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**Shadow of trouble: The effect of pre-recession
characteristics on the severity of recession impact**

by

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ABSTRACT

The recent financial crisis has heightened the need to understand why some firms are more severely affected by recessions than others and how different firm and industry characteristics affect firms' vulnerability to such shocks. To study these questions empirically, we complement secondary financial data with primary data from an extensive questionnaire about the effects of the recent recession distributed to 5000 Norwegian CEOs in late 2010. We find that high pre-recession operating profits make firms less vulnerable to recessions, while high pre-recession growth, pre-recession debt ratio, firm size, share of durable goods and level of vertical product differentiation make firms more vulnerable to recessions. When comparing effect sizes, we find that other characteristics than pre-recession profits are the most important determinants of the severity of recession impact. We argue that these results indicate that recession can cause the shape of fitness landscapes to change.

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INTRODUCTION

The recent financial crisis and the recession that followed heightened the need to understand why some firms are more vulnerable to recessions than others. Evolutionary theories focus on the dynamic process by which patterns of firm behavior and market outcomes are jointly determined over time, and such theories are well suited to study economic changes like shifts in demand- or supply conditions (Nelson & Winter, 1982). A general evolutionary process can be outlined as follows. One variable (or a set of variables) is subject to some sort of random variation, before a selection mechanism works to winnow out the variation by selecting firms that are most fit to the criteria of selection (Nelson, 1995). Fitness is not a property of the firm itself, but is determined by the interaction between competing firms in a given market environment (Metcalfe, 2005). If this market environment changes, which may happen in severe recessions, a redistribution of economic fitness across the population of firms may follow (Metcalfe, 2005). The question is, however, how fitness is changed by recessions? One scenario is that the shape of the fitness landscape is unchanged by recessions, which implies that more of the less profitable firms struggle in such times. The other scenario is that recessions change the shape of the fitness landscapes causing firms with other pre-recession characteristics than low profits to struggle.

Unfortunately, the knowledge related to how fitness is affected by recessions is limited, and empirical results that can shed light on this question are mainly “leftovers” from work intended to study other issues. The majority of these studies use ex post performance measures derived from secondary financial data as dependent variables (e.g. exit/survival, profits, growth, market shares). Their results must therefore be interpreted with caution as such measures are functions of i) the impact of the recession on firms’ operations, ii) the actions firms undertake to respond to these changed environmental conditions iii) an error term consisting of all non-recession related factors that affect firm performance/ exit decisions. To investigate how severely recessions affect the fitness of firms one needs to direct the focus to the first of these aspects, namely the impact of the recession on firms operations, and isolate it as much as possible. Doing so makes it possible to study why some firms’ are more vulnerable to recessions than others and thereby also increase the understanding of how fitness is affected by recessions.

To fill some of these knowledge gaps we use the financial crisis of 2008 and the recession that followed as the empirical setting and study the effect of different pre-recession characteristics on how severely firms themselves report to be affected by the recession. Our dataset is made up from two sources; one is the answers of 1248 Norwegian CEOs to an extensive questionnaire about the

effects of the recession, while the other is publicly available financial information. The two data sources are in turn combined into one firm level panel.

We find that high pre-recession operating profits make firms less vulnerable to recessions, while high pre-recession growth, pre-recession debt ratio, firm size, share of durable goods and level of vertical product differentiation make firms more vulnerable to recessions. Further, by examining the effect size of the different variables we find that *durable goods share, industry concentration, debt-ratio and export intensity* all have a bigger impact on the probability that firms are severely affected by the recession than *profitability*. When comparing effect sizes, we find that other characteristics than pre-recession profits are the most important determinants of the severity of recession impact. These results may indicate that recessions can create changes in the shape of fitness landscapes.

The paper is structured as follows: In Section 2, we discuss relevant literature and develop our hypotheses, before our methods and data are presented in Section 3. In Section 4 we present the findings of our analyses before, in Section 5, we discuss the results, alternative interpretations, implications and suggestions for future studies.

THEORY AND HYPOTHESES

Evolutionary theories focus on the dynamic process by which patterns of firm behavior and market outcomes are jointly determined over time and such theories are well suited to study economic changes such as shifts in demand or supply conditions (Nelson & Winter, 1982). A general evolutionary process can be outlined as follows. One variable (or a set of variables) is subject to some sort of random variation, before a selection mechanism works to winnow out the variation by selecting firms that are most fit to the criteria of selection (Nelson, 1995). Fitness is determined by the interaction between competing firms in a given market environment, and if the market environment changes, a redistribution of economic fitness across the population of firms may follow (Metcalf, 2005). A population, in this setting, is defined as a set of firms that are subject to common environmental and selective pressures (Metcalf, 2005). In line with the “population thinking” (Mayr, 1976) that underlies evolutionary models the focus is on the variety of characteristics within a population of firms, averages and representative types (Hodgson & Knudsen, 2010; Metcalf, 2005).

In economic settings, selection models usually have market dynamics as the selection mechanism, firms as the unit of selection and productivity as the selection criteria (Alchian, 1950; Friedman, 1953). Hodgson and Knudsen (2010:24) emphasize that a distinction should be made between “the relatively cohesive entity that is actually being selected (the phenotypes or interactors) and the

entities that replicate differentially as a result of selection (genotype or replicators)". Different firm characteristics such as profitability, productivity, growth, leverage etc. are thus interactors, while the underlying routines that make up a firm (Nelson & Winter, 1982) are replicators. Fitness is a function of both interactor and replicator fitness, and the interactor-replicator-distinction is essential for defining the concept in a non-tautological way (Hodgson & Knudsen, 2004; Hull, 1988; Metcalfe, 2005). The fitness of a replicator is the propensity "[...] to produce copies and increase the frequency of similar replicators in the population", while the fitness of an interactor is "[...] the propensity of its replicators to increase their frequency" (Hodgson & Knudsen, 2010:107). The question is, then, how fitness is affected by recessions. If we imagine a rugged fitness landscape (Levinthal, 1997), there are two likely scenarios of how fitness is affected by recessions. The first scenario is that the shape of the fitness landscape is unchanged by the recessions, which implies that more of the less profitable firms struggle. The second scenario is that the shape of the fitness landscape is changed by the recession, which implies that firms with other pre-recession characteristics than low profits have their fitness destroyed and struggle more in recessions.

The relevant selective characteristics of firms are multidimensional and related to their underlying replicators in complex ways, but a great deal of understanding can be achieved by focusing on only one dimension of firm variety (Metcalfe, 2005). In this paper we stick to the interactor dimension and complement our general evolutionary model with specific theories and empirical results related to how a number of different firm characteristics (interactors) explain why some firms are more severely affected by recessions than others. To study fitness over different environmental states, which is of interest here, one has to either reproduce a fitness mapping for each environmental state or include a set of environmental variables (Hodgson & Knudsen, 2010). Following the first strategy, several studies use measures of ex post performance (e.g. exit/survival, profits, growth, and market shares) derived from secondary data as proxies for fitness and compare these across different environmental states (Hodgson & Knudsen, 2010). Such a strategy thus assumes that firms which experience a negative (positive) change in fitness between two environmental states also experience a corresponding decline (increase) in performance. While ex post performance measures do encompass the impact of recessions on firms' fitness, they are also functions of the actions firms undertake to respond to the changed conditions and of an error term consisting of all non-recession related factors that affect firm performance. The highly aggregated nature of such measures highlights the importance of interpreting results from such studies with caution. A study that uses an alternative measure is Geroski and Gregg (1993, 1996, 1997) who used a large scale questionnaire to ask UK manufacturing firms to evaluate how severely they had been affected by the 1991-92

recession. This measure is likely to isolate the effects of the recessions on firms' fitness better than annual performance data.

So what effect do different firm and industry characteristics have on how severely firms are affected by recessions? In the following, we will present earlier findings regarding how several such characteristics affect firms' vulnerability to recession, starting with pre-recession profitability. The classical selection argument states that the least productive firms leave the market while the most efficient ones survive (Alchian, 1950; Friedman, 1953). The number of empirical studies that support a positive relationship between past profitability and performance is vast (e.g. Aw, Chen, & Roberts, 2001; Baily, Hulten, Campbell, Bresnahan, & Caves, 1992; Bellone, Musso, Nesta, & Quéré, 2008; Carreira & Teixeira, 2011; Foster, Haltiwanger, & Krizan, 2001; Griliches & Regev, 1995; Haltiwanger, 1997), which makes it reasonable to believe that the less profitable firms are punished harder when recessions hit. However, there are empirical results questioning this view. Geroski and Gregg (1996, 1997) study the link between pre-recession profits and how severely firms were affected by the recession, and find no statistically significant relationship between the two measures. Nishimura, Nakajima and Kiyota (2005) study the relationship between total factor productivity and Japanese firms' entry, survival and exit in the period 1994-98, and find that efficient firms exited while inefficient ones survived. They suggest that this can be explained by the poorly functioning Japanese banking system which selected firms by other criteria than productivity.

Another characteristic is firms' pre-recession growth. Geroski and Gregg (1996, 1997) found that firms with relatively higher pre-recession growth were more severely affected by recessions. Lien (2010) suggested that high pre-recession growth rates make firms more vulnerable to recessionary pressures because the marginal customers who enter a market in the later stages of a boom and cause the growth, are likely to be the first to exit the market when the good times end. Therefore, the contraction in demand is likely to be larger for firms with higher pre-recession growth, which makes them more vulnerable to recessions.

Size is also found to affect firms' vulnerability to recessions. Geroski and Gregg (1996, 1997) found that smaller firms were more severely affected by the 1991-92 recession than their larger counterparts. They suggested that the results could come from larger firms having economies of scale and/or easier access to external finance. The latter argument is supported empirically by Gertler and Gilchrist (1994) and Lang and Nakamura (1995) who found that smaller and riskier firms were affected disproportionately harder than larger firms in periods of tight money. These results are consistent with the view that creditors go into "flight to quality mode" during recessions by preferring firms with strong balance sheets, easily liquidated assets and low information asymmetry

problems, something that tends to favour larger firms (Bernanke, 1983). Larger firms are therefore less likely to be severely affected by recessions.

Financial leverage has also been found to explain differences in how firms are affected by recessions. Geroski and Gregg (1993) found that firms with high pre-recession debt levels were more severely affected by the 1991-92 recession than their less leveraged counterparts. High debt both reduces profits received by the firms' owners from fulfilling their obligations and increases the costs associated with not fulfilling them, which again reduces firms' ability to make credible contracts as they become more likely to default their obligations and to act opportunistically (Maksimovic, 1995). The effect of leverage on market shares in recessionary times has also been studied. Opler and Titman (1994) found evidence that highly leveraged firms lost more market shares and experienced higher drops in operating profits during economic downturns than firms with lower debt levels. They also investigated the link between leverage, market share losses and industry characteristics, and found that highly leveraged firms with specialized products and in concentrated industries struggle more during recessions. The former can be explained by customers being more reluctant to purchase specialized products that require future servicing from distressed firms (Maksimovic & Titman, 1991; Titman, 1984), while the latter findings may be due to such industries either having more specialized products or that the gain from removing weakened competitors is higher in concentrated industries (Opler & Titman, 1994). Campello and Fluck (2006) found evidence that market share losses were higher among leveraged firms during recessions in industries with low debt levels, significant switching costs and less liquid assets. In addition, Campello (2003) found that sales growth was low during recessions for highly leveraged firms in low-debt industries, and that no such effect could be found for highly leveraged firms in high-debt industries. These latter findings indicate that the effect of financial leverage differs between industries with different characteristics. However, the general prediction is that highly leveraged firms are more vulnerable to recessions.

Other characteristics that may affect firms' vulnerability to recessions are found in studies of how cyclicalities vary between industries with different product characteristics. The price elasticity of demand tends to become more inelastic during recessions (Stiglitz, 1984), and the level of product differentiation will affect the degree of this effect. An important distinction is between products that are vertically and horizontally differentiated. Whereas vertical differentiation implies that all customers would prefer one product over another if they were sold at the same price (Sutton, 1986), this would not be the case with horizontally differentiated products as differences in customer preferences imply positive demand for both products if sold at equal prices (Hotelling, 1929). Both types of differentiation imply that customers face switching costs and thus predict more inelastic demand during recessions. However, high levels of vertical product differentiation are usually accompanied

by higher prices which make such products more vulnerable to low cost substitutes. Industries with vertically differentiated products are therefore likely to experience relatively more elastic demand during recessions, something that increases their vulnerability to recessions.

The durability of products may also affect firms' vulnerability to recessions. Petersen and Strongin (1996) found that demand in durable goods industries is approximately three times more cyclical than in non-durable goods industries, and that durability is the most important factor in explaining the cyclical nature of an industry. They suggested several explanations for why industries with durable goods are more cyclical. One explanation was that small changes in customers' desirable stock of durable goods lead to large percentage changes in the demand for such products, while another was that durable goods purchases often rely on external financing which may be more difficult to obtain in periods of financial turbulence. A third explanation was that buying durable goods involves a higher involvement of irreversibility for customers than non-durable goods, which makes it more tempting to postpone the purchase of durable goods. A fourth possible explanation can be derived from Bernanke (1983), who proposed that there is an option value associated with avoiding irreversible actions under uncertainty, and that this option value would increase during recessions. As durable goods investments involve some irreversibility, the value of the delay option increases during recessions, which causes the negative drop in demand to increase (Petersen & Strongin, 1996). Firms with a high share of durable goods are therefore more likely to be severely affected by a recession.

The above discussions can be summarized into the following six hypotheses:

H1: High pre-recession profitability makes firms less vulnerable to recessions

H2: High pre-recession growth makes firms more vulnerable to recessions

H3: Large size makes firms less vulnerable to recessions

H4: High pre-recession leverage makes firms more vulnerable to recessions

H5: High level of vertical product differentiation makes firms more vulnerable to recessions

H6: High share of durable goods makes firms more vulnerable to recessions

DATA AND METHODS

To study the questions raised above, we created an extensive questionnaire about the effects of the recent financial crisis and the subsequent recession on Norwegian firms. Questions were constructed based on a literature review, and went through a number of revision rounds before a complete draft was tested on 12 CEOs from firms of different sizes and from different industries. The final questionnaire consisted of 39 questions divided into three sections. The first section focused on issues regarding the pre-crisis period, the second on how firms were affected by the recession and how they responded to it, while the third section focused on firms' expectations for the future. The survey was distributed to 5000 Norwegian firms (for the attention of the CEO) in November 2010, with two reminders being sent out in December 2010. The data collection was completed at the end of January, 2011.

Sample

We found it necessary to exclude a number of firms and industries from the sample in order to make the empirical setting as representative as possible of the population of Norwegian firms. Cut off limits were set on the basis of 2007 data, the year before the crisis, and included the following. First, we removed firms with an annual turnover smaller than NOK 10 million (approximately \$ 1.7 million) to avoid very small firms to dominate the sample, and to exclude holding and real estate firms with no day-to-day operations. Second, we removed firms with labour and social expenses lower than NOK 3 million (approximately \$ 0.5 million) to secure that the firms at least had a few employees. Setting a limit on number of employees would be preferable, but unfortunately not possible as the employee variable in the dataset was rather incomplete. Third, we removed firms with legal forms other than AS, ASA, ANS and DA, and fourth, we removed all publicly owned firms as these are likely to be little motivated by profits. Fifth, we removed a total of 13 two-digit NACE-industries which were believed to disturb the generality of the sample. Industries from the finance and insurance sector were removed as their financial reporting tends to differ from that of other firms, while the agriculture, health and culture sectors were removed as their close connections to the public sector make them less likely to experience normal market forces or to be motivated by profits. This left us with a total sample frame of 17.312 firms from which 5000 firms were randomly chosen to receive the questionnaire. The data collection was completed at the end of January 2011 with a total response rate of 25% (1248 usable responses). However, missing data on one or more of the variables used in this study reduced the size of the effective sample to 1075 respondents.

Source of variation

The financial crisis of 2008 and the recession that followed was the biggest economic crisis in Norway since the 1930s. GDP growth dropped from 2.7 % in 2007, to 1.8% in 2008 and -1.5% in 2009, growth in gross capital investments dropped from 16.1 percent in 2007 to -7 percent in 2009, while the number of yearly bankruptcies increased by 106 percent between 2007-2009 (StatisticsNorway, 2010). The effect on firm performance was also substantial. Mean operating profits for our population of Norwegian firms dropped from 8.84 percent in 2007 to 5.67 percent in 2009, while the standard deviation of operating profits increased from 0.105 to 0.306 in the same period. Meyer (1995:151) states that “good natural experiments are studies in which there is a transparent exogenous source of variation in the explanatory variables that determine the treatment assignment”. The financial crisis of 2008 did not originate in Norway, something that increases the exogenous dimension of the shock. In this paper, the financial crisis of 2008 and the recession that followed are therefore used as a natural experiment on the population of Norwegian firms.

Variables

We use CEOs’ subjective evaluation of how severely they were affected by the recession as a proxy for the impact of the recession on firms’ economic fitness. Our dependent variable is dichotomous, simply whether a firm was severely affected by the recession (severely =1) or not (not severely = 0). The variable is constructed based on the following question in the survey: “to what degree was/is your firm affected by the financial crisis and the recession that followed? Please evaluate the answer relative to what you define as normal market conditions”. The respondents could choose between the five categories “Extremely severely affected“, “Severely affected“, “Moderately negatively affected“, “Not affected” and “Positively affected”. Firms which answered either “Extremely severely affected” or “Severely affected” were given the value 1, while the others were given the value 0.

We have four independent variables that capture different pre-recession firm characteristics. The first independent variable is pre-recession *profitability* which is measured as operating profit margins adjusted for the profitability of each firm’s two-digit NACE industry. The second variable, *firm size*, is measured as the natural logarithm of firms’ total turnover, while the third variable, pre-recession *leverage*, is measured as industry adjusted ratio of debt to total assts. The fourth variable, pre-recession *sales growth*, is measured as industry adjusted growth in sales from 2006 to 2007. All variables that are based on financial information were constructed using 2007 numbers. Further, we have two independent variables that measure characteristics of the firms’ products. *Durability of products* is taken from the questionnaire and is measured as the self-reported share of durable

goods to total sales before the crisis, and ranges from a minimum of 0 to a maximum of 100. The *vertical product differentiation* variable was constructed by summing up four different seven-point Likert-scale questions from the questionnaire, and thus ranges from a minimum of four to a maximum of 28. Respondents were asked to rate to what extent they agreed/disagreed with four statements related to how their main market differed before the recession in regard to customer needs, customers' willingness to pay, product prices and number of product variants. The scale has a high emphasis on differences in prices and willingness to pay, which defines it closer to the definition of vertical product differentiation than to that of horizontal differentiation. DeVellis (2003) suggested that the Cronbach Alpha of a scale should be above .7 to make sure that its internal consistency is acceptable. The Cronbach alpha of our scale was .708, which indicates that it is reliable.

As control variables, we include five pre-recession industry characteristics that may affect how severely firms were affected by the recession. *Industry concentration* is measured using the self-reported number of competitors from the questionnaire. As NACE-codes do not capture industry concentration, our subjective measure is likely to be more accurate than anything that could be constructed based on register data. *Industry profits*, *sales growth* and *leverage* are measured using aggregates of operating profits, sales growth and debt-to-equity ratio of two-digit NACE industries in 2007. The last control variable, *export intensity*, is measured as the self-reported share of turnover coming from customers located outside of Norway and ranges from a minimum of 0 to a maximum of 100. The means, standard deviations and correlations of all independent variables are shown in table 1.

Table 1 - Means, standard deviatons and correlation coefficients of independent variables

	Mean	Std. Deviation	1	2	3	4	5	6	7	8	9	10	11
1. Number of Competitors	12,9158	54,01935	1										
2. Operating Profits Industry	,0678	,04378	-.010	1									
3. Growth 1 y Industry	1,1598	,07612	-.007	,038	1								
4. Debt Ratio Industry	,6401	,06702	,002	-.183**	,111***	1							
5. Operating profits	,0104	,07366	,025	-.241***	,044	,028	1						
6. Growth 1y	,1116	,51300	,045	-.029	-.081***	-.028	,046	1					
7. Firm Size	10,6160	1,08600	-.013	-.020	-.178***	-.151*	-.046	,027	1				
8. Debt Ratio	,0822	,16636	-.018	,023	,009	-.237***	-.158***	,141***	,021	1			
9. Export Intensity	8,0856	20,85807	-.016	,114***	-.098**	-.255***	-.154***	,039	,237***	,036	1		
10. Durable Goods Share	48,4171	44,61774	-.049	-.100***	,122***	,074**	,017	-.041	,125***	-.127***	,003	1	
11. Vertical Product Differentiation	16,6308	4,89278	,107***	-.128***	,031	,095***	-.045	,035	-.040	-.019	-.034	,039	1

***, **, and * represent statistical significance at the 1, 5, and 10 percent levels, respectively.

Statistical approach

Our dependent variable is dichotomous, a firm is either severely negatively affected by the crisis or not, so we use logistic regressions. The general model is the following:

$$(1) \text{ Logit } Y = \alpha + \beta_1 \text{ Concentration} + \beta_2 \text{ Profitability Industry} + \beta_3 \text{ Growth Industry} + \beta_4 \text{ Debt Ratio Industry} + \beta_5 \text{ Profitability} + \beta_6 \text{ Sales growth} + \beta_7 \text{ Firm size} + \beta_8 \text{ Debt ratio} + \beta_9 \text{ Export Intensity} + \beta_{10} \text{ Durable goods} + \beta_{11} \text{ Product differentiation} + \varepsilon$$

Logit Y is the natural logarithm of the odds that a firm is actually severely affected by the recession:

$$(2) \ln [p(Y = 1) / (1 - p(Y = 1))]$$

We have two main questions of interest from the general model. The first is the direction of each of the independent variables, e.g. whether the variables are positively or negatively signed. The second is how each of the independent variables affects the probability that a firm is severely affected by the recession. This can be investigated through the odds ratio which is “the change in odds of being in one of the categories of outcome when the value of a predictor increases by one unit” (Tabachnick & Fidell, 2007:461). To facilitate comparison between the variables, we transform the odds ratios into the increase in probability that a firm is severely negatively affected when the value of a predictor variable increases by one standard deviation, two standard deviations, 10- and 100%, respectively. To do so, we first calculate the odds of a firm being severely affected by the recession given that the predictor variables were at their mean. We then calculate the odds of a firm being severely affected by the recession given the different increases in predictor variable values, while holding the rest of the variables at their mean. Finally, the odds were transformed into probabilities, before calculating the proportional change in probabilities of firms being severely affected due to the variable manipulations.

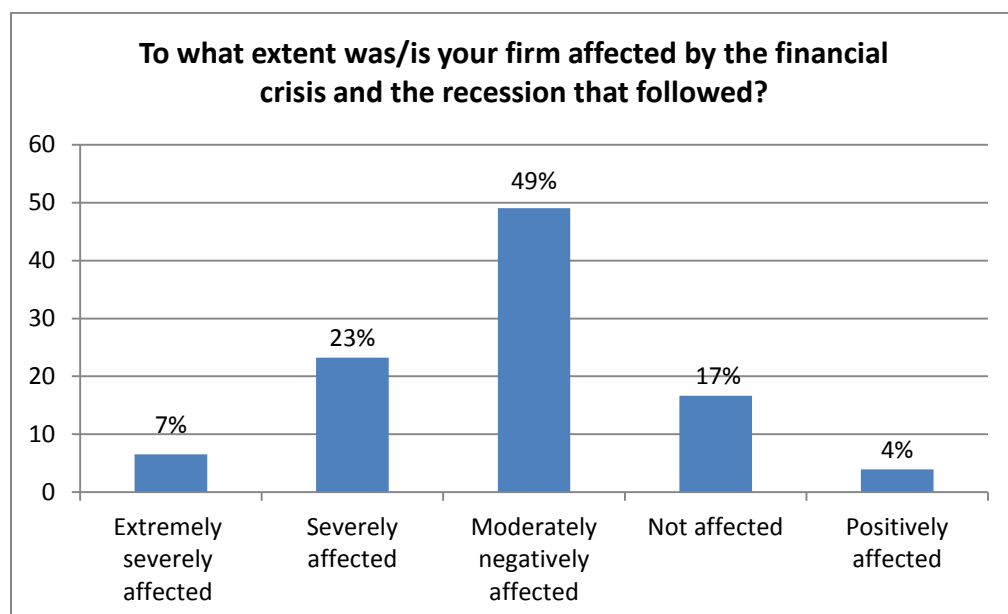
Data concerns

A number of potential biases are present when using survey data. First, we may have respondent biases, e.g. that the firms that answered the survey are different from the firms that did not answer it. To investigate if this is the case, we used register data to check if the firms that responded differ from the sample of 5000 firms that received the questionnaire. Differences were checked on a number of variables, including size, pre-crisis growth, pre-crisis debt ratio, pre-crisis profitability, pre-crisis total assets, geography, industry, ownership, age and legal form. Without exception, no indications of respondent biases were found. Second, as our survey data is retrospective, an obvious

concern is biases associated with the accuracy of the memory of the respondents. Unfortunately, there is no way we can check for such biases but as the questionnaire was sent out relatively close up to the recession, we have, hopefully, minimized this problem. Also, it seems unlikely that memory biases are distributed across firms in any systematic way, which implies that potential biases will appear in our data as random sources of error. Third, as there was only one respondent in each firm, the CEO, our data is also vulnerable to single respondent biases. This is problematic if there are any systematic biases of CEOs' responses, such as self-serving bias where poor performance is blamed on the recession. However, as only our dependent variable is vulnerable to such biases, this is less of a problem as the biases will reduce rather than increase our chances of finding the relationships we want to investigate. Fourth, as the survey was distributed only to firms that were "alive and kicking" and not to the firms that disappeared during the recession, our data is also vulnerable to survivor biases.

FINDINGS

We start by presenting some descriptive statistics of how the CEOs evaluated how severely their firm was affected by the crisis. Figure 1 below shows the frequency of firms (in percent) that reported to be "Extremely severely affected", "Severely affected", "Moderately negatively affected", "Not affected" and "Positively affected" by the recession, respectively.



From the graph we see that about half the sample reported to be moderately negatively affected, which corresponds well to the moderately negative drops in GDP growth experienced by the

Norwegian economy as a whole in the same period. However, the interesting feature of the figure is that a total of 30 percent of the surveyed firms reported to be either “Extremely severely affected”- or “Severely affected” by the crisis. To find out which pre-crisis characteristics that explain why some firms are more vulnerable to the recession than others, we conducted a series of logistic regressions, the results of which are presented in table 2 below.

Table 2 - Logistic regression output				
	Model 1	Model 2	Model 3	Expected sign
CONTROL VARIABLES				
Number of competitors	0,005** (0,002)	0,004** (0,002)	0,005** (0,002)	+
Operating Profits Industry	-0,996 (1,781)	-1,659 (1,875)	-0,175 (1,785)	-
Growth 1 y Industry	2,186** (0,923)	2,861*** (0,950)	2,010** (0,969)	+
Debt Ratio Industry	0,347 (1,066)	0,798 (1,118)	0,606 (1,153)	+
Export Intensity	0,013*** (0,003)	0,010*** (0,003)	0,010*** (0,003)	+
INDEPENDENT VARIABLES				
Operating Profits		-2,363** (1,019)	-2,167** (1,048)	-
Growth 1 y		0,238* (0,129)	0,242* (0,132)	+
Firm size		0,192*** (0,066)	0,148** (0,068)	-
Debt Ratio		1,044** (0,448)	1,375*** (0,463)	+
Durable Goods Share			0,008*** (0,002)	+
Vertical product differentiation			0,027* (0,015)	+
Constant	-2,755** (1,192)	-6,878*** (1,536)	-6,336*** (1,587)	
-2LL	1274,637	1247,556	1216,494	
Model Chi-square	31,006***	58,087***	89,149***	
Nagelkerke R2	0,04	0,075	0,113	
Logistic regressions of the probability of firms being severely affected by the recession. Standard errors in parantheses. ***, **, and * represent statistical significance at the 1, 5, and 10 percent levels, respectively. N=1075				

We ran three different models. Model 1 consists of the five control variables and a constant. The results show that the model is significant on a 1% level with a Chi-square value of 31,006 and a pseudo R^2 of only 0.04. Of the four control variables, *number of competitors* and *pre-recession industry growth* variables are statistically significant on a 0.05 level, while *export intensity* is significant on a 1% level.

Model 2 adds the four firm characteristics variables and is significant on a 1% level with a Chi-square value of 58.087 and a pseudo R^2 of 0,075. H1 predicted that pre-recession profitability is negatively related to how severely firms are affected by recessions, which implies that the *Operating Profits* coefficient should be negative. From the results we see that the coefficient is negative and significant on a 0.05 level, which makes us conclude that H1 is supported. H2 predicted that high pre-recession growth is positively related to the severity of recessions, which implies a positive *Growth* coefficient. From the results we see that the coefficient is positive, although only on a 0.1 level (P-value of 0,065). H3 predicted that larger firms are less severely affected by recessions, which implies a negatively signed *firm size* coefficient. To our surprise, we find the opposite, namely that the firm size coefficient is positive and statistically significant on a 0.05 level. H4 predicted that high export intensity is positively related to the severity of recessions, which implies that the *export intensity* variable should be positively signed. We find that the coefficient is positive and statistically significant on a 0.001 level, which supports this hypothesis. Further, H5 predicted that high leverage is also positively related to how severely firms were affected by recessions, which implies that the *debt-ratio* coefficient should be positively signed. We find that the coefficient is positive and statistically significant on a 0.01 level, which supports H5.

Model 3 adds the two product characteristics variables of Models 1 and 2, and is significant on a 1% level with a Chi-square value of 89.149 and a pseudo R^2 of 0,113. H6 predicted that the share of durable goods is positively related to the severity of recessions, which implies that the *durable goods* coefficient should be negative. Our results are consistent with this prediction, as the coefficient is negative and statistically significant on a 0.01 level. Our last hypothesis, H7, predicted that having vertically differentiated products increases the severity of recessions. From the results we see that the coefficient is positive, although statistically significant only on a 0.1 level (P-value of 0,065).

The models were checked for violations of the assumptions of logistic regressions, with no results indicating any causes for concern regarding multicollinearity, independence of errors or regarding the linearity of the logit.

Next, we wanted to investigate how each of the independent variables affects the probability that a firm is severely affected by the recession. Table 3 shows the proportional change in probability of a firm being severely affected coming from different changes in the value of the independent variables. While manipulating the value of one variable, all other variables are held at their means (see section 3 for a detailed description of the procedure).

Table 3 -Change in the Probability of firms being severely affected by the crisis for given changes of Independent variables

	+ 1 SD	+ 2 SD	+ 10%	+ 100 %
Number of competitors	20,60 %	43,13 %	0,47 %	4,73 %
Growth 1 y Industry	3,37 %	6,81 %	5,16 %	57,56 %
Export Intensity	16,54 %	34,42 %	0,61 %	6,24 %
Operating Profits	-11,13 %	-21,40 %	-0,16 %	-1,62 %
Growth 1 y	9,22 %	18,91 %	0,20 %	1,96 %
Firm size	12,08 %	24,93 %	11,80 %	134,91 %
Debt Ratio	17,38 %	36,20 %	0,82 %	8,38 %
Durable Goods Share	29,48 %	62,28 %	3,62 %	32,17 %
Vertical product differentiation	9,83 %	20,19 %	3,28 %	35,45 %

Change in probabilities that a firm is severely affected by the recession from one-standard deviation, ten percent and 100 percent changes in the independent variables evaluated at the mean.

From the table we see that a one standard deviation increase in firm *profitability* reduces the probability that a firm is severely negatively affected by the recession by 11.13 percent. This change in probability is lower than that of *number of competitors*-, *firm size*-, *debt ratio*-, *export intensity*- and *durable goods share*. Similarly, when we increase each of the independent variables by 10 %, pre-recession profitability ends up having the lowest change of all the variables in the probability that firms are severely affected. The next step, then, is to investigate which of the other characteristics that has the largest effect on how severely firms are affected by the recession. From table 2 we see that the most important determinant for how severely firms are affected is *durable goods share*, where a one standard deviation increase in this variable increased the probability of being severely affected by 29.48%. The second most important variable is *number of competitors* where an increase of one standard deviation increased the probability that firms were severely affected by 20.60%. The third and fourth most important determinants are debt ratio and export intensity, where an increase of one standard deviation leads to an increase in the probability of being severely affected of 17.38- and 16.54 percent, respectively.

DISCUSSION AND CONCLUSION

This paper investigates how fitness of firms is affected by severe recessions and how different pre-recession characteristics, or interactors, affect how vulnerable they are to such shocks. Two scenarios were proposed. One was that the shape of fitness landscapes remains unchanged by recessions and that more of the less profitable firms will struggle in recessions. The other scenario was that recessions change the shape of the fitness landscapes and cause firms with other pre-recession characteristics than low profits to struggle. We investigated these issues empirically using a dataset combining primary survey data with secondary financial data for a sample of 1248 Norwegian firms.

Our first main interest was the way in which each of the pre-recession characteristics affected economic fitness. Pre-recession *profitability* was found to have a negative relationship with the

probability that a firm was severely affected by the recession, e.g. that firms with high pre-recession profits are less likely to be severely affected by the recession. The direction of this relationship is consistent with earlier empirical findings of the least profitable firms being forced out of business while the most profitable firms survive (e.g. Aw et al., 2001; Baily et al., 1992; Bellone et al., 2008; Carreira & Teixeira, 2011; Foster et al., 2001; Griliches & Regev, 1995; Haltiwanger, 1997), while it contrasts findings by Geroski and Gregg (1996) and Nishimura et al. (2005) indicating a possible breakdown of this relationship in recessions. An explanation for why we do find this relationship could be that the 2008-09 recession in Norway was milder than the recessions in The UK in 1991-1992 and in Japan 1996-1997, and therefore not severe enough for a breakdown to occur. Another, related explanation could be that Norway experienced relatively few problems in its financial sector compared to Japan in the 1996-97- recession. The “flight to quality” selection from distressed Norwegian banks may therefore not have been prevalent enough to outrun the selection of profitable firms, as was the case in Japan. Further, pre-recession *sales growth*, *debt-ratio*, *export intensity*, *durable goods share* and *vertical product differentiation*, were all found to increase the probability that a firm was severely affected by the recession. *Firm size* was also found to be positively related to the probability that a firm is severely affected by recessions, which was not as expected. Earlier studies by Gertler and Gilchrist (1994), Lang and Nakamura (1995) and Geroski and Gregg (1996) found that smaller firms were affected disproportionately harder than larger firms, so our findings came as a surprise. One explanation could be that smaller firms are more flexible than larger firms in recessions, which may be an advantage in times of rapid reductions in demand. Also, Norway experienced less severe problems in its banking sector than other countries, making the “flight to quality” behavior from banks less prevalent. Advantages of larger firms with strong balance sheets will not be of much use if the problems are related to reductions in demand rather than to financial issues.

Our second main interest was to compare the relative effect sizes of the independent variables by testing how changes in each of them affect the probability that a firm is severely affected by the recession. Of particular interest was the effect size of the pre-recession *profitability* variable relative to that of the other characteristics found to affect the dependent variable. We find that one standard deviation increase in firm *profitability* reduces the probability that a firm is severely affected by the recession by 11.13 percent, an effect size that is lower than that of *number of competitors*, *firm size*, *debt ratio*, *export intensity* and *durable goods share*. Similarly, when we increased each of the independent variables by 10 %, pre-recession profitability had the lowest change of all the variables in probability of firms being severely affected. If we are to interpret these results, they indicate that several pre-crisis characteristics are important determinants of how severely firms’ economic fitness

is affected by recessions. In addition, the comparisons of effect sizes show that *pre-recession profitability* is less important than many other characteristics in determining how severely firms are affected. The most important determinant for firms' vulnerability is durable *goods share*, the second most important determinant is the *numbers of competitors*, while the third- and fourth most important determinants are *debt ratio* and *export intensity*. These results contrast the so-called "shadow of death" studies that find a strong relationship between which firms that die and historical profitability (e.g. Carreira & Teixeira, 2011; Griliches & Regev, 1995). The fact that pre-recession debt ratio, firm size and growth all had similar or larger effect sizes than pre-recession profitability, may indicate that the recession caused the shape of the fitness landscapes to change for a shorter or longer period of time.

The findings outlined above have several important implications. Theoretically, knowledge about how recessions affect economic fitness is important as changes in fitness lay contingencies for how firms respond to recessions. The distinction between the impact of recession and firms' responses to them has more often than not been aggregated away in earlier studies by investigating such phenomena by only using yearly secondary data. The disaggregation of recessions into their impact on firms' fitness presented in this study addresses some of these weaknesses of earlier work and contributes to the literature by enhancing the understanding of how environmental shocks affect firm selection. Future research should, however, focus on how firms respond to changed environmental conditions, and, in particular, how these responses are related to the changes in fitness caused by the shocks.

The findings also have practical implications. Knowledge about how different characteristics affect firms' vulnerability makes it possible for managers, investors and creditors to evaluate how vulnerable different firms are to recessions. For managers, this information can be used to decide whether or not preventive actions are needed, while investors and creditors can use the knowledge to evaluate the risks associated with investing in, or borrowing to, different firms.

REFERENCES

- Alchian, A. A. 1950. Uncertainty, Evolution, and Economic Theory. *The Journal of Political Economy*, 58(3): 211-221.
- Aw, B. Y., Chen, X., & Roberts, M. J. 2001. Firm-level evidence on productivity differentials and turnover in Taiwanese manufacturing. *Journal of Development Economics*, 66(1): 51-86.
- Baily, M. N., Hulten, C., Campbell, D., Bresnahan, T., & Caves, R. E. 1992. Productivity Dynamics in Manufacturing Plants. *Brookings Papers on Economic Activity. Microeconomics*, 1992: 187-267.
- Bellone, F., Musso, P., Nesta, L., & Quéré, M. 2008. Market selection along the firm life cycle. *Industrial and Corporate Change*, 17(4): 753-777.
- Bernanke, B. S. 1983. Irreversibilities, Uncertainty, and Cyclical Investment. *Quarterly Journal of Economics*, 93: 85-106.
- Carreira, C., & Teixeira, P. 2011. The shadow of death: analysing the pre-exit productivity of Portuguese manufacturing firms. *Small Business Economics*, 36(3): 337-351.
- DeVellis, R. F. 2003. *Scale development: Theory and applications* (2nd ed.). Thousand Oaks, CA: Sage.
- Foster, L., Haltiwanger, J. C., & Krizan, C. J. 2001. Aggregate Productivity Growth. Lessons from Microeconomic Evidence. In C. R. Hulten, E. R. Dean, & M. J. Harper (Eds.), Vol. New Developments in Productivity Analysis: 303 - 372. Chicago: University of Chicago Press.
- Friedman, M. 1953. The Methodology of Positive Economics, *Essays in Positive Economics* Chicago: University of Chicago Press.
- Geroski, P. A., & Gregg, P. 1993. Coping the Recession. *National Institute Economic Review*, 146(1): 64-75.
- Geroski, P. A., & Gregg, P. 1996. What makes firms vulnerable to recessionary pressures? *European Economic Review*, 40(3-5): 551-557.
- Geroski, P. A., & Gregg, P. 1997. *Coping with Recession: UK Company Performance in Adversity*. Cambridge: Cambridge University Press.
- Gertler, M., & Gilchrist, S. 1994. Monetary Policy, Business Cycles, and the Behavior of Small Manufacturing Firms. *The Quarterly Journal of Economics*, 109(2): 309-340.
- Griliches, Z., & Regev, H. 1995. Firm productivity in Israeli industry 1979-1988. *Journal of Econometrics*, 65(1): 175-203.
- Haltiwanger, J. C. 1997. Measuring and analyzing aggregate fluctuations: the importance of building from microeconomic evidence *Review, Federal Reserve Bank of St. Louis*, (May): 55-78.
- Hodgson, G., & Knudsen, T. 2004. The firm as an interactor: firms as vehicles for habits and routines. *Journal of Evolutionary Economics*, 14(3): 281-307.
- Hodgson, G. M., & Knudsen, T. 2010. *Darwin's Conjecture*. Chicago: The University of Chicago Press.
- Hotelling, H. 1929. Stability in Competition. *Economic Journal*, 39 41-57.
- Hull, D. 1988. *Science as a Process*. Chicago: Chicago University Press.
- Lang, W. W., & Nakamura, L. I. 1995. Flight to quality' in banking and economic activity. *Journal of Monetary Economics*, 36(1): 145-164.
- Levinthal, D. A. 1997. Adaptation on Rugged Landscapes. *Management Science*, 43(7): 934-950.
- Lien, L. B. 2010. Recessions across Industries: A Survey, *Working Paper No 16/10*. Bergen: SNF project no 1306 "Crisis, Restructuring and Growth".
- Maksimovic, V. 1995. Financial structure and product market competition - Chapter 27. In R. A. Jarrow, V. Maksimovic, & W. T. E. Ziemba (Eds.), *Handbooks in Operations Research and Management Science*, Vol. vol. 9. : pp. 887-920. North-Holland, Amsterdam.
- Mayr, E. 1976. *Evolution and the Diversity of Life*. Cambridge, MA: Harvard University Press.
- Metcalfe, J. S. 2005. Evolutionary concepts in relation to evolutionary economics In K. Dopfer (Ed.), *The Evolutionary Foundation of Economics* 391-430. Cambridge, UK: Cambridge University Press.

- Meyer, B. D. 1995. Natural and Quasi-Experiments in Economics. *Journal of Business & Economic Statistics*, 13(2): 151-161.
- Nelson, R. R. 1995. Recent Evolutionary Theorizing About Economic Change. *Journal of Economic Literature*, 33(1): 48-90.
- Nelson, R. R., & Winter, S. G. 1982. *An Evolutionary Theory of Economic Change* Cambridge, MA: Harvard University Press.
- Nishimura, K. G., Nakajima, T., & Kiyota, K. 2005. Does the natural selection mechanism still work in severe recessions?: Examination of the Japanese economy in the 1990s. *Journal of Economic Behavior & Organization*, 58(1): 53-78.
- Petersen, B., & Strongin, S. 1996. Why Are Some Industries More Cyclical than Others? *Journal of Business & Economic Statistics*, 14(2): 189-198.
- StatisticsNorway. 2010. Statistikkbanken, Vol. 2010.
- Stiglitz, J. E. 1984. Price Rigidities and Market Structure. *The American Economic Review*, 74(2): 350-355.
- Sutton, J. 1986. Vertical Product Differentiation: Some Basic Themes. *The American Economic Review*, 76(2): 393-398.
- Tabachnick, B. G., & Fidell, L. S. 2007. *Using multivariate statistics* (5th ed.). Boston: Pearson Education.

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