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Three perspectives on real investments in the manufacturing industry

An empirical approach

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Thesis for the degree of Philosophiae Doctor

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Abstract

This Ph.D. thesis discusses the real investment in the manufacturing industry in Norway and the firms' decision-making-process from three different perspectives. I show, using a novel approach, that firms, and particularly small firms, in the manufacturing industry do, to a lesser degree, use standard methods to shed light on their investment decision. Analyzing a business survey with panel data methods, I find that it is access to credit and demand expectations that are the most critical factors in explaining changes in investment plans. Lastly, the last chapter of this thesis suggests a model for aggregate investments in the manufacturing industry can. Based on the findings of the first chapters of this thesis, I suggest a way to expand the classic investment Euler equation such that it includes financial conditions and the cost of external financing. The investment Euler equation is estimated empirically using standard time series methods, and the estimated equation can forecast the decline in investments during the financial crisis.

Preface

This thesis is submitted to the Norwegian University of Science and Technology (NTNU) for partial fulfillment of the requirements for the degree of Philosophiae Doctor.

The doctoral work has been performed at the Department of Economics, NTNU, Trondheim. Professor Gunnar Bårdsen, John Dagsvik and Håvard Hungnes have supervised the work. Gunnar, my main supervisor, has been supporting me throughout the writing of this thesis, and I owe him a great thank for his patience. I would also thank John for his excellent suggestion and lively discussions. Håvard, thank you for giving me the necessary motivation to finish my dissertation when I left Statistics Norway for my job at BN Bank. I want to thank all of them for their guidance and many comments on my writing.

I would also take the opportunity to thank my former colleagues at Statistics Norway, and particularly Roger Bjørnstad, for encouraging me to start the work on my dissertation. I will also thank Ådne Cappelen and Torbjørn Eika, for the many discussion we had; they played an essential role in the papers of this thesis. I am grateful to my current employer, BN Bank, which gave me time to focus on finishing the Ph.D study – thanks to Trond Søraas.

Last, but not least, I would like to thank my wife Sina Therese, as well as my parents and the rest of my family for all the support they have given me.

The Research Department at Statistics Norway funded this thesis.

Trondheim, March 2020
Joakim Blix Prestmo

Chapter 1

Preamble

1.1 Introduction

Real business investments; investments in machines, research and development, and buildings and transportation vehicles; fluctuates significantly. During the last two decades, the growth and decline of aggregated business investments have several times shown two-digit figures for the yearly change in investments. The high fluctuations must be seen in contrast to the development in private and public consumption, which shows far less fluctuation, both in absolute and relative terms. This is supporting the view that investment behavior is crucial for predicting economic trends.

Explanations for the fluctuations in real investments are many, but there is still no consensus in the fields of economics about the driving factors behind the variations in investments from one year to another. My research project makes use of three different methodological strategies to shed light on factors explaining investment behavior. The strategy attacks the problem from three different angles, and the hypothesis is that this will help us to gain new insight for understanding the fluctuations in real investments.

1.2 Research question

This Ph.D. dissertation addresses the question: What causes the large fluctuations in real investments in the manufacturing industry, and how can we forecast aggregate investment?

My approach to answering this question is to apply three very different methodological strategies. I combine insight from a survey I sent out to the industry, with

an empirical analysis of a quarterly investment survey and an empirical analysis of macroeconomic data. The first essay discusses a business survey I sent out in 2012. In this essay, I show that there are substantial differences in how large and small firms plan their investments. Valuable insight from this study is that the cost of capital is less important, but access to financial capital is so. The second essay builds on this insight from the first essay and finds supporting evidence for the results of the first essay. Studying a couple of years of data from a business tendency survey, I show that demand expectations and access to credit are by far the most important factors affecting revisions in investment plans. In the first essay I present figures showing that a motive for firms' investments is to reduce labor costs. This result contrasts the conclusion in second essay, where I show in the very short run that it is a positive relationship between capital and labor. These are all hints that tell us that we should model long-term and short-term investments different. The third and last essay of this thesis uses the insight from the two first essays to propose a twist to the classic Q-theory model of Tobin (1969). I suggest that instead of the traditional investment cost function, where there is a cost of installation of the new capital, we should take into effect the cost of funding that is caused by the tightening of the credit market. This way of extending the Q-model is inspired by Kaplan and Zingales (1997). However, in contrast to Kaplan and Zingales (1997), I suggest a way to specify this cost function. In an empirical analysis using time series data, I show how long and short-run investment can be modeled in a way that utilizes the theory model and fully describes the decline in real investments during the financial crisis in 2008 and the lack of growth in investment the years that follow.

1.3 Theoretical background

There are four leading investment theories, all of which are built on the idea that the motivation of the firm is profit-maximizing:

1. The Q-theory, (Tobin 1969)
2. The neo-classical investment theory (Jorgenson 1963) and (Jorgenson and Hall 1967)
3. The Euler-equation (Smith 1960), (Whited 1998) and (Chirinko 1993)
4. Putty-clay (Johansen 1959), (Atkeson and Kehoe 1999) and (Gilchrist and Williams 2005)

The goal of the firm is per definition (in economics) to maximize the profit of the owner. The firms' motivation for running the firm then has some obvious implications.

1. The firm wants to keep costs at a minimum,

   (a) Which imply that the firms should keep employ as low as possible

   (b) Buy the cheapest factor input, given the quality

2. The firm would put/invest its money where the return is the highest

Following those two theorems, we may find the level of the firms' consumption of goods, their level of employment, and their choice of capital investment by minimizing costs at given revenues or by maximizing sales given the costs.

All four investment models generate the result that an investment project starts – if and only if – the return of the investments, measured by the net present value of the future profit stream relative to the investment cost, is larger than the estimated hurdle rate or the market return. Moreover, if the firm receives a higher profit of investing in the firms' money elsewhere, the manager would not invest in her company.

The results in the first essay show that firms only, to some degree, calculate the profitability of their investment projects. They also put their calculations into question. I further show that a fundamental motive for the firm is to both keep the firm alive and create jobs, as well as making a profit, which means that the manager is likely to conduct investments when the profitability is unknown. These results put the researcher in a situation where he wants to question the assumptions above – that one of the goals of this thesis.

1.4 Data

The data used in this dissertation comes from three very different sources. The first essay studies the result of a one-off business survey conducted by myself. The second essay studies the results from the quarterly business tendency survey by Statistics Norway. While the third essay studies aggregated time series investment data from the National account.

These are three widely different data sources, which need profoundly different modeling techniques. The first study is an empirical study on individual firm level (managers are questioned). The second study also has a quantitative approach and is still at an individual firm level, but because the survey is repeated every quarter, the data is organized as a panel dataset. The third and last study is purely quantitative, and the data is macroeconomic data aggregated up to industry level.

1.5 Empirical strategy

The empirical methods applied in this thesis are, because of the variance of the data type, highly different. The first essay makes use of a combination of ordered logit models and multinomial logit models to find the firms' most preferred method for making investment decisions. I combine this with two-way diagrams and non-parametric statistics in order to verify the results of the survey.

The second essay studies a binary dependent variable. To study the change in the probability of a change in the firms' response, a probabilistic model, like the probit or logit model, is most appropriate. Due to the dynamics in the panel data, the choice of methodology is not apparent; this is why several model specifications are tested.

The third essay studies whether the knowledge gained from the two first articles may apply to macroeconomics. Using time-series data, the methodology changes dramatically. I apply standard time-series methods, like the Error correction models (ECM) and bounds testing. I have also tested a vector autoregression (VARX), without changing the results of the analysis. Hence the simple ECM framework is kept.

1.6 Summary of the essays

This section gives a brief overview of the papers in this thesis.

1.6.1 Paper 1

The first paper discusses the which methods, if any, are the most preferred ones when the firms make their investment decision. To answer this question, I send out a business survey to firms in the manufacturing industry in Norway. The business survey poses several questions to business managers in the manufacturing industry regarding capital budgeting and how they plan their investment projects. Questions, such as which methods they use to calculate the profitability of their investment decisions and how the firms fund their investments. The firms are further asked a range of questions that might shed light on the driving factors behind which methods they use. The motivation behind this survey is, therefore, to uncover some qualitative characteristics of the investment decisions; this is done by applying both descriptive methods and empirical analysis.

To answer which method is the preferred one, I apply a two-step process. The first step is to estimate the frequency of choosing a given method, using an ordered logit model. The second step utilizes the results from the ordered logit model by inserting the estimated parameters in a multinomial logit model. This gives us an

estimated probability that the given method is most preferred by the firm.

The analysis in the first essay shows that the managers' practice differs between small and large firms. I find that smaller firms embrace simple methods for these calculations, and the results show that small firms have less sophisticated decision rules than large firms. A surprisingly large share of the firms prefers to use the Payback model for calculating the profitability of an investment. Moreover, nearly no firms prefer the net present value methods, which is the method textbooks recommend.

1.6.2 Paper 2

Firms continuously analyze whether to stand by their planned investment projects or whether they need to adjust their investment plans. This essay applies panel data to assess the relative contribution of factors explaining changes in firms' investment plans. The analysis builds on data from a quarterly business tendency survey as well as national accounts statistics and register data. Conventional register data on investment decisions contain systematic measurement error due to time lag from when an investment decision is taken to it is effectuated. In contrast, survey data do not suffer from this problem and therefore are particularly well suited for studying investment behavior. I find that changes in the firms' expected demand and access to credit are the most important variables for explaining changes in investment plans. Firms; independent of size; are most likely to adjust their investment downwards when demand expectations are weak, and credit conditions are tight. Neither changes in capital costs nor the financing costs seem to play a significant role in the short-run investment dynamics.

1.6.3 Paper 3

The third paper shows how the Investment Euler equation may be extended to capture the cost of external funding and the tightness in the credit market. The theoretical model is tested empirically on aggregated time series data for the manufacturing industry in Norway. I find empirical support for the theoretical model, and present a model where real aggregated investments are explained by the cost of external finance, production, profitability, and the credit spreads. Aggregated manufacturing investments are modeled using the bounds testing approach, together with the error correction framework using national accounts figures and financial statistics. I find that an increase in the cost of external funding relative to the cost of internal funding reduces the return on investments. The analysis shows that a one percentage point increase in the credit spread decreases investments with 7 percent. The profit ratio is known to be essential for investments. I find that the effect of a one percent increase in the profit to production ratio raises investments

with a rate of 0.13 percent.

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PAPER I

Investments and Capital Budgeting Practice: Is there a difference between small and large firms?*†

Joakim Blix Prestmo[a, b]

March 10, 2020

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This paper is awaiting publication and is not iincluded in NTNU Open

PAPER II

Constraining Factors for Manufacturing Investments: An Empirical Study of the Norwegian Manufacturing Industry

Joakim Blix Prestmo *†

March 10, 2020

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PAPER III

Manufacturing Investments in Norway – The Effects of Internal Funds and Credit Spreads* †

Joakim Blix Prestmo[a, b]

March 10, 2020

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