dominated by non-profit organizations. We also eliminated banking and insurance, since our interest is in the nonfinancial sector. We received a total of 1248 responses, yielding a response rate of 25 % which is above the median for surveys using CEOs as respondents. Missing data from the survey, or missing accounting data reduced the sample to approximately 930 usable responses We could find no response bias with respect to size, profitability, industry membership, debt ratio, growth and geography.

We use a total of five dependent variables measuring changes in firms' investment behavior as a result of the recession, namely *investments in plants/machines/equipment (INV_MACH), research and development (INV_R&D), - innovation (INV_INNO), organizational capital (INV_ORG) and –human capital (INV_HUMAN).* All five variables were based on single item answers to the following question: "How did your firm change its investments as a result of the crisis". The scale ranged from -3 (reduced) to +3 (increased) with 0 indicating no change. However, we recoded the scales to a 1-7 scale for the purpose of analysis, which means that the neutral value is 4 instead of 0 in our subsequent analyses.

We have two independent variables. *Reductions in access to credit* was constructed based on a question where the respondents were asked to rate how their access to credit was affected by

the crisis on a scale from -3 (reduced) to + 3 (increased) with 0 indicating no change. This scale was also recoded to a 1-7 scale and reversed, so that a higher score reflects larger reductions in access to credit. *Reductions in demand* was constructed by summing up two items from the survey where the respondents were asked to i) evaluate how the crisis had affected the demand for the firms products and services and ii) how the crisis affected their capacity utilization. Both items had scales ranging from -3 (reduced) to +3 (increased) with 0 indicating no change. These scales were also recoded to a 1-7 scale, and reversed so that a higher value reflects a larger reduction in demand. After summarizing the two items, the scale ranges from 2-14.

As control variables, we included eleven firm- and industry characteristics that earlier theoretical- and empirical research has found to affect how severely firms are hit by recessions. Very briefly, these include the share of revenue from *durable goods, number of competitors* in the firms main market, the degree of *vertical differentiation* in the firms main market, *knowledge intensity* - the share of employees (in percent) that have more than four years of higher education, the firms *export intensity, -size* (Ln sales), *-profits* (industry adjusted), *-growth* (industry adjusted) and *-leverage* (industry adjusted). The first seven variables were based on data from the questionnaire while the latter four were based on accounting data from 2007, the last observations available before the recession.

FINDINGS

We apply OLS-regressions to test our hypotheses. The regression outputs are presented in table 1 and 2. Our basic model is as shown in equation 1. $Y_{1\text{-}5}$ represents the five dependent variables. Note that in some specifications *reduction in demand* is analyzed as a cubic term.

(1) $Y_{1\text{-}6} = A + \beta 1$ Reductions in demand $+ \beta 2$ Reductions in access to credit $+ \beta 3\text{-}\beta 13$ Controls $+ \varepsilon$

First, we test the effect of reductions in demand and access to credit on investments in physical assets. We use INV_MACH as the dependent variable, and find that the model is significant on a 1% level with a F-value of 8.415 and an adjusted R^2 of 0,094. H1 predicted that demand reductions and problems with access to credit are both negatively related to

investments in physical assets. *Reductions in demand* and *reductions in access to credit* are indeed both found to have a negative coefficient, and both are statistically significant on a 0.01 level. H1 is therefore supported. H2 predicted that reductions in demand would have a larger negative effect on investments in physical assets than problems with access to credit. This implies that the standardized coefficients of reductions in demand should be larger (in absolute value) than the coefficients of reductions in access to credit. As we see from Table 1 this is the case (-0.238 vs. -0.102), and H2 is therefore supported.

Second, we test the effect of the independent variables on knowledge investments. Continuing in Table 1, we start by using INV_R&D as the dependent variable, and find that our model is significant on a 0.01 level with a F-value of 3.352 and an adjusted R^2 of 0,032. *Reduction in access to credit* is found to be negative and statistically significant on a 0.05 level, while *reductions in demand* is negative but only statistically significant on a 0.10 level. Next, we use INV_INNO as the dependent variable and find that the model is significant on a 1% level with a F-value of 2.584 and an adjusted R^2 of 0,022. *Reduction in access to credit* is negative and significant on a 0.05 level while *reduction in demand* is negative but not statistically significant.

H3 predicted that investments in R&D and innovation are less sensitive to demand reductions than investments in physical capital. Given our finding that reductions in demand does not have a significant relationship (on a 0.05 level) with either INV_R&D or INV_INNO, H3 is supported. H4 predicted that investments in R&D and innovation are more sensitive to credit availability problems than to demand reductions, which implies that the standardized coefficients of the former should be larger than the latter. From the results we find that this is the case both for INV_ R&D (-0.078 vs. -0.062) and for INV_INNO (-0.069 vs. 0.048). In addition, the coefficient of *reduction in demand* is not statistically significant on a 0.05 level for either of these dependent variables. We therefore conclude that H4 is also supported. The results discussed thus far are presented in Table 1 below:

Table 1 - OLS regressions investements in physical assets and knowledge

DEPENDENT VARIABLE	PHYSICAL INVESTMENTS		KNOWLEDGE INVESTMENTS			
	INV_MACH		*INV_R&D*		*INV_INNO*	
	Coeff	Std Coeff	Coeff	Std Coeff	Coeff	Std Coeff
INDEPENDENT VARIABLES						
Reductions in demand	-0.155***	-0.238***	-0.031*	-0.062*	-0.025	-0.048
	(0.022)		(0.18)		(0.019)	
Reductions in access to credit	-0.153***	-0.102***	-0.092**	-0.078**	-0.084**	-0.069**
	(0.049)		(0.040)		(0.042)	
Constant	6.662***		3.633***		4.453***	
	(1.017)		(0.821)		(0.857)	
N	927		924		928	
F-value	8.415***		3.352***		2.584***	
R2	0.107		0.046		0.035	
Adjusted R2	0.094		0.032		0.022	

OLS-regressions. Standard errors in parantheses. ***, **, and * represent statistical significance at the 1, 5, and 10 percent levels, respectively. Control variables not reported due to space considerations.

Finally, we test the effects of our independent variables on investments in organizational- and human capital, cfr. Table 2 below. We start by using INV_ORG as the dependent variable, and find that our model is significant on a 0.01 level with a F-value of 2.898 and an adjusted R^2 of 0,026. *Reduction in demand* is found to be negative and statistically significant on a 0.01 level, while *reduction in access to credit* is found not to have a significant relationship with INV_ORG. Next we use INV_HUMAN as the dependent variable, and find that our model is significant only on a 0.1 level with a F-value of 1.556 and an adjusted R^2 of 0,008. Neither *reduction in demand* nor *reduction in access to credit* is found have a significant relationship with INV_HUMAN. We then repeat the above regressions with a cubed *reduction in demand* term. Once again we start by using INV_ORG as the dependent variable, and find that the model is significant on a 0.01 level with a F-value of 3.294 and an adjusted R^2 of 0,031. *Reduction in demand cubed* is found to be negative and statistically significant on a 0.01 level, while *reduction in access to credit* is found not to have a significant relationship with INV_ORG. Next we use INV_HUMAN as the dependent variable, and find that the model is now significant on a 0.01 level with a F-value of 1.749 and an adjusted R^2 of 0,010. *Reduction in demand cubed* is negative and statistically significant on a 0.05 level, while *reduction in access to credit* is found not to have a significant relationship with INV_HUMAN.

H5 predicted that investments in human and organizational capital are more sensitive to demand reductions than to credit problems, which implies that the standardized coefficients of the former should be larger than the latter. Using the linear term for reduction in demand, we find that *reductions in demand* are statistically significant on INV_ORG while no such effect

is found for *reductions in access to credit.* Neither of the variables have a statistically significant relationship with INV_ORG. However, when using the cubic function of *reduction in demand*, we find that reductions in demand are statistically significant for both INV_ORG and INV_HUMAN while *reductions in access to credit* are insignificant for both. We thus conclude that H5 is supported. H6 predicted that changes in investments human and organizational capital are a negative cubic function of demand problems. This implies that the coefficient of *reductions in demand cubed* should be negative and statistically significant and that the model should have better fit with the cubed term than with a linear term. The cubed terms are statistically significant on a 0.01 and 0.05 levels for INV_ORG and INV_HUMAN, respectively and the adjusted R^2 increases for both models when the cubic term is used as compared to using a linear term. We thus conclude that H6 is supported. The results regarding investments in human- and organizational capital are presented in table 2 below:

Table 2 - OLS regressions investements organizational- and human capital

DEPENDENT VARIABLE	HUMAN AND ORG CAPITAL				HUMAN AND ORG CAPITAL			
	INV_ORG		*INV_HUMAN*		*INV_ORG*		*INV_HUMAN*	
	Coeff	Std Coeff	Coeff	Std Coeff	Coeff	Std Coeff	Coeff	Std Coeff
INDEPENDENT VARIABLES								
Reductions in demand	-0.050***	-0.095***	-0.026	-0.049				
	(0.019)		(0.019)					
(Reductions in demand)^3					-0.003***	-0.117***	-0.002**	-0.070**
					(0.001)		(0.001)	
Reductions in access to credit	-0.036	-0.029	-0.007	-0.005	-0.041	-0.034	-0.007	-0.006
	(0.042)		(0.042)		(0.041)		(0.041)	
Constant	2.188**		3.265***		1.921**		3.111***	
	(0.863)		(0.858)		(0.862)		(0.859)	
N	929		928		929		928	
F-value	2.898***		1.556*		3.294***		1.749**	
R2	0.04		0.022		0.045		0.024	
Adjusted R2	0.026		0.008		0.031		0.010	

OLS-regressions. Standard errors in parantheses. ***, **, and * represent statistical significance at the 1, 5, and 10 percent levels, respectively. Control variables not reported due to space considerations.

CONCLUSION AND IMPLICATIONS

Our study differs from other studies of recessions by separating and comparing the effects of financial constraints and demand reductions. Existing work tends to focus on one or the other, or lump both together. We also split a firm's knowledge investments into four categories, while existing work tends to focus on s subset of these. We find important differences along both dimensions.

For example, we find that investments in physical assets are most sensitive to demand reductions while investments in new knowledge (R&D and innovation) are more sensitive to credit availability. Investments in human- and organizational capital, like physical

investments, are more sensitive to demand reductions, but unlike physical capital these investments are strongly nonlinear in the degree of demand reductions.

If we categorize R&D and innovation as investments in *new knowledge*, and human- and organizational capital as investments in *existing knowledge* (i.e., to close the gap to best practice), we find that recessions reduce investments in new knowledge, while it increases investment in existing knowledge, but only for firms with the "right amount" of excess capacity and sufficiently strong incentives to hoard labor. The likely implication from this is that during a recession, R&D and innovation based advantages become more sustainable for firms that are financially unconstrained, since these face weakened R&D competition, while they become less sustainable for firms that are financially constrained. Advantages that result from superior human- and (even more so-) organizational capital, will face increased imitation and be subject to a catching up effect. This effect will be most pronounced for imitation of firms that maintain high capacity utilization through the recession, by labor hoarding firms that face mild increases in excess capacity.

In our opinion these findings underscore the need for more work on how competitive behavior changes in periods when our standard assumptions are questionable. For example, we have seen that access to credit and internal finance becomes an unusually important constraint on R&D and innovation in such periods, presumably to some extent at the expense of the criterion of expected returns. We have also seen that for some firms, investments in human- and organizational capital receives a temporary "subsidy" in the form of reduced opportunity costs. While these effects are typically temporary, their competitive effects can be long lasting. Presently, we know little about whether and how firms take such effects into account in their behavior before and during a recession

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We examine how recessions change firms' knowledge investments. Unlike existing work we split the effects of recessions into demand reductions, and problems with access to credit. Our main findings are that investments in R&D and innovation are more sensitive to problems with access to credit than they are to reductions in demand. For investments in human and organizational capital, the relationship is the opposite, i.e. they are more sensitive to demand reductions than access to credit. Furthermore, we hypothesize and find support for important nonlinearities in the effects of demand changes on investments in human and organizational capital. For mild demand reductions these investments increase, but for strong demand reductions they decrease, and, notably, they also decrease for firms that experience demand increases.

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