PREREQUISITES FOR PRODUCTIVITY IMPROVEMENT

-A CLASSIFICATION MODEL DEVELOPED FOR THE VOLVO CAR CORPORATION

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2004-08-30

PREFACE

This master thesis, entitled 'Prerequisites for Productivity Improvement, a Classification Model Developed for the Volvo Car Corporation' was conducted as a compulsory part of the master thesis education in Industrial Management and Engineering at the Lund Institute of Technology.

The task has been carried out at the Volvo Car Corporation in Torslanda Gothenburg between February and August 2004.

We would like to thank our supervisor at the Lund Institute of Technology, Bertil I Nilsson, for his continuous support and aid, our supervisor at the Volvo Car Corporation, Anders Nyström, for the background and the help in making it possible to conduct the thesis, and special thanks to Ingrid Hansson, for all the arrangements she made and her assistance to two sometimes puzzled students.

We would also like to thank the respondents at Volvo Torslanda for their time and effort as well as the respondents from all the investigated suppliers.

Lund, August 2004

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Abstract

The Volvo Car Corporation experience diversities in the price development of the four different business areas electronics, interior, exterior and chassis and power train. The purpose of this master thesis was to investigate if there are any structural differences that give the suppliers different prerequisites for productivity development thus different prerequisites for price reductions.

When conducting interviews with commodity buyers at VCC, two factors that influence the suppliers' potential for productivity development and price reductions were identified:

1. The technological maturity of the suppliers.

2. The amount of Value Added of the suppliers' products.

By combining these two factors, a two dimensional supplier classification model can be developed, where suppliers are classified according to their productivity development potential. This should be a better way to categorize the suppliers when comparing price developments

The factor technological maturity has a connection to the amount of Value Added and with further investigation the model might be reduced to one dimension.

According to several investigations made there is a strong connection between R&D intensity and productivity development, where companies with high R&D intensity show better productivity developments than companies with a low R&D intensity. Companies with higher R&D intensity have a lower technological maturity. OECD has used the R&D intensity measure to classify companies into four different groups depending on their R&D intensity. By using this classification the dimension of technological maturity can be quantified and a classification can be made according to the suppliers' prerequisites for productivity development.

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1 INTRODUCTION

In this introductory chapter the background for the thesis is presented as well as the purpose. Our research approach with the assumptions that we have made and the hypotheses that we originated from and how these evolved are explained. Scope and limitations of the investigation are clarified and discussed. Finally we will exhibit and illustrate the outline of the thesis.

1.1 BACKGROUND

The Volvo Car Corporation's (VCC) productivity improvement demands on their suppliers are expected to show as a decrease in product prices. VCC experience diversities in the price development of the four different business areas electronics, interior, exterior and chassis and powertrain. The same diversities are experienced by Ford. VCC wants to investigate the reasons for these differences to better understand the supplier situation and to find out if the demands are in line with the different suppliers' productivity improvement potential.

1.2 PURPOSE

The main purpose is to investigate the factors behind these differences. Are there structural differences that result in different price development potentials? Is the explanation that some suppliers have less price reduction and thereby higher margins? We will try to find the factors that are the prerequisites for diversities in productivity growth and the price development. These factors should also be able to be quantified and measured.

We are very customer oriented when conducting this research and the ambition is to deliver a, for the VCC, relevent investigation.

1.3 APPROACH

The approach that we have used to explain the diversities that VCC experience in their suppliers' different price developments is founded on the requirements that a company needs to meet to be able to frequently decrease their output price. VCC is often connected to their suppliers in long term relationships.

The main hypothesis (hypothesis 1) that we originated from was:

1. A manufacturer needs to constantly increase their productivity to be able to decrease their output price and thereby be competitive.

Some basic assumptions was made about what factors that control the productivity and the effect that a productivity growth has on the price of the product. We decided from the start that we wanted to quantify the prerequisites that determine a company's ability for productivity growth. These requisites are then exploited in the "Black Box" and what can be measured is the actual increase in productivity. The Black Box contains the company's ability for exploitation of the prerequisites and is not taken into consideration, since this is not the purpose of the thesis.

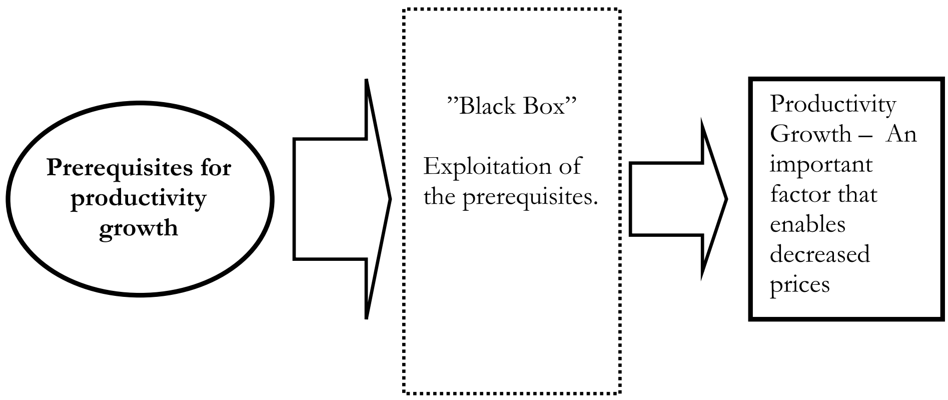

Figure 1.1 Prerequisites for Productivity – Exploitation.

During the first interviews at VCC, that were made to gain construct validity of our investigation and assumptions, we tried to focus on the productivity development of the various suppliers. Questions were based on which areas that set the prerequisites for price reduction and thereby productivity growth as we assumed. We noticed that several of the respondents clarified that some business sectors are more reluctant to reduce their prices due to the slow development of technology and/or that the products that they manufacture mainly consist of raw material. Based on the interviews we found which areas to focus on and from which our further hypotheses should originate.

Under the assumption of the main hypothesis (hypothesis 1) and based on the interviews we set up the factors that we wanted to investigate as prerequisites for how much a company can increase the productivity. This productivity growth should then according to hypothesis 1 show as a decrease in output prices. Two new hypotheses was formed:

2. The technological progress in the industry sector is linked to the ability for productivity growth.

3. The amount of Value Added per unit is different depending on the product that is manufactured and this is linked to productivity growth.

There are several other different ways to reduce the output price for manufacturing companies such as larger orders, buying larger quantities from their own suppliers or simply pass on the demands for decreased prices further down the supply chain. To be able to consistently reduce prices, the suppliers need to focus on long term solutions such as continuous improvements and thereby increase their productivity over time.

1.4 SCOPE AND LIMITATIONS

We will describe the limitations that we have set up for this investigation. Many new topic areas and suggestions for more extensive investigations have come up during the thesis work. These areas are described and discussed in Chapter 8.2, "Suggestions for extended research."

1.4.1 LIMITATIONS OF THE INVESTIGATION

There is a wide scope of factors that influences and determines price, cost and productivity development. Our introductory interviews at VCC indicated that two factors seem to be dominating in affecting the suppliers' price development. In this master thesis we have decided to investigate how these two factors, R&D intensity e.g. technological maturity and Value Added per unit determine a company's productivity development potential.

1.4.2 LIMITATIONS OF OUR EMPIRICAL DATA

Our empirical data is limited by the following factors:

- The study is made based on a limited number of suppliers selected by VCC. These suppliers are considered to constitute a good representative selection of the suppliers to VCC.

- Because of the key figure analysis, the number of suppliers is further limited. Only suppliers with comparable acquirable key figures are included in the investigation.

- Some suppliers have because of secrecy or lack of insight chosen not to answer all questions in our questionnaire or have not returned the questionnaire at all. Due to this we cannot use this information to draw any valid conclusions based on the answers. The answers have been used as indicators for the discussion and further investigations.

- Price development figures from all the selected suppliers were not acquirable.

1.4.3 LIMITATIONS OF THE MODEL

The model is designed to evaluate a supplier's present productivity development potential depending on the factors Technologic maturity and the amount of Value Added. The model does not account for other factors that affects the suppliers productivity.

1.4.4 TIME LIMITATIONS

The time limitations of this master thesis work is 20 weeks, due to guidelines at Lund Institute of Technology. Given more time and resources it would have been desirable to investigate a wider spectre of the VCC supplier network.

1.5 OUTLINE

CHAPTER 1

Gives an introduction to the thesis containing background to the investigation, our research approach, the hypotheses that were raised in the beginning of our investigation and the scope and limitations of the thesis.

CHAPTER 2

Every research has its own methodology and in chapter 2 methodology in general is described and presented together with the methodology of our research.

CHAPTER 3

The main purpose of the thesis is to explain why VCC experience diversities in the price development. We will explain this by introducing a new way of classifying the suppliers according to their productivity improvement potential.

The three hypotheses that were presented in the introductory Chapter 1 are the basis for the theory investigation. A selection of the theories that we have found to support these hypotheses and that lie beneath the development of the two dimensions for the classification model are presented in Chapter 3.

CHAPTER 4

In this chapter the supplier classification model is illustrated and how we have developed the dimensions for this model is explained. Further we will introduce the term environment. An illustration of the different environments that a supplier can be situated in and how these environments gives the supplier stronger or weaker prerequisites for productivity growth is explained.

CHAPTER 5

Only a small selection of VCC suppliers is a part of the study and in Chapter 5 the empirical findings, such as key figures and the classification of these suppliers, is presented.

CHAPTER 6

Chapter six contains an analysis of the model and the dimensions that constitute the model. In addition to this an evaluation of the model and a discussion of the improvements that can be made regarding the classification of the suppliers is presented.

CHAPTER 7

Chapter seven contains a summary of the conclusions that we have made and the validity of these conclusions. Both concerning the newly introduced way to classify suppliers and the conclusions from the key figures are presented.

CHAPTER 8

In this last chapter we will have a brief discussion of the supplier situation as we interpret it. We will further present some suggestions for extended research within the area that have come up during our investigation.

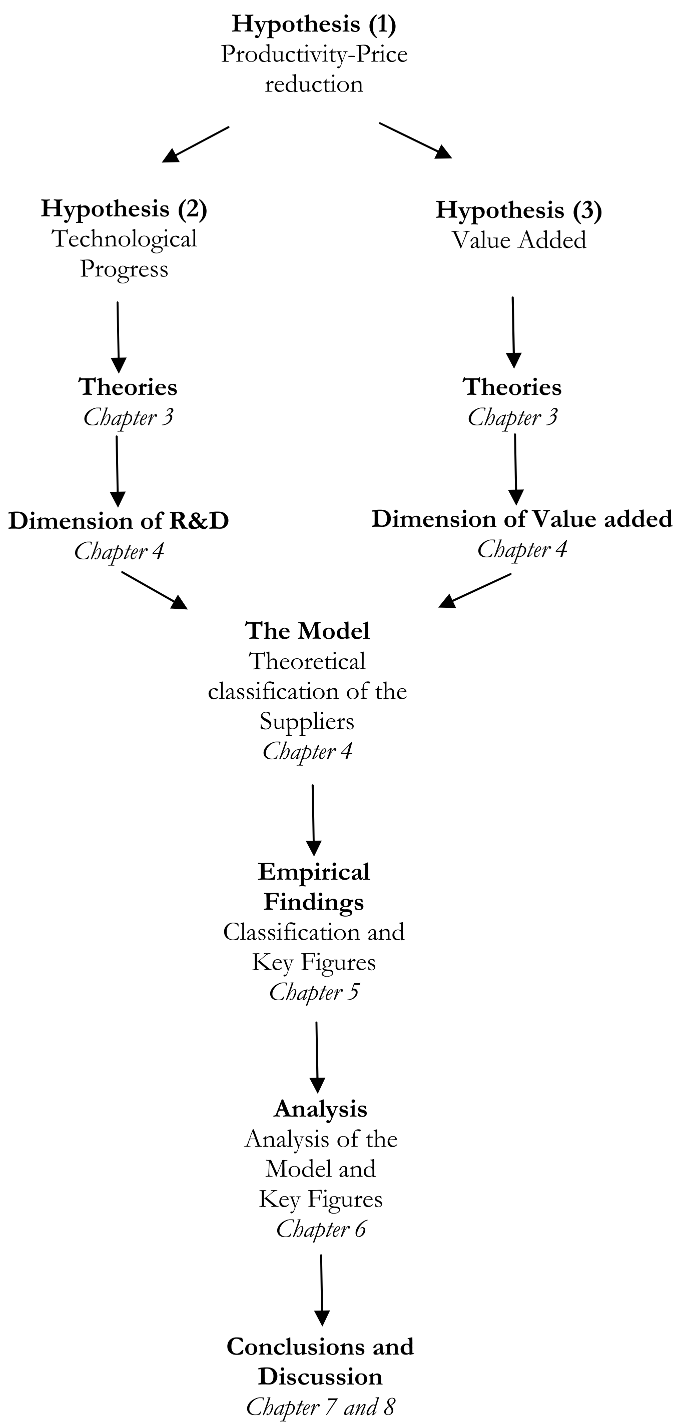

Figure 1.2 Outline of the Thesis

2 METHODOLOGY

In this chapter a brief discussion regarding methodology in general and ways to address the development of hypotheses will be presented. Further we will portray the research approach with the different methods or strategies that can be used when conducting a research and explain which ones we have used and motivate why we have used these methods to design our research strategy. The selection of suppliers will be discussed as well as the data collection.

2.1 RESEARCH APPROACH AND STRATEGY

When conducting a study there are different ways of approaching the investigation depending on the purpose of the study. When forming a research strategy one must consider the "art" of the study. Yin (2003) lists five and Mumford (1984) lists 15 strategies. Bryman (1995) makes a fairly different classification. He distinguishes between research designs and methods whereas design refers to disposition and methods to methods for collecting data.

Lundahl & Skärvad (1999) lists five main categories depending on the purpose of the study, but describes seven initial positions to categorize a research study into different dimensions. The dimensions are Purpose, Method, Scope, Disposition, Type of Data, Time and Methods for Collecting Data. All authors have chosen different ways to categorize the research strategies and there does not seem to exist a common definition of what is research strategy, design or method. For that reason we have chosen to categorize these listings in a format somewhat according to the dimensions presented by Lundahl & Skärvad (1999), with the aim to find the essence of each method and thereby designing our own research strategy.

Types of Data, which is linked to Theory of Method, and the implications it has when collecting data is discussed under Methods for Collecting Data/ Sources of Information. A new dimension, Theory and Theory Development is introduced, in difference to Lundahl & Skärvad's presentation. The dimensions are presented in Table 2.1 on the next page.

Table 2.1 The Dimensions of a Research Design

Theory of Method	Purpose	Scope	Disposition	Theory and Theory Develop-ment	Methods for Collecting Data / Sources of Information
Quantitative Qualitative	Explorative Descriptive Explanatory Diagnostic Evaluating	Entire population Sample	Experiment Case Study Survey Action research	Inductive Deductive Abductive	**Primary data** Questionnaire Interview Observation Simulation Archival sources of in-formation **Secondary data** Literature, theo-ries, papers, reports, etc.

The dimensions of a research design in table 2.1 implies to illustrate the various methods or strategies that can be used when conducting a research. This is the platform that we originated from when we formed our own research design.

The methods and strategies have been divided into 6 different dimensions as illustrated above in table 2.1. These dimensions will be presented in the next chapter 2.2 *Research Design* and evaluated with regards to our research design. From this we will find the essence of the various dimensions and form our own research design.

2.2 RESEARCH DESIGN

"Every type of empirical research has an implicit, if not explicit, research design. In the most elementary sense, the design is the logical sequence that connects the empirical data to a study's initial research questions and, ultimately, to its conclusions." (Yin, 2003, p 20)

With the matrix introduced in the former chapter we will explain how we are going to address our task and consequently describe our chosen research design and explain the various methods that will fill our dimensions and constitute our platform or logical sequence as Yin (2003) wishes to describe the research design.

2.2.1 THEORY OF METHOD

The fundamental difference between a quantitative method and a qualitative is that the first one is used when dealing with numbers or facts that can be transformed into numbers and presented this way. The latter handles interpretations, situations, motives, perceptions and everything else that has one common denominator that it cannot be transformed into numbers (Holme & Solvang 1996). Through qualitative methods more complex links are revealed from a relatively small selection. The main purpose is hereby to gather information to receive more understanding for the area that is to be investigated (ibid).

The qualitative investigation is less controlled and gives the investigator more room for interpretations and a greater possibility to acquire knowledge and understanding (ibid).

Quantitative methods intend to evaluate something. The evaluation can be used to describe or to explain. If the function is to explain, then the methods are concentrated on measuring the relations between different characteristics (Lundahl & Skärvad, 1999). Quantitative investigations that are carried out with the intention to explain are most commonly performed by testing hypotheses (ibid.). There are a few guidelines, according to Lundahl & Skärvad (1999), which distinguish a well-formed hypothesis (see next page):

1. The hypothesis should be a possible solution to the problem that the study aspires to explain.

2. The hypothesis should be able to be tested.

3. The hypothesis should be reasonable and well founded by arguments and facts.

Sigmund Grønmo mentions four strategies to combine qualitative and quantitative methods (Holme & Solvang 1996). One of them is: *Qualitative investigations as a preparation for a quantitative*. The qualitative part is then performed to achieve understanding for the situation and to prepare for the actual quantitative investigation (ibid.).

We had two intentions with the study, where the first was to explain why VCC experience diverse price developments in the supplier-sectors defined by VCC. We wanted to explain these diversities using a quantitative method, combined with a qualitative where we through interviews were to get a general view of the situation. The answers are then interpreted and the problem-area defined. Hypotheses are created and then transformed into a model to get another approach for classifying the suppliers (see Chapter 4, The Model). The classification of the suppliers has a quantitative approach where the hypotheses are transformed into relative figures and numbers that can be used to classify a supplier and to test the hypotheses.

The second intention is to find possible relations between the price developments in the different supplier sectors of VCC and the suppliers' accounting numbers. We are seeking to find some relations, between numbers and static facts, which have been defined and are commonly used.

2.2.2 PURPOSE

Our study is performed in three different phases that somewhat overlaps or runs into each other. These phases are based on the different levels of ambition of the study. These different levels are referred to as purpose in the matrix. The different levels of ambition are presented in logical order, meaning that the problem formulated in the latter level is based on the results from the foregoing.

EXPLORATIVE

An investigation with the purpose to formulate and specify a problem is often expressed in a hypothesis. It aims to give the investigator an overview of the problem-area and the related questions, to inform and to enlighten the investigator in the fields that interact with the problem. Common features in an explorative investigation are interviews, literature studies and simple familiarizing case studies. Often does the literature exposition result in a better identified approach to the problem or situation that should be investigated.

DESCRIPTIVE

A descriptive investigation has the purpose to describe a condition, a certain situation or a phenomenon and the aspiration to generate more profound knowledge within the area of research.

EXPLANATORY

An explanatory investigation is often conducted when the objective is to find answers to the question why and is often performed by statistically testing hypotheses. The investigator tries to find the factors or determinants that cause a certain effect or phenomenon.

DIAGNOSTIC

Diagnostic investigation has the purpose of finding the reasons underlying a certain phenomenon. Investigations carried out in a diagnostic way are focused on finding solutions to problems. The presentation of distinctive methods and measures for the solution of the problem is the characterization of a well performed diagnostic investigation.

EVALUATING

An evaluating investigation has the purpose to evaluate a certain implementation and its effects. This is performed when the investigator wants to measure the effects of an already made implementation

During the first phase of the study we made interviews with Commodity buyers. The interviewees were selected based upon which suppliers that should be a part of the second and third phase of the study. The motif for this was to get more involved in VCC, to acquire knowledge about their buying process, evaluation of suppliers and what relationships they have to their suppliers. We wanted to get a general overview of the situation in the different sectors and to try and find dissimilarities between them, but also within the sectors. The first phase had an *explorative/descriptive* approach and our aspiration was to be able to specify the fields that affect the price development situation and then to make literature studies within these fields. Hypotheses were formed which built a platform for the second phase of the study.

The thesis has the main objective to explain the diversities in price developments and this was encountered in the second phase. For this explanation we needed to simplify the conditions and in some way illustrate which underlying factors that we denote are the principal conditions that influence a supplier's ability to increase their productivity. The frequently increased productivity of the suppliers makes them able to consistently meet the customers' (in this case VCC) yearly demands on decreased prices. We developed a theory based upon the hypotheses formed in the prior phase of the study. The theory describes the environment in which the different suppliers act. This environment is categorised by two dimensions and consists of the semi-static principal conditions that influence a supplier's ability to increase their productivity. The second phase of the study had a *descriptive/explanatory* level of ambition where the aim was to describe the environment under certain assumptions by combining existing theories. The description clarified how the principal conditions affected the supplier's abilities to meet VCC's demands on decreasing prices. The outcome was a model consisting of the two dimensions. This model can then be used to categorize the suppliers and group them into clusters of suppliers situated in the same environment that show similar prerequisites for increased productivity. The classification will explain why VCC experience the diversities in price development. The suppliers within the same environmental group should according to our hypothesis show similar price developments.

The second objective was to find relations between accounting numbers and the price developments within these groups. By doing this we also tested our model to some extent. The third phase was carried out using an *explanatory* level of ambition.

When adopting an *explanatory* study using a quantitative approach the investigator tries to identify the factors or determinants that cause a certain phenomenon, more commonly called resultants (Lundahl & Skärvad, 1999). In the third phase the determinants are the accounting numbers and the resultant the price developments. When classifying suppliers according to the model, suppliers in the same cluster should, according to our hypothesis, show the same price developments and relations to accounting numbers.

The phases and the different levels of ambition that our phases consist of can be illustrated as:

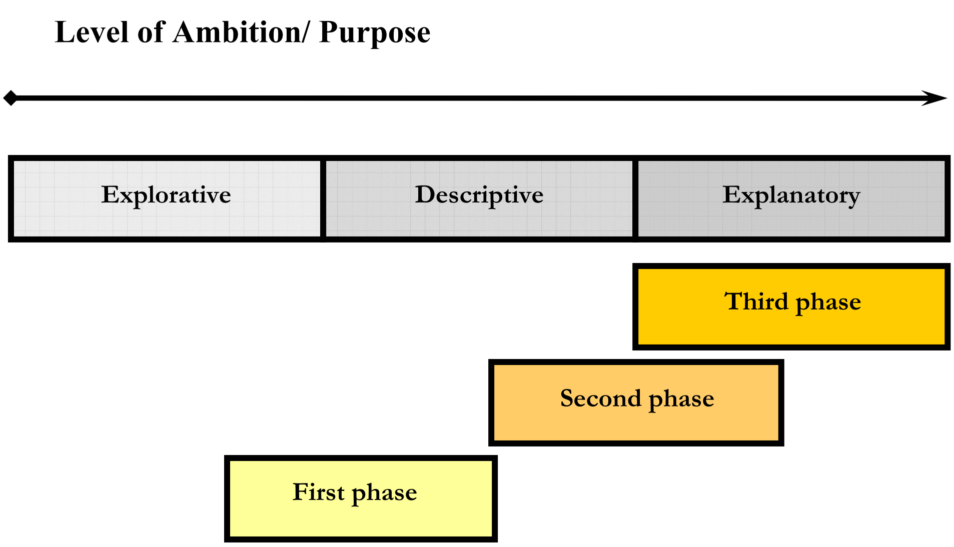

Figure 2.1 Levels of Ambition during the different phases of our investigation.

He who according to qualitative Theory of Method gains understanding for a phenomenon can often explain the phenomenon. Understanding renders explanation (Lundahl & Skärvad, 1999). This is not only valid when using a qualitative method. The fact that understanding renders explanation ought to be universal. We sought to gain understanding for the phenomenon that VCC experience. This is the reason why we not only wanted to find and explain the relations between key accountant numbers, but also to try and gain an understanding of the underlying factors and how they affect the supplier's prerequisites for an increased productivity and thereby explain why VCC experience diverse price developments.

There is a thin line between the explanatory and the diagnostic method. We have not tried to solve a problem, but to explain the phenomenon that VCC experience. Therefore the understanding that we have required can be referred to as an explanatory study. The second phase where we described the environment that affects the suppliers' abilities to increase their productivity is the platform for the thesis and renders the understanding to why VCC experience different price developments among their suppliers.

2.2.3 SCOPE

The scope can be the entire population or a sample of the population. If the samples have been randomly chosen one can say that the sample represents the entire population and conclusions can be made that are valid for the entire population (Lundahl & Skärvad, 1999). The sample needs to be a representative sample in the meaning that it represents the entire population. If not, the results can always be claimed to be individual and not general (Bryman, 1995)

We were aware of this when we set up the demands. Instead of selecting a random sample we wanted to focus on suppliers that met three terms:

1. The supplier is a major[1] contractor to VCC.

2. The supplier manufactures few/similar[2] products.

[1] Major supplier is defined as the one or group of suppliers that deliver the major part of a product or product group to VCC.

[2] The products consist of similar materials and/or the manufacturing of the product can be classified in the same industry branch according to the ISIC classification rev. 3.

3. That we easily could obtain accounting figures and have an open dialogue with the supplier.

The selection of suppliers was then made by VCC section executives, as they are the ones with the accurate insight and knowledge in this matter. The reason for this selection is that (1) we wanted to focus on the suppliers that have a substantial effect on the price development and (2) that the price developments should derive from a product base that we could define, evaluate and classify. Demand (3) is self-given since we needed accounting figures and a certain openness to be able to get accurate and true answers from questionnaires. The first demand was stipulated as the major suppliers are of a greater interest to VCC both for the study and the economical aspect. The second demand gave better reliability when classified in the model, as it makes the suppliers more correctly categorised. The third demand unfortunately ruled out German and Japanese companies to be a part of the third phase.

2.2.4 DISPOSITION

EXPERIMENT

An experiment is a bit simplified explained as *"….trying something out and observing the consequences of our actions"* (Bryman, 1995, p 72). Experiments are carried out when the investigator wants to test a causal hypothesis, since the investigator can control alternative explanations and thereby establish a high level of internal validity (ibid).

SURVEY

There are two essential classes that a survey can be categorized as:

1. descriptive survey-investigation and
2. explaining survey-investigation

where the descriptive aims to describe a certain phenomenon and the explanatory aims to explain the same phenomenon (Lundahl & Skärvad, 1999), both according to the levels of ambition presented earlier in the chapter 2.2.2 Purpose.

The most common methods for the collection of data are personal interviews, telephone interviews and questionnaires (Bryman, 1995; Lundahl & Skärvad, 1999).

The tendency to associate the survey exclusively with interviewing and questionnaires is inappropriate, because the method can integrate investigations using other methods of data collection, such as structured observations or research based on pre-existing statistics (Bryman, 1995).

CASE STUDY RESEARCH

A case study can be described as an empirical study, with qualitative collection of data and interpretation of the data, which investigates contemporary phenomena in its real context (Lundahl & Skärvad, 1999). It can further be demarcated to a few aspects that are relevant to the purpose of the study (ibid). When focusing on a few specific questions the investigator needs to have a lot of flexibility to be able to adapt if the situation evolves (Alvesson & Sköldberg, 1998).

Case studies are commonly used with qualitative Method of Theory (Lundahl & Skärvad, 1999). *"…some writers treat qualitative research and case study as synonyms"* (Bryman, 1989, p170). Case studies are often performed when the purpose is to create hypotheses, to develop theories, to test theories and to exemplify and illustrate (Lundahl & Skärvad, 1999). Case studies give the investigator the possibility to combine quantitative and qualitative methods as well as the use of several different methods for collecting data. The advantages of being able to combine quantitative methods are to check the validity in findings by using very different approaches when collecting the data (Bryman, 1989).

ACTION RESEARCH

In action research the investigator is involved as a member of the organization. The investigator identifies the organizational problem, gives information about actions to be taken and observes the impact when these actions are implemented.

In spite of what some of the writers say, the investigation we have done has mostly characteristics from the case study. We have mixed interviews, hypotheses and questionnaires in our thesis and thereby combined qualitative methods with quantitative. The questionnaire that we sent out can be seen as a survey part of the case study, but to call the investigation a survey is not fair. A survey is often conducted in large scales to describe or to explain a phenomena. Our questionnaire was sent out to a very small sample and with the intention to gather some information from the suppliers. This information was then used to find indications on the suppliers situation and mentioned in chapter 8, Discussion.

2.2.5 THEORY AND THEORY DEVELOPMENT

In every scientific investigation there is an aspiration to develop a better understanding for the phenomena that are studied. For that reason we are dependent on new theories and the development of theories. There are two commonly used and accepted methods for the development of new theories: the *inductive* and the *deductive*. Apart from this there is a third approach: the hypothetically deductive method, which in reality is a combination of the two mentioned. The last method is also known as the *abductive* approach (Alvesson & Sköldberg, 1998).

The inductive approach is to begin with empirical findings and through them seek to acquire knowledge and understanding (Wiedersheim-Paul & Eriksson, 1997). The deductive approach is to assess already developed theories. This is often done through the development of hypotheses, which then are tested and confirmed or rejected. One method presumes the other, since all theories originates from empirical findings. It is, according to Holme & Solvang (1998), often when the two methods are combined that new and exciting knowledge is found.

Holme & Solvang further describe the most commonly used method for the development of new theories, the hypothetically deductive approach. It means that new hypotheses are derived from predications. These derived hypotheses can then be tested through empirical investigations.

What we have done is best described as a deductive method. We have developed hypotheses, supported these with existing theories and used these hypotheses for the model from which we then classified the suppliers. Most of the assessment is built on the theories that we have found and some of the assessment is done in the third phase.

2.2.6 METHODS FOR COLLECTING DATA

Whenever conducting an investigation it is important to know from where and in what form data originate. Quantitative investigations use quantitative data which is considered to be measurable. The collection of quantitative data is often characterized by organized and structured methods, such as questionnaires and structured interviews. Qualitative data refers to non-measurable data such as attitudes and values and is often collected through non-structured interviews.

Whether it is quantitative or qualitative data it is always important to follow some rules, both for the validity and the reliability of the study that has been conducted.

Yin, (2003) proposes three principles for data collection. These are:

Principle 1: Use multiple sources of evidence.

> The use of multiple sources of evidence, or triangulation, is important in order to withhold high validity. This is true for the study of available research as well as the collection of data.

Principle 2: Create a database.

> Regardless of the type of data, the uninterpreted data should be kept and separated from the interpretations made by the investigator. This is common in statistical research but also with qualitative evidence the data should be made available for other researchers to draw independent conclusions.

Principle 3: Maintain a chain of evidence.

> It should be possible for the reader to trace the conclusions back to the original data. Also, the database should reveal in what context and when the data was collected. The data should also be linked to the questions posed in e.g. an interview protocol.

PRIMARY DATA

Data can be categorized in two main groups, namely primary data and secondary. Primary data refers to data which is gathered by the investigator himself and secondary is data gathered by others.

QUESTIONNAIRE

A questionnaire is a rather cheap method for collecting data as compared to interviews (Bryman, 1989). There are many similarities between a structured interview and a questionnaire. *"In many respects, the structured interview is simply a questionnaire that is administered in a face-to-face setting"* (ibid, p 41). It is important to take a lot of factors into consideration when creating a questionnaire. Questions must be constructed in such a way that they cannot lead to misinterpretations. The order in which the questions are presented should also be taken into consideration.

According to Lundahl and Skärvad (1999) there are a few basic common rules to the construction of a question:

- Make the question as understandable as possible to the respondent.
- Avoid rare, unfamiliar, "big" words.
- Thoroughly specify the conceptions that are a part of the question.
- Specify the question in time and space.
- Avoid action-loaded words and leading questions.
- Try to obtain short questions.
- Ask only for one thing at a time.

and to the order:

- Start with basic non-threatening questions and questions that wake the interest of the respondent.
- Wait with delicate and more difficult questions until the end of the interview.
- Start with more common questions and finish with the special ones.

Lundahl & Skärvad (1999) mentions further that the last rule can be reversed so that you start with the special questions and finish with the common ones. It is all dependant of the purpose (ibid). These rules also comply when making questions for an interview.

INTERVIEW

When constructing an interview schedule the purpose and the goal of the interview has to be defined (Yin, 2003). Depending on the purpose of the interview it can be carried out using different levels of structure. There are three different levels: unstructured, semi-structured and structured interview. The structured interview is conducted with a collection of specific and precisely formulated questions, which are presented to the respondent by the interviewer (Bryman, 1989). Semi-structured interviews allow the interviewer to be more flexible and to engage in discussions related to the problem area. Yet with a certain level of structure in comparison to the unstructured interview, which has an even more flexible and adaptable approach and does not even have the need for questions to be prepared. It is important to have in mind that the level of validity with the interview is proportional to the level of structure to which it is carried out.

OBSERVATION

The observation is performed by the investigator by observing specific events that takes place during a period of time. Bryman (1989) distinguishes between two different methods when conducting an observation: the participant observation and the structured observation. The difference between them is that in the structured the investigator records observations in terms of a predetermined schedule and does not participate a great deal in the life of the organization. In the participant observation the technique implies that the investigator should participate in the life of the organization and make somewhat unstructured recordings of the behaviour associated with the organizational environment.

SIMULATION

Simulation can be to ask individuals to imitate real-life behaviour in order to see how they react in various sceneries. The behaviour can then be recorded through observations (Bryman, 1989). A simulation can also refer to computer simulations of different situations that can occur in real life or simulations of product flows. The latter part is often used in logistics.

ARCHIVAL SOURCES OF INFORMATION

This is more a source of data, than a method of collecting data, where the investigator uses existing materials to carry out an analysis (Bryman, 1989). The information can consist of historical information, contemporary records and existing statistics.

SECONDARY DATA

Secondary data already exists and is collected at a lower cost and in less time than primary data. The thesis has mostly used secondary data to form the hypotheses and to find supporting theories for the hypotheses that we formed in the beginning. Examples of secondary data are literature studies, reports, theories and articles

We used extensive searches in various places for theories and literature to find support for the hypotheses that we set up in the beginning of the thesis work.

We have used ELIN-article search, an article search within the University Library of Lund and our mentor at Lund Technological University has used his wide network to help us find material. Searches were made using the following words and phrases, both solitarily and in combinations. *productivity, measurement, productivity measurement, productivity indexes, productivity growth, performance measurement, Value Added, supplier evaluation, value chain, supply chain, R&D, intensity, R&D measure and value chain.* The source OECD has also served as a platform for collecting data. Data, statistics, OECD and OCDE reports from STAN Industry Structural Analysis Database and data from ANBERD (Analytical Business Enterprise Research and Development) was mainly collected at sourceOECD.

Accountant figures were gathered from Affärsdata as well as the classification of the suppliers into the different industry sectors based on SNI 2002.

The aim of the study was to develop quantitative measures, but in order to specify the task we needed an initial qualitative phase. For our study, in the first phase, we have used qualitative sources through interviews to isolate our hypotheses and to get a general view of which theory fields we needed to make literature studies within. After the pre-study had guided us we could transform our hypotheses into a model from which we then proceeded in the making of our questionnaires.

In the study, we have used theory, literature, articles and archival sources of information as the support for the hypotheses that we have formed and which lie beneath the development of our model.

2.3 OUR RESEARCH DESIGN

The matrix introduced in the former chapter has now been explained and the methods reduced into the ones that are a part of our research design. The dimensions now consist of the methods shown below.

Table 2.3 The Dimensions of our Research Design

Theory of Method	Purpose	Scope	Disposition	Theory and Theory Development	Methods for Collecting Data / Sources of Information
Quantitative Qualitative	Explorative Descriptive Explanatory	Sample	Case Study	Deductive	Questionnaire Interview Archival sources Literature, theories, papers, reports, etc.

From the platform that was presented in table 2.1 we have now found the essence of the various strategies and methods and derived the platform to our own research design. The outcome is illustrated in table 2.3 above.

2.4 VALIDITY AND RELIABILITY

Validity in a measure can be defined as: *absence of systematic errors* (Lundahl & Skärvad, 1999). They divide validity into two different sub-groups: internal and external validity. Internal validity exists if the tool for measuring actually measures what it was intended to. To achieve 100% validity is seldom reached, but more important is to clarify, when conducting an investigation, the level of internal validity and to be aware of which actions to take to uphold a high level of validity (ibid). External validity is achieved if the results from the study are valid for other investigations in the future. Reliability can be referred to as *the possibility to reproduce the operations*. Both the validity and the reliability is hard to measure but there are a few things that an investigator must have in mind when conducting an investigation to be able to uphold as high validity and reliability as possible.

To establish the quality of any empirical social research there are four tests that are commonly used (Yin, 2003). He adds an extra subgroup to validity called *construct validity*. The tests according to Yin are defined as:

- *Construct* validity: establishing correct operational measures for the concepts being studied.

- *Internal validity* (for explanatory or causal studies only, and not for descriptive or exploratory studies): establishing a causal relationship, whereby certain conditions are shown to lead to other conditions, as distinguished from spurious relationships.

- *External* validity: establishing a domain to which a study's findings can be generalized.

- *Reliability:* demonstrating that the operations of a study – as the data collection procedures can be repeated, with the same results.

CONSTRUCT VALIDITY

To meet the test of construct validity the investigator needs to cover two steps (Yin, 1994)

1. Select the specific types of changes that are to be studied.

2. Demonstrate that the selected measures of these changes do indeed reflect the specific types of changes that have been selected.

Yin mentions three tactics that are available to meet the demands for construct validity: (1) use multiple sources of evidence, (2) establish a chain of evidence and (3) have the draft case study report reviewed by key informants.

INTERNAL VALIDITY

First, internal validity is only a concern for causal (or explanatory) case studies, in which an investigator is trying to determine whether event x led to event y. If the investigator comes to the conclusion that there is a causal effect between x and y without knowing that there is a third factor z that may have caused y, then the research design has failed to deal with some threat to internal validity (Yin, 1994).

Second, there is a threat to internal validity with the assumptions that the investigator makes. A case study involves an assumption every time an event cannot be directly observed (Yin, 1994).

EXTERNAL VALIDITY

The third test deals with the problems of recognizing whether a study's findings are generalizable for other similar environments (Yin, 1994).

A theory is not automatically generalized. It must be tested through replications in more environments, where the theory has specified that the same results should occur. Once such replication has been made, the results might be accepted for a much larger number of similar environments (Yin, 1994)

RELIABILITY

The objective and the test is to be sure that if a later investigation followed the exact same procedures as described by an earlier investigation they would come up with the same findings and conclusions. Yin mentions two tactics to uphold the reliability: (1) use a case study protocol and (2) develop a case study database, which should consist of two separate collections: the data base and the formal report of the investigator.

VALIDITY AND RELIABILITY OF OUR INVESTIGATION

The interviews that we made were homogenous and carried out in a semi-structured way. The same interview sheet was the basis for our questions and multiple sources of informants were used. We made a total of 6 interviews with Commodity Buyers within different Buyer groups. We noticed during the interviews that answers were very much the same. A summary of the interviews was made and sent to Anders Nyström for evaluation. The answers that we received were the basis for the hypotheses that we formed. Since all of the respondents seemed to pinpoint a few factors that affected the suppliers abilities to manage VCC's demand for decreased prices we focused on these factors. This was made to be able to obtain high construct validity, according to Yin's first step (see construct validity page 35). The second step of construct validity, we feel have been fulfilled since the theories of R&D intensity and the relations to productivity are strong. This combined with the connections to the industry life cycle, Value Added and the value chain, gives the model high construct validity.

The internal validity is hard to measure. We are aware that there are more factors that affect a company's ability to increase their productivity. The company's network, linkages and cooperation with suppliers, customers and similar manufactures or clusters that they are situated in are highly relevant. This is the "Black Box" and means how the company utilises their prerequisites. This was not what we focused on. We chose to find the specific prerequisites that are as basic as possible and were not interested in how the company then took advantage and exploited these prerequisites. It is not certain that the company exploits the prerequisites to 100% and the outcome is less productivity growth than what could have been expected. It is hard to measure this exploitation and if is referred to as the Black Box in figure 2.4 on the next page. There are some threats to the internal validity, such as the basic assumptions that we made, in the beginning of our thesis, and built our hypotheses on. Theories and other investigations has supported these assumptions and given our hypotheses a quite solid foundation. However there can be other factors that are prerequisites for productivity growth.

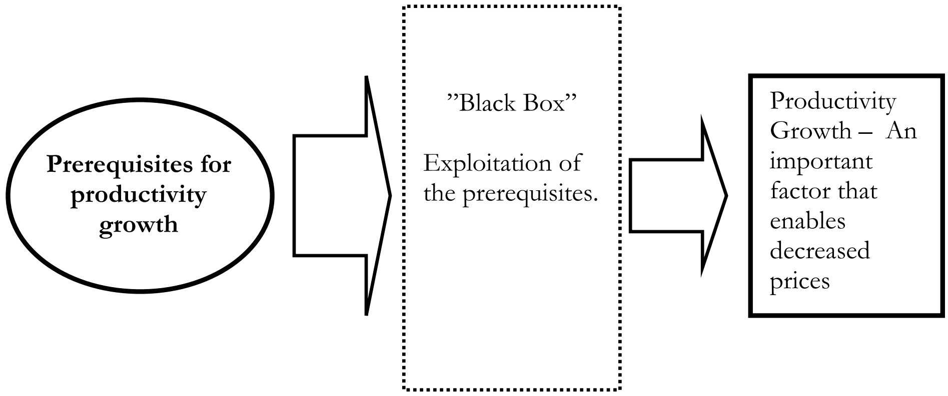

Figure 2.4 Prerequisites - Black Box – Productivity growth.

According to the theory the model ought to have rather high external validity as well. We are well aware of that the sample of suppliers is neither representative because the sample is not based on probability nor large enough to say that external validity is high. Based on this the model needs to be tested more to gain external validity.

The description of the dimensions in the model is based on semi-static facts and the classification of the suppliers according to the model is based on perceptions that have a certain inertia in the sense that conditions and factors that change, if changing, do so under a long period of time and not suddenly. Therefore we have not taken too much consideration to when in time numbers, facts and theories originate. To uphold the validity we have always used the latest available findings that were correct for the study.

All proceedings in the thesis have been well documented. Interview protocol, questionnaires and secondary data have been documented. Interviews were made with Commodity Buyers that were chosen by their executives and questionnaires were sent out to the supplier contacts that were named by these Commodity Buyers. It is not sure that all Commodity Buyers would give the same answers to our questions or the same supplier contacts. There is also a reliability problem with the answers that were collected from the questionnaire (see appendix III). Timing, mood and commitment of the respondent affect the answers and we observed that some respondents gave quite short and not very informative answers to our questions.

3 THEORY

In this chapter we will present a selection of the different theories that support our hypotheses and constitute the frame for the development of the model which is done in the following chapter 4: The Model. In the last part of this chapter we make a summarization and illustrate how these theories are related to the hypotheses.

3.1 HYPOTHESIS 1 PRODUCTIVITY

We need performance measures to realise new strategies and decisions full impact on the overall performance of the company. Traditionally performance is measured based on financial results, which in reality reflects history and say very little about the future. Further more, financial results are affected by economic trends as well as the company's performance, and do very little for identifying the causes of poor or high performance. Therefore organizations need productivity measurements in order to improve internal efficiency and company competitiveness (Hannula, 2000).

3.1.1 DEFINITION

Productivity is generally defined as the relationship between input and output (Tangen, 2002).

$$P = \frac{Output}{Input} \quad (1)$$

Where P = Productivity

According to equation (1) on the former page productivity improvements can be achieved by five different relationships (Tangen, 2002):

- Output and input increases, but the increase in input is proportionally less than the increase in output.

- Output increases while input stays the same.

- Output increases while input is reduced.

- Output stays the same while input decreases.

- Output decreases while input decreases even more.

Productivity is strongly linked to the creation of value, and the opposite of productivity is waste. According to this, all activities must add value to the customer, otherwise they represent a waste of input resources (Petersson, 2000).

3.1.2 PRODUCTIVITY HIERARCHY

There are different hierarchical levels in which productivity can be discussed. According to Tangen (2003), these can be divided into:

- *Partial productivity measures* - the ratio between output and one source of input

- *Total productivity measures* - the ratio between total output and the sum of all inputs

PARTIAL PRODUCTIVITY

The most common partial productivity measure is labour productivity, e.g. output per working hour. Other partial productivity measures are capital productivity, material productivity and energy productivity (Hannula, 2000).

The advantage of partial productivity measures is that they are comparably simple to measure and understand. With partial productivity measurements it is also easy to focus on a specific part of the company, and measure changes in productivity and their causes. It is however important to use relevant partial productivity measures. Much criticism has been aimed at labour productivity measurements since the total direct labour cost is becoming smaller and smaller. Labour costs usually accounts for less than 15 % of total costs in most manufacturing companies. Labour productivity can however be useful if the work force is a dominating production factor (Tangen, 2003).

The disadvantage of partial productivity measures is that they only focus on one productivity measure and does not account for the interplay between the different production factors. Problems that can occur are for example capital-labour substitution. An increase in labour productivity might be achieved at the cost of capital, thus a decrease in capital productivity and perhaps also in over-all productivity (Tangen, 2003).

TOTAL PRODUCTIVITY

Total productivity measurements accounts for the overall company productivity. This means that the risk of sub optimizing and trade offs like labour-capital substitution is eliminated. The disadvantage is that total productivity is more difficult to measure and understand. It is also hard to pinpoint activities that improve total productivity with total productivity measures (Tangen, 2003).

3.1.3 CONNECTIONS TO OTHER SIMILAR TERMS

The concept of productivity should be distinguished from other similar terms like: profitability, performance, efficiency and effectiveness (Tangen, 2002).

PROFITABILITY

Profitability is generally defined as a ratio between revenue and cost and is the overriding goal for the success and growth of any business. However changes in profitability can occur for reasons that have little to do with productivity. Examples are inflation and changes in market prices. Therefore productivity is a more suitable measure to monitor manufacturing excellence in the long run (Tangen, 2002).

Productivity is however closely linked to profitability. An increase in productivity will affect profitability in a positive direction (Tangen, 2002).

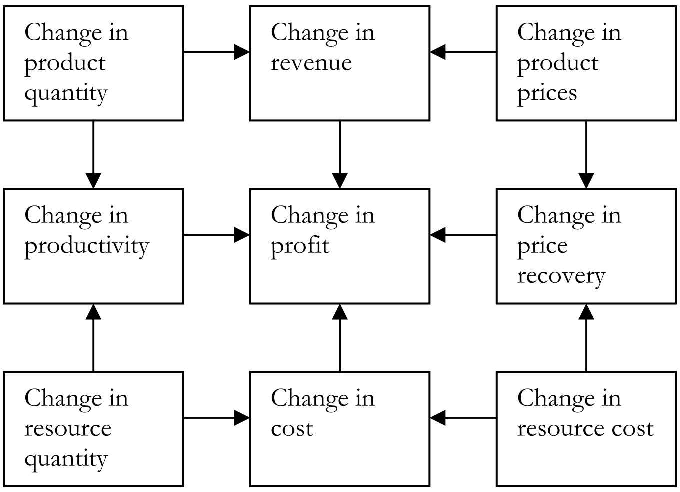

Figure 3.1 What affects the profitability (Tangen, 2002)

PERFORMANCE

Productivity is a specific term that focuses on the ratio between input and output. Performance, however, includes almost any objective of competition and manufacturing excellence such as cost, speed, flexibility dependability and quality. Performance objectives can however have a great impact on productivity development (Tangen, 2002).

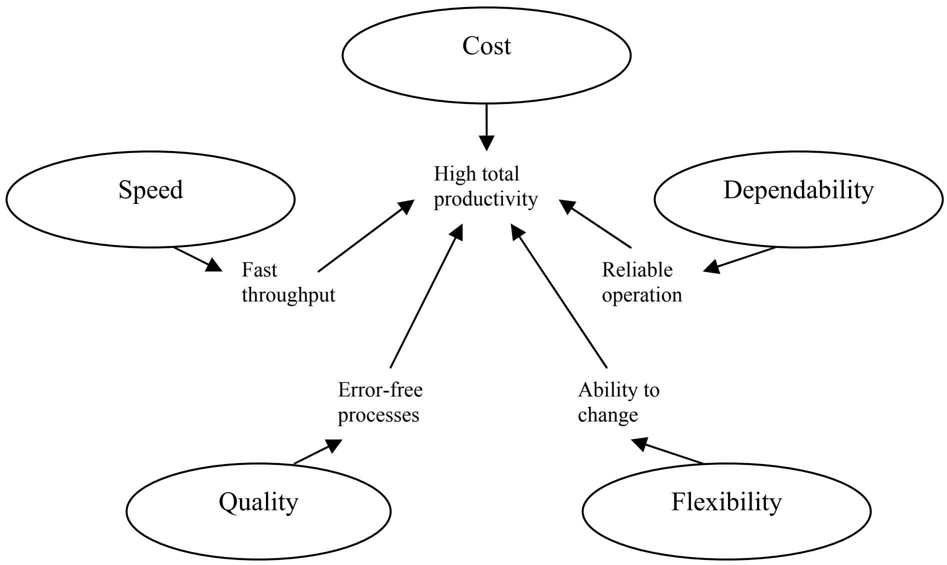

Figure 3.2 What affects the productivity (Tangen, 2002)

EFFICIENCY AND EFFECTIVENESS

Efficiency is generally described as "doing things right" while effectiveness is described as "doing the right things". Efficiency is closely linked to productivity since it focuses on effective resource utilization and therefore affects the input of the productivity ratio. Effectiveness on the other hand is linked to the creation of value for the customer, which affects the output of the productivity ratio (Tangen, 2002).

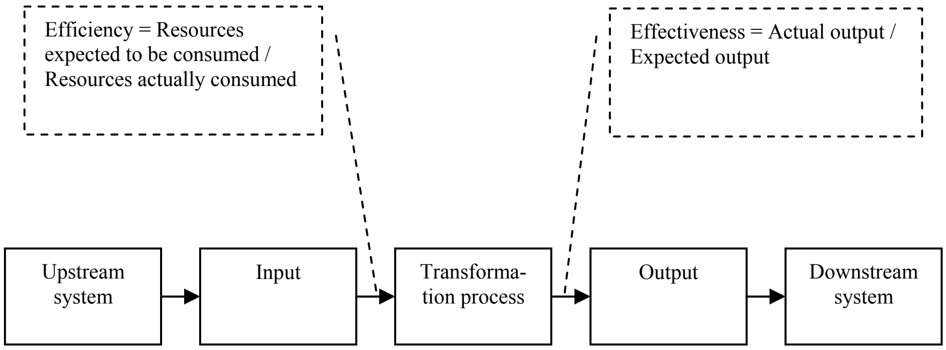

Figure 3.3 Efficiency and Effectiveness (Tangen, 2002).

There are productivity definitions that are based on the efficiency/ effectiveness factors.

$$P = E_s \cdot E_y$$

Where P = Productivity
E_s = Effectiveness
E_y = Efficiency

3.2 HYPOTHESIS 2 TECHNOLOGICAL PROGRESS

3.2.1 R&D INTENSITY

Several investigations have been done since Zvi Griliches's work in 1957 Econometrica hybrid corn paper that is a foundation of the economics of technological innovation, concerning R&D investments and its impact on the growth of productivity. The relationship between them has numerously times been the topic in the economic literature as well as in the political debate. Mansfield (1972) did a review of the empirical investigations performed in the prior last two decades and came up with the conclusion that R&D investments make a considerable contribution to the growth of productivity (Nadiri, 1991). Later surveys done by Nadiri (1980b), Griliches (1991) among others have confirmed this conclusion (ibid).

"Firms which are technology-intensive innovate more, win mew markets, use available resources more productively and generally offer higher remuneration to the people that they employ" (Hatzichronoglou, 1997, p 4).

The measure of R&D intensity is used by organizations to categorize corporations in groups with varying technology intensity from high to low. The first classification done by the OECD was based on direct investments done by the different industry sectors and led to a list placing industries in three categories (high, medium or low technology). Ten years after the first list there was a need for an updated version. OECD improved their methods and categorized industry branches based on ISIC[3] rev 2 into four different groups according to their level of R&D intensity (see appendix I). The methodology, called the sectoral approach, uses three indicators of technology intensity reflecting, to different degrees, "technology-producer" and "technology-user" aspects: (1) R&D expenditures divided by Value Added; (2) R&D expenditures divided by production; and (3) R&D expenditures plus technology embodied in intermediate and investment goods divided by production. These indicators were calculated over a long period of time (1973-92) and the classification was created for 1980 and 1990. The advantage with this approach was that both direct and

[3] International Standard of Industry Classification

indirect R&D investments were taken into account when classifying the different sectors. Direct investments are the investments made by the company and indirect refers to R&D investments embodied in intermediates and capital goods purchased on the domestic market or imported. Technology moves from one sector to another when one sector performs R&D and then sells its products embodying that R&D to other industries, which then use them as manufacturing inputs.

Products have also been classified by OECD, taking into account not only the technological intensity of their own sector but the technological intensities added along the supply chain as well. This is known as the *product approach*. Hatzichronoglou (1997) made a study in the period of 1988-95 and classified more than 2000 high-technology USA products. The product approach was developed as a supplement to the sectoral and to provide a more appropriate tool for analysing international trade. The products are based on the SITC[4] Rev 3. The classification consists solely of high-technology products.

The product approach differs in at least three ways compared to the sectoral approach according to Hatzichronoglou:

1. The technology-intensity of an industry can differ between countries. It is unbelievable that products are classified as high-tech in one country and medium – or low-tech in another. The product approach is more consistent in the classification.

2. The product approach makes it possible to estimate the true proportion of high technology in a sector since all products not being high-tech are excluded, even if they are manufactured by high technology industries.

3. It consists only of products in the high-technology category.

The latest update of the classification of industries according to R&D intensity done by the OECD is based on the ISIC rev 3 (see appendix II). Hatzichronoglou, (1997), came up with the conclusion that taking indirect investments into account, as done in the prior classification, was unlikely to affect the industry's classification in the different groups. The 2003 Science, Technology and Industry Scoreboard wrote that *"Embodied technology intensities appear to be highly correlated with direct R&D intensities; this reinforces the view that the latter largely reflect an industry's technological sophistication"*.

[4] Standard International Trade Classification

Due to the absence of updated ISIC Rev. 3 input-output tables which was required for estimating embodied technology, only the first two indicators was calculated in the latest updated revision (OECD, 2003).

3.2.2 A Swedish Investigation

New technology can increase the productivity, when measured as labour-productivity in two ways. Either as an increase of the Value Added to the product or as a decrease of the number of persons employed.

In an investigation made by SIND[5] 1991, a classification of Swedish corporations with at least 50 employees was made. The investigation was based on empirical data ranging between the years 1978 to 1986. A total of 1154 corporations were included and classified according to R&D intensity defined as the quota between R&D investment and value-added sales. The mean value was calculated and based on this value the corporations where arranged in five groups from group 1 with no R&D intensity and in 2-5 with increasing intensity (SIND 1990:a). The R&D intensity intervals were established as illustrated in table 3.4 on the next page.

[5] Statens industriverk. In the present day known as NUTEK.

Table 3.4 Intervals for the mean average of R&D intensity in percent (SIND 1990a:88)

R&D group	Total industry, Heavy industry, Manufacturing industry with and without transport industry	Light industry
1	0	0
2	>0-3	>0-1,5
3	>3-6	>1,5-3
4	>6-9	>3-4,5
5	>9	>4,5

Productivity was defined as $\frac{value\ added}{employee}$

Labour-productivity as defined above is not the best or most accurate way to measure productivity especially not when compared between different industry branches. However it is often used because it is easy to measure and to compare.

From this classification the investigation came up with a few conclusions:

- No direct relations where found between R&D intensity and profit on the aggregated level.
- There is a strong positive relation between R&D investments and increased sales volume. Companies with no R&D investments did not have any mentionable increase in production volume whereas the group with the highest level of R&D intensity had a huge increase in volume.
- Only the most R&D intense corporations were able to uphold their rate of employment.
- Productivity increases with the R&D intensity. The difference in productivity is besides this of great difference between the different groups.
- The share of export increases with increased R&D intensity

The reason for using R&D intensity as a measurement of productivity and productivity growth is because of the availability of comparable data between countries.

However there are a few implications pointed out by Edquist in his report

- R&D investments are not a measure of how effectively the companies actually realise the investments made.

- Secondly the R&D intensity measure classifies the technology based on science as high technology rather than knowledge or interactive learning. Seen from this perspective, the R&D intensity measure overrates certain kinds of technological change and underrates other kinds.

- The third implication means that R&D intensity does not measure the technology level in the production process. Even if a computer is an R&D intensive product, the assembly of it is classified as low technology.

Since we are not interested in what actual productivity development the companies have but the prerequisites they have to be able to increase their productivity the first problem is overlooked.

The second implication is nothing that we can take under consideration, since the measurement of knowledge-based technology is almost impossible.

The third problem pointed out by Edquist is focusing on a macroeconomic level when for example measuring the growth of the economy.

3.2.3 DISTRIBUTION OF R&D INVESTMENTS

R&D investments are assumed to affect the productivity in a positive mode by two principles. First by the development of new or modified (improved) products and secondly through more effective ways to manufacture these products.

The distribution of R&D investments made by Swedish industries in 1989.

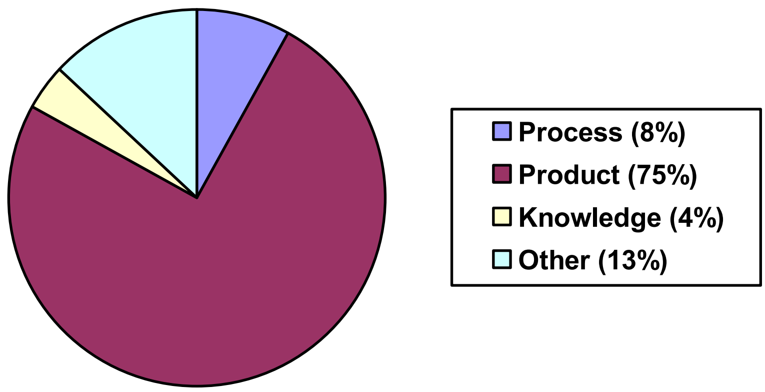

Diagram 3.5 Distribution of R&D investments (Edquist, Forskning, teknikspridning och Produktivitet, 1991, p 147)

75 % of the R&D investments made in Sweden were made to improve existing products or to develop new products. Only 8% were made to improve or to develop new processes to manufacture the products. Of the investments made to improve or to develop new products were 49 % used to improve existing products, 26 % to develop products already existing on the market, but new to the company and 25 % to develop new products.

Of the investments made to improve or to develop new process technologies were 46 % used to develop new processes and systems and 54 % to improve existing processes. The conclusion is that 60 % of the total R&D investments made were made to improve existing process techniques and products

(Edquist, 1991) and the assumption that R&D investments are made to improve products and manufacturing processes seems to have a high validity.

3.2.4 THE INDUSTRY LIFE CYCLE

There is a connection between the industry life cycle and the strategies that a corporation should adopt depending on which stage they are present in. In the stages of introduction and growth companies should obtain market position through R&D, product development, the introduction of new models and varieties and improvement of existing products. Companies to be found in the stages of saturation and decline can only maintain or reinforce their market positions if able to sell end products at very competitive prices. Technology in these stages is mature and does not change significantly (van Weele, 1994).

The Industry Life Cycle

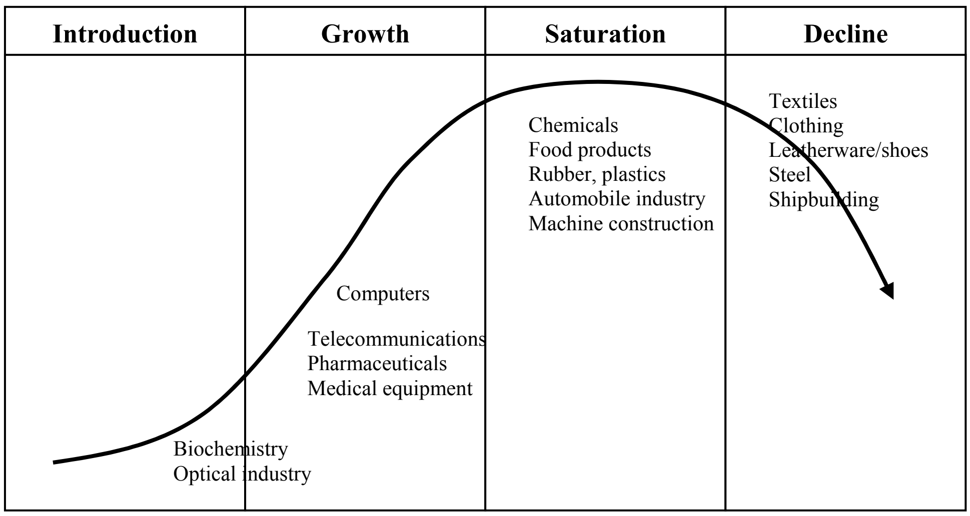

Figure 3.6 The industry life cycle. (van Weele, 1994, p 110)

3.3 HYPOTHESIS 3 VALUE ADDED

In an effective value chain the value of its outputs is higher than the sum of its inputs. Value can be produced by for example manufacturing, marketing and research and development. It is important to understand that processing a product only creates value if the activity is creating value for the customer (Olsson & Skärvad, 2000). By breaking down the output products it is possible to analyse how the value chain creates value and which resources that are critical for the value creating activities. See figure below.

- A Material intense value chain (A)
- A Manufacturing intense value chain (B)
- A Research and Development intense value chain (C)
- A Marketing and Distribution intense value chain (D)

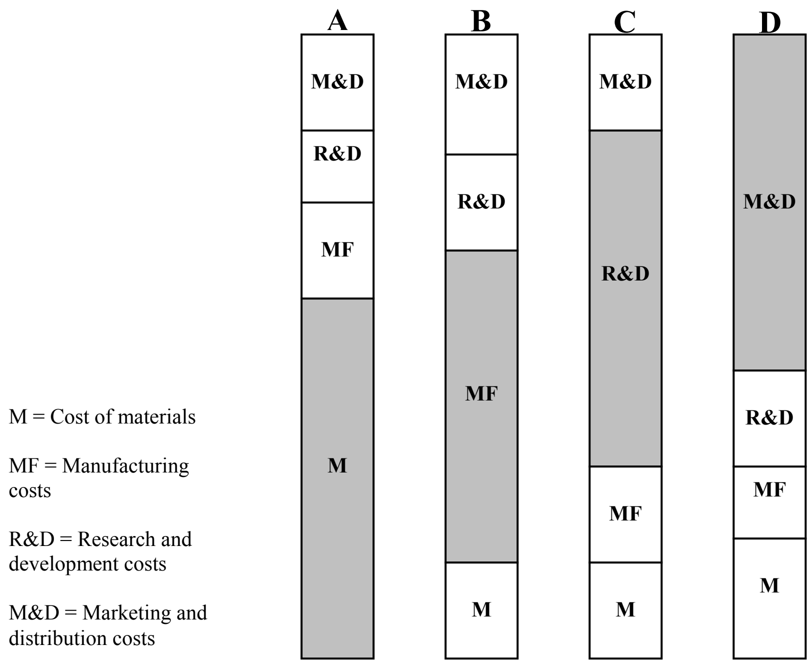

Figure 3.7 Value creation in different value chains (Olsson, Skärvad 2000)

3.3.1 THE PRODUCT LIFE CYCLE

The Product Life Cycle

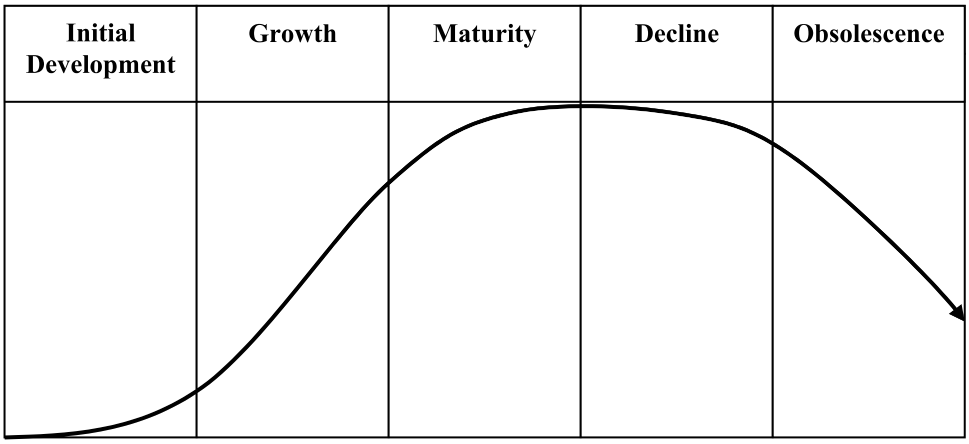

Figure 3.8 The Product Life Cycle, (Dicken, 1998)

During the *early stages* of the product life cycle technology shifts rapidly and production tends to be in small runs or batches. As the product has progressed to the *growth stage* mass production is introduced and the capital intensity is considerably higher. In the *mature stage* the demand cycle has reached its peak. Focus is set on long production runs to reduce costs. Technology is stable and emphasis is on unskilled labour to perform repetitive tasks in a mechanized way (Dicken, 1998)

Dicken (1998) states that as the cycle proceeds forward, the weight shifts from product-related technologies to process technologies and, in particular, to ways of minimizing production costs.

This view or way of systematic changes in the production process as a product matures is according to Dicken (1998) appealing and has some validity. He further maker the remark that denoting this relationship as linear is to excessively simplify the relationship.

3.4 THE VALUE CHAIN AND THE SUPPLY CHAIN

A product is produced by a series of processes. Therefore the purchasing of a product can be seen as an order of this series of activities. Sometimes the purchasing organization processes the purchased product further, thus adding value to the product (Gadde & Håkansson).

3.4.1 THE VALUE CHAIN

The value chain concept is used to understand how value is created or lost. The value chain describes the activities, which together create a product. The activities can be divided into primary activities and support activities. The primary activities can be grouped into five main areas: inbound logistics, outbound logistics, operations, marketing and sales and services. These activities are directly concerned with the creation or delivery of a product or service (Johnson & Scholes, 2002).

The support activities are procurement, technology development, human resource management and infrastructure. These activities help to improve the effectiveness and efficiency of the primary activities (Johnson & Scholes, 2002).

In most industries it is rare for a single organisation to undertake all of these activities. The value system commonly consists of a number of organizations, each with a special role (Johnson & Scholes, 2002).

3.4.2 THE SUPPLY CHAIN

The supply chain consists of all activities, information knowledge and financial resources associated with the flow and transformation of goods and services, from raw material suppliers and component suppliers to the final product. Supply chain management differs from purchasing in that it also includes all logistic activities (van Weele, 1994). The relationship between supply chain management and value chain management is illustrated in figure 3.5 below.

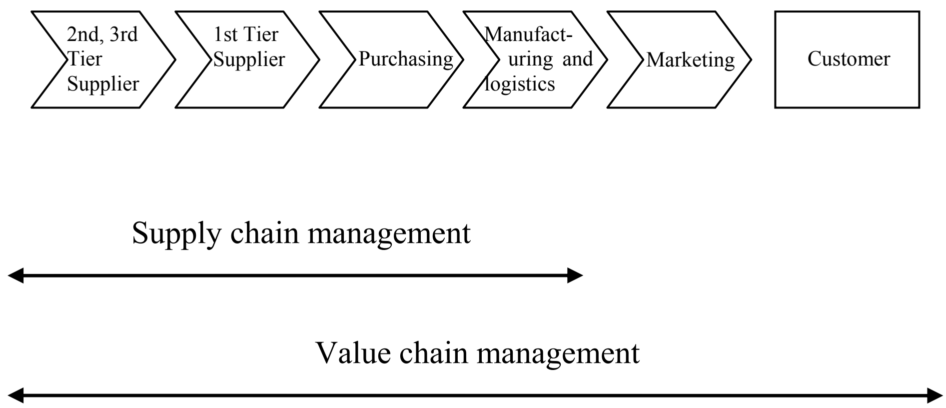

Figure 3.9 Supply and Value Chain (van Weele, 1994)

3.4.3 THE NETWORK APPROACH

According to van Weele (1994) the relationship between manufacturer and supplier is not only influenced by product characteristics and the involved organizations, but also by the relationships between the organizations in the entire supplier network. Effective purchasing requires an understanding of the cost structures and power balance of the entire supplier network. An effective supply chain is not characterized only by the flow of products, but also by the flow of information through the entire network. Reliable information is the key to reduced quality costs, increased flexibility and effective stock reduction.

3.5 KEY FIGURE ANALYSIS

Key Figure analysis is a way to evaluate different aspects of a company's economical situation and follow the progress of customers, suppliers and the own company. According to MMP (1996) it is important to evaluate the supplier network. If the supplier's economical situation is unstable the customer company is in danger of loosing this relationship, which can be disastrous in long-term relationships.

LIQUIDITY

Liquidity is a measure of a company's ability to meet short-term commitments to creditors and wages. A dwindling liquidity position may require additional loans and thereby an increased risk profile (Johnson&Scholes 2002).

There are different guidelines to liquidity but according to Ernst & Young (1995) the liquidity of an economically healthy company should not be below 80%.

Liquidity is defined by Affärsdata (2004) as $\frac{Liquidity\ assets - Stock}{Short\ term\ debts}$

SOLIDITY

Solidity is measure of a company's ability to meet long-term commitments to creditors. A deteriorating solidity position may result in a crisis situation even if results go down marginally. Therefore the higher the business risk, the higher the demand for high solidity.

Normally, according to Ernst & Young (1995) the solidity of an economically healthy company should not be below 15%.

Solidity is defined by Affärsdata (2004) as $\frac{Shareholders\ equity}{Total\ assets}$

PROFIT MARGIN

Profit margin measurements are one way of illustrating the profit margins of a company. This key figure illustrates the relation between profit and turnover.

Profit margin is defined by Affärsdata (2004) as $\dfrac{\textit{Profit after financial items}}{\textit{Turnover}}$

3.6 Hypothesis Summarization

The theories that have been presented in the prior chapters have a connection to the hypotheses that we presented in the introduction. We will now present a summarization of the theories that are related to the three hypotheses.

Hypothesis 1

- *A manufacturer needs to constantly increase their productivity to be able to decrease their output price and thereby be competitive.*

A company such as a supplier needs to stay competitive to be able to survive. To be competitive in the automotive industry as a supplier to VCC implies that annual price reductions should be met. A reduction of the output price can be obtained by lowering the profit margin. This is a short-term solution. In order to be able to reduce the output prices annually the supplier needs to adopt long-term solutions. The long term solution is to improve their productivity and by this increasing their output in comparison to their input.

Hypothesis 2

- *The technological progress in the industry sector is linked to the ability to improve productivity.*

A company situated in the first stages of the industry life cycle invest more in R&D, products and manufacturing processes are developed and rapid technological shifts are made, hence higher possibilities of yield from these investments. The technological of the industry sector is not very progressed. The technological maturity is considered to be low.

Companies situated in the latter stages of the industry life cycle already have developed and refined their products and manufacturing processes. The technology has progressed to a level where further development is either impossible or not very profitable. Due to this R&D investments have decreased substantially. The technological maturity is said to be high.

The R&D intensity measure is used by OECD to classify different industry sectors into 4 more or less technology intense groups. The groups are high, medium-high, medium-low and low, where the high technology group has the highest level of R&D intensity and hence the lowest technological maturity.

The R&D intensity measure has also a strong positive relationship to productivity growth, measured as TFP (Total Factor Productivity, or simply Total Productivity).

HYPOTHESIS 3

- *The amount of Value Added per unit is different depending on the product that is manufactured and this is linked to productivity growth.*

The third hypothesis seems to be related to the second. We have not been able to find any investigations that elucidate this relationship. In theory the amount of Value Added in the products decrease as the industry evolves, the technology progresses and the products and manufacturing processes develops.

4 THE MODEL

In this chapter we will present how we used the theories presented in the prior chapter to develop the platform for our model. A description of two dimensions will further be presented and how suppliers can be classified using these two dimensions. Further we will introduce the term environment, with regards to the model and explain how suppliers are situated in different environments and what implications this have for the productivity and price development.

4.1 THEORY DEVELOPMENT

The hypotheses that were presented in the approach chapter are the basis for the development of the model. As said before the aim was to classify the suppliers according to their productivity improvement potential. It is difficult to measure the productivity between different industry sectors in a correct and reliable way. Depending on whether the sector is capital or labour intense the measurement of partial productivity can be unfair in comparison between the sectors. The solution is to use a total productivity measurement where all the factors are taken into account. To measure productivity using a total productivity measure is not very common and very time consuming. We needed another approach that took the technological progress in consideration and was linked to productivity. This measure also needed to be applicable on different kinds of companies in different sectors. Besides this the measurement should take the marginal productivity in consideration since we wanted to measure the prerequisites that a company had to increase their margin for productivity and thereby being able to reduce the output price.

4.1.1 THE SUPPLY CHAIN

When evaluating the productivity improvement potentials of a supplier it is important to evaluate not only the first tier supplier but the whole supply chain. Even if the first tier supplier's productivity improvement potential is low, there could be a high potential in the supply chain as a whole.

If a supplier is trying to meet VCC's price demands by lowering their own supplier prices, the supplier is not contributing to the supply chain productivity improvement. The demands are just being passed on to the next supplier in the chain. This demand can be met by either decreasing margins or improved productivity. In the ideal supply chain with stable non changing margins, productivity improvements are shown directly in lower prices through the chain, thus lower prices for VCC. In a supply chain with many actors there is of course a risk that the effects of increased productivity disappears along the way as increased margins. Therefore it is important to investigate the supply chain's potential for increased productivity.

4.1.2 THE DIMENSION OF R&D

A company can be in a line of business, which is more or less technologically developed. The technological development is essential for the productivity growth. The more the production process and product development has been upgraded and refined during the years the smaller the margin gets for extended refinement and new developments. A company that for example manufactures computers are in a less technologically mature line of business and more technological progress is still to be made, than for example the steel industry. Given this the computer manufacturer can increase its productivity more than the steel manufacturer. The technological development in the steel industry is mature and that makes it hard to find any productivity improvements.

The R&D intensity measurement, which has been used by OECD for decades as a way to classify sectors into more or less technologically advanced sectors, is a highly used and well-founded measurement of productivity growth. A high technology classification means that the technological advancement is low, much progress and breakthroughs are still to be made and the sector can be classified as technologically immature. These sectors show larger R&D investment, due to the possibilities of higher yield on the invested capital. Low technology sectors are more technologically mature and further development is based on small improvements of existing products and processes rather than technological breakthroughs. The yield of returns is lower and very little is invested in R&D. This can be connected to the industry life cycle, where companies situated in the two initial stages are less technologically mature and companies situated in the last two stages are more mature.

The R&D intensity measure is especially suitable when comparing different sectors. The classification in high, medium-high, medium-low and low based on the ISIC rev 2 considered the amount of technology embodied in inter-mediate and investment goods. Although the latest classification based on the ISIC rev 3 did not have the measurement of embodied technology it shows similarities with the prior classification when comparing them due to some rethinking of the classification (see APPENDIX II). Also the OECD came up with the conclusion that taking indirect investments into consideration did not classify industries into different groups than what prior classifications had done.

The relation between R&D intensity and growth of productivity, measured as total factor productivity, is strong. Extended research and several investigations have come up with the same conclusion that there is a strong relationship between R&D intensity and the growth of total factor productivity.

Other investigations, among them a Swedish made by SIND in 1990, came up with the conclusion that there is a connection between R&D investment and productivity. The investigation also came up with the conclusion that the most R&D intense sectors were the only ones that were able to uphold their level of employment. If the other sectors had been able to uphold this level they would have had less productivity since Edquist used labour productivity as the measure for productivity.

The R&D intensity measurement and classification is related to the maturity of the technology. Industries situated in a mature technology sector are reluctant to large investments in R&D, since the return on invested money is low. Companies that are classified as low technology according to OECD have less invested in R&D than the ones that are classified as high technology, hence are the low technology companies also in the most technologically mature line of business.

The R&D intensity measure indicates the prerequisite the company (supplier in this case) has for an increased productivity, whereas the Value Added indicates the productivity improvements that are strictly related to the product that the supplier manufactures.

4.1.3 THE DIMENSION OF VALUE ADDED

The Value Added is more difficult to measure. We have not been able to measure the Value Added for the products that the selected suppliers manufacture and we have only found indications that the Value Added is related to the productivity. The approach for the Dimension of Value Added is more theoretical than the Dimension of R&D due to these implications.

A product's price consists of raw material and Value Added in terms of embodied value in the product. The cost for raw material is hard to alter, since world demand and supply sets the market price. Small fluctuations can occur over time and even rapid price changes due to unexpected events.

Value Added is everything else but the cost of raw material. The amount of Value Added in a product is in some terms proportional to the complexity of the product, the complexity of the manufacturing process, the knowledge, technology and other costs that are a part of the product. By increasing the productivity and thereby increasing output in proportion to the amount of labour, capital and energy inputs, the companies receive a larger marginal profit. This profit can then be reduced to the former level and what has happened is that the output price has been decreased.

This productivity-price relationship can be illustrated with a hypothetical example:

A productivity growth decreases either the variable cost ($VC_1 \rightarrow VC_2$) or the fixed cost ($FC_1 \rightarrow FC_2$) of the product. In reality it is often a combination of the two that is the result of a productivity growth. The result is experienced as a reduction ($P_1 \rightarrow P_2$) of the manufacturing price (output price). See figure 4.1 on the next page.

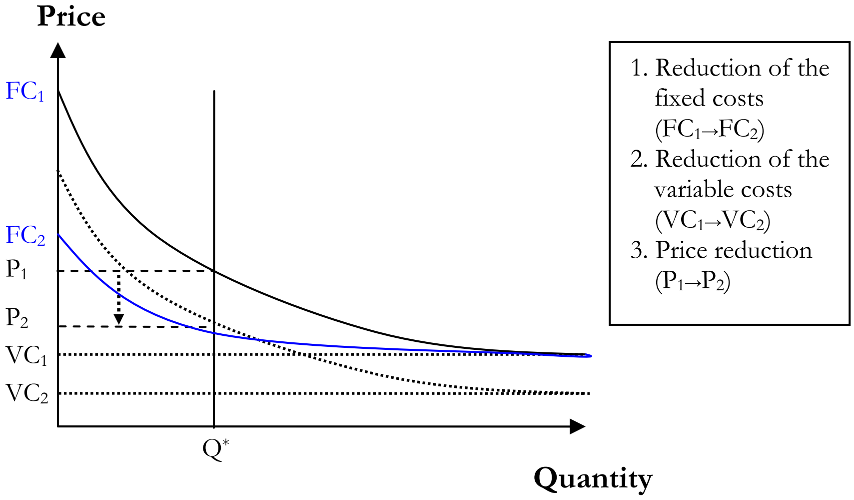

Figure 4.1 Productivity – Price Relationship

Many industries such as the leather and textile industry have lowered their use of raw material to such an efficient level that very small reductions are left to be made. Similar to other industries such as the steel industry they show the same dependability of raw material. In addition to this the technology is mature which means that further productivity improvements are difficult.

Other industries such as the computer industry can among other options increase the Value Added by technological progressions to make a productivity improvement. The price of the manufactured products is not dependant on raw material prices, since this is a very small part of the total price.

We tried to investigate what relationship different sectors had to Value Added and raw material and what factors that controlled this relationship. We were not able to find any investigations or were able to measure the amount of Value Added in the products that the suppliers manufacture. Because of this the dimension of Value Added is based on theories and assumptions.

4.2 THE MODEL

The model is a two dimensional representation, consisting of the two dimensions presented in the prior chapters.

4.2.1 THE DIMENSION OF R&D

As said before and based on hypothesis(2) that the technological advancement is a factor for productivity and productivity growth, we have formed the first dimension of our model that describes one part of the environment in which the suppliers are situated in. The higher R&D intensity, the less technologically progressed the industry is and hence has greater margins for productivity growth and thereby should be able to reduce prices more. The R&D intensity-based classification is strongly related to the productivity growth, measured as total factor productivity.

The R&D dimension is based on the ISIC rev 3 based classification of industry sectors. The supplier's classification into the different sectors is collected from Affärsdata (Affärsdata, 2004)[6]. Affärsdata uses the Swedish SNI 2002 to classify the companies into different sectors. This classification is based on the NACE rev. 1, which is used by European members. The NACE rev. 1 is according to UNSD[7] compatible to ISIC rev. 3.

This dimension puts the companies into four different sectors based on their R&D intensity. Both the R&D intensity per production and the R&D intensity per Value Added are taken into consideration[8].

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[6] See Chapter 5 Empirical Findings for the classification of the suppliers

[7] United Nations Statistical Division

[8] See Appendix II for more detailed information on how the classification was made by OECD

4.2.2 THE DIMENSION OF VALUE ADDED

Since we have not been able to measure the Value Added in the products that the suppliers manufacture we can not present any approach in how this measurement can be done.

It seems that the dimension of Value Added is related to the dimension of R&D intensity in the sense that companies in a more technologically mature line of business has a more progressed technology for the product and manufacturing processes. They have a material intense value chain and the technology does not give them any prerequisites for much further reduction of the margins. This assumption is based on the product and the industry life cycle.

THE MODEL

This model shall illustrate the two dimensions that we have investigated and are two factors that determine a company's ability for productivity growth. The model serves the purpose to gain understanding of the diversities in price development that VCC experience. It further aims to introduce a way of quantifying the prerequisites for productivity growth.

The horizontal axle is the R&D intensity measure and this corresponds to the first dimension. The productivity improvement potential increases as the R&D intensity increases.

The vertical axle is represented by the Value Added in the products that the supplier manufactures. The higher the Value Added is the greater the productivity improvement potential gets.

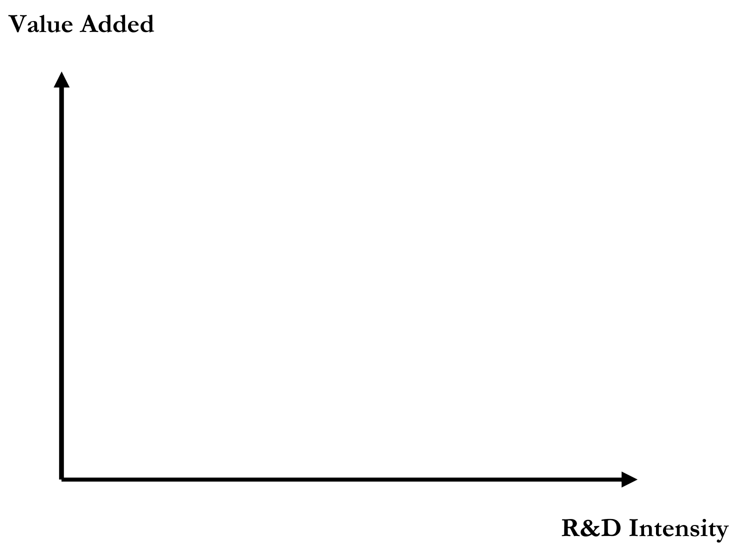


Figure 4.2 The dimensions of productivity growth

The suppliers can be gathered in different groups. These groups have similar prerequisites for productivity growth and should be able to, under the assumption that they exploit these requisites to the maximum, have the same price development.

THE ENVIRONMENT

With the classification of the different suppliers we should find groups that show similar R&D intensity measures and Value Added. This is defined by us as the environment that they are situated in. Diverse environments should give the suppliers contrasting prerequisites for productivity growth. The important thing to remember is that suppliers within the same environment have equivalent conditions to productivity growth and should for that reason be able to show similar price development (Hypothesis 1).

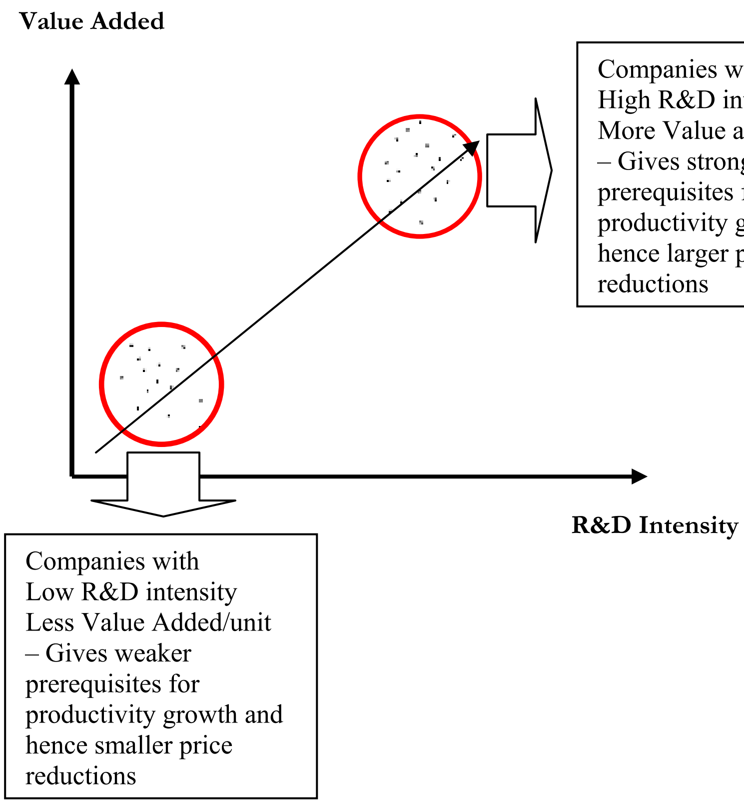


Figure 4.3 The Environment

Figure 4.3 illustrates the two outskirts. The lower left corner inhabits companies with a low R&D intensity and a small amount of Value Added in the products that they manufacture. Theses companies have a high level of technological maturity, products and manufacturing processes have been developed and refined during a period of time and much further productivity increases are difficult. This gives these companies weaker prerequisites for productivity improvement. The outcome is a smaller price reduction than other companies.

In the upper right corner situated companies have high R&D intensity level and a high amount of Value Added in the products that they manufacture. The technological progression has not come far. Major technological breakthroughs are still made, products and production processes are under constant development. They have much stronger prerequisites for productivity improvement and are therefore able to decrease their output prices more.

When a classification of the suppliers is done according to the model it is of interest to compare the companies that are situated in the same environment with regards to their prerequisites for productivity improvement. The companies that are situated in the same environment have equal prerequisites for productivity improvement and should for that reason be able to show a similar price development.

5 EMPIRICAL FINDINGS

This chapter contains our empirical findings. Due to secrecy we are not able to publish all our findings. All information is however used and commented in chapter 6 "Analysis" and chapter 7 "Conclusions".

5.1 CLASSIFICATION OF SUPPLIERS

Since we have not been able to fully investigate the dimension of Value Added, nor been able to measure the amount of Value Added in the products that the suppliers manufacture this has been excluded when classifying the suppliers in chapter 5. The suppliers have only been classified according to the R&D intensity level of the industry sector that they are situated in.

The classification is made from the classification of the suppliers into industry sectors, presented by Affärsdata, based on the Swedish SNI 2002 classification and the classification on theses industry sectors into the four different technology intensity groups defined by OECD. The groups are low, medium-low, medium-high and high technology. The classification that has been made is based on the ISIC rev. 3, since it is identical with SNI 2002 on a two-digit level[9]. The classification is presented in table 5.1 on the next page.

[9] Stated by Hans Agrell of the Statistiska CentralByrån (SCB) and by the UNSD.

Table 5.1 Classification of Suppliers

Supplier	Industry Sector[10]	Technology Classification[11]
1	34300	Medium-High Technology
2	25110	Medium-Low Technology
3	25110	Medium-Low Technology
4	32300, 33200	High Technology
5	34300	Medium-High Technology
6	34300	Medium-High Technology
7	34300	Medium-High Technology

This is the classification of the different suppliers of VCC that has been a part of the study. The suppliers has initially been classified into various industry sectors according to SNI 2002. These sectors have then been classified by OECD depending on their R&D intensity into four different technology groups. Table 5.1 illustrates this classification of the different suppliers both into industry sectors (column 2, Industry Sector) and their R&D intense technology classification (column 3 Technology Classification).

[10] According to Affärsdata, SNI 2002.

[11] According to OECD Classification based on the ISIC rev. 3. See Appendix III, Table II.1 for the whole presentation of the different technology intense groups made by OECD.

5.2 KEY FIGURES

These tables and diagrams contains key figures of the investigated suppliers. Due to secrecy the individual price developments of the suppliers are not published

In table 5.2 you will find a classification of the investigated suppliers as well as the suppliers solidity, liquidity and profit margins.

Table 5.2 Key Figures of the suppliers

Supplier	**1**				
Industry Sector	**34300**				
Classified as	**Medium-High-Technology**				
	02	01	00	99	Average
Solidity	17,34	22,93	20,78	43,21	26,07
Liquidity	44,20	39,65	72,52	38,59	48,74
Profit Margin	-6,25	-4,50	-15,22	-5,46	-7,86

Supplier	**2**				
Industry Sector	**25110**				
Classified as	**Medium-Low-Technology**				
	02	01	00	99	Average
Solidity	40,92	45,71	46,12	34,22	41,74
Liquidity	132,21	144,53	143,39	145,30	141,36
Profit Margin	-3,33	0,36	10,11	0,19	1,83

Supplier	**3**				
Industry Sector	**25110**				
Classified as	**Medium-Low-Technology**				
	02	01	00	99	Average
Solidity	74,08	76,36	71,96	70,66	73,27
Liquidity	482,66	361,90	309,23	299,22	363,25
Profit Margin	-0,47	2,63	-2,75	9,42	2,21

Supplier	**4**				
Industry Sector	**32300, 33200**				
Classified as	**High-Technology**				
	02	01	00	99	Average
Solidity	21,54	21,72	25,84	48,09	29,30
Liquidity	77,74	90,26	97,77	126,95	98,18
Profit Margin	-9,78	-18,82	-21,08	-4,79	-13,62

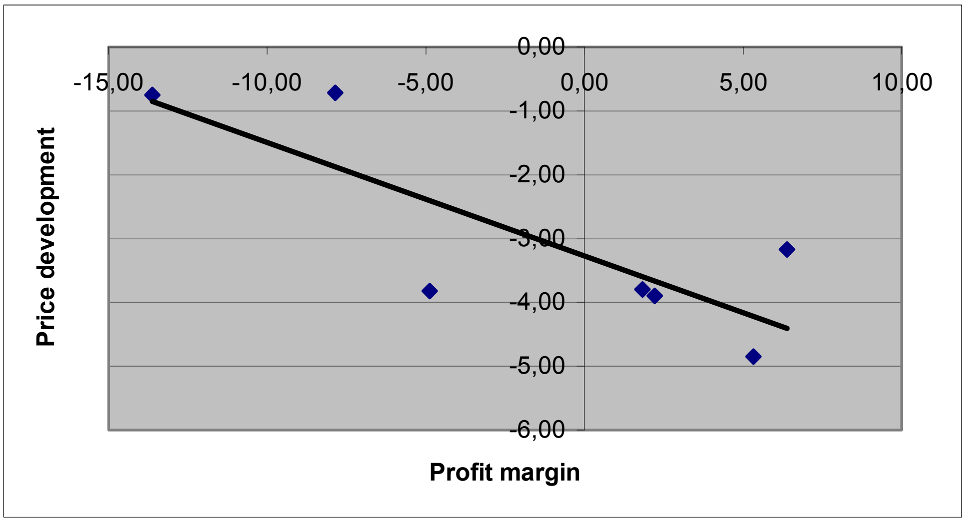
Supplier	**5**				
Industry Sector	**34300**				
Classified as	**Medium-High-Technology**				
	02	01	00	99	Average
Solidity	47,35	41,71	36,09	43,93	42,27
Liquidity	112,65	108,85	88,37	90,61	100,12
Profit Margin	6,57	5,85	2,48	6,41	5,33

Supplier	**6**				
Industry Sector	**34300**				
Classified as	**Medium-High Technology**				
	02	01	00	99	Average
Solidity	38,81	38,88	40,68	42,34	40,18
Liquidity	93,87	95,55	93,98	84,00	91,85
Profit Margin	-11,08	-4,35	0,58	-4,65	-4,88

Supplier	**7**				
Industry Sector	**34300**				
Classified as	**Medium-High Technology**				
	02	01	00	99	Average
Solidity	22,13	22,48	28,12	30,1	25,7075
Liquidity	183,69	86,23	86,98	86,94	110,96
Profit Margin	1,22	-0,1	14,28	10,11	6,3775

In diagram 5.1 the relationship between the suppliers price development and profit margin is illustrated.

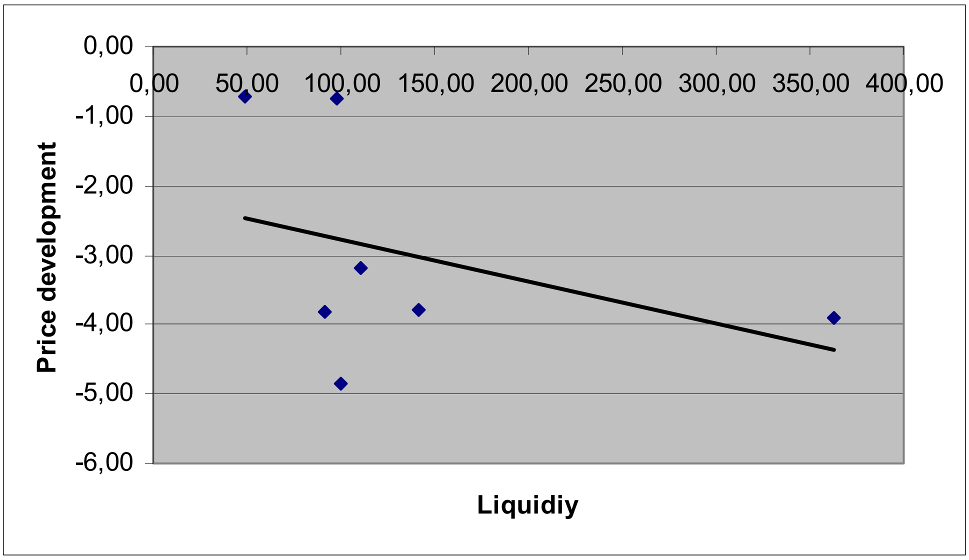
Diagram 5.1 Plotting the Price development with regards to Profit Margin (Mean Average, 1999-2002)



You can see that there seem to be a relationship between price development and profit margin, where a higher profit margin gives higher price reductions.

In diagram 5.2 the relationship between price development and liquidity is illustrated.

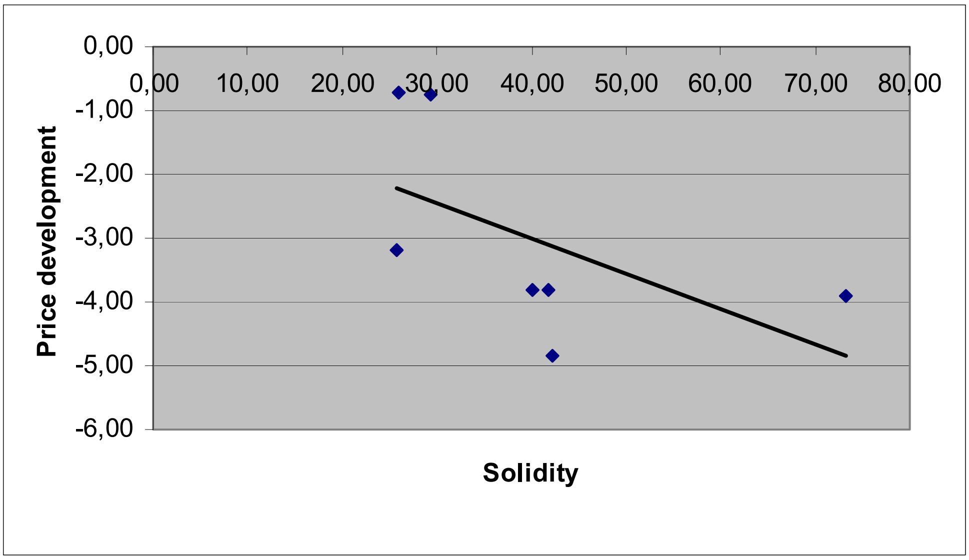
Diagram 5.2 Plotting the Price development with regards to Liquidity (Mean Average, 1999-2002)



As the trend line illustrates, there seem to be a relationship between liquidity and price development where a higher liquidity gives a higher price reduction.

In diagram 5.3 the relationship between price development and solidity is illustrated.

Diagram 5.3 Plotting the Price development with regards to Solidity (Mean Average, 1999-2002)



As the trend line illustrates, there seem to be a relationship between solidity and price development where a higher solidity gives a higher price reduction.

In this table you can see the key figures of each classified technology group put together.

Table 5.3 Key Figures, Mean Average of the selection of suppliers divided among R&D intensity groups

Medium-Low Technology	Average 99 - 02
Price development	-3,85
Solidity	57,50
Liquidity	252,31
Profit margin	2,02

Medium-High Technology	Average 99 - 02
Price development	-3,14
Solidity	33,56
Liquidity	87,92
Profit margin	-0,26

High Technology	Average 99 - 02
Price development	-0,75
Solidity	29,30
Liquidity	98,18
Profit margin	-13,62

Table 5.3 shows the mean average of the price development, solidity, liquidity and the profit margin for the three different technology groups that the suppliers were classified into. We see that the medium-low and medium-high technology group are the ones with the most price reductions, highest profit margin and the best economical health. This is just the opposite of what we expected.

In this table you can see the key figures of group according to the VCC classification system put together.

Table 5.4 Key Figures, Mean Average of the selection of suppliers divided among VCC business areas

Exterior	**Average 99 - 02**
Price development	-1,95
Solidity	25,89
Liquidity	79,85
Profit margin	-0,74

Interior	**Average 99 - 02**
Price development	-3,83
Solidity	40,18
Liquidity	91,85
Profit margin	-4,88

Chassis and powertrain	**Average 99 - 02**
Price development	-4,18
Solidity	52,43
Liquidity	201,58
Profit margin	3,12

Electrical	**Average 99 - 02**
Price development	-0,75
Solidity	29,30
Liquidity	98,18
Profit margin	-13,62

Here you can see that Interior an chassis and power train shows the highest price reductions, and Electrical and exterior the lowest. This is the opposite of the relationship that VCC normally experiences.

6 ANALYSIS

The analysis chapter contains an analysis of the developed model. The two dimensions that are a part of the model will be analysed and evaluated. We will in addition to this discuss the advantages and disadvantages of the model and improvements that can be done.

6.1 ANALYSIS OF THE MODEL

The model has the purpose of illustrating the different environments that a supplier can be situated in and thereby explain why VCC experience diversities in the price developments. It is also presented as a tool for further more extensive or specific investigations. This investigation has been carried out to present a way of quantifying the prerequisites that a supplier has for productivity growth. The model is applicable to manufacturing companies, within any line of business and in most countries in Europe, the United States of America and the developed countries of Asia. The model is a general view of the prerequisites and not specifically constructed to suit VCC situation.

More specific classifications of the company's R&D intensity can be made. The R&D intensity can be measured for each individual company and constitute the basis for the technology classification. By doing this another problem evolves. The indirect R&D investments made by suppliers further down the value chain are difficult to measure and require that the complete value chain be represented. Although OECD came up with the conclusion that taking indirect investments into consideration did not alter the sector classification into different technology groups, the indirect investments will be of greater value when focusing on a specific company e.g. value chain. It is also important to focus on the main activities of the value chain when classifying the suppliers. In addition to this R&D intensity levels differs in the same industry sector depending on which country that the sector is situated in.

There is not any doubt that the R&D intensity measure is related to the productivity and productivity growth. Several independent investigations have shown that R&D investments both primarily are done for product and process development and that the R&D intensity is related to the productivity growth.

As a dimension in our model the R&D intensity must be considered to have a high validity.

If the dimension of Value Added is related to R&D intensity, then we will find groups of suppliers situated in environments on a line. The problem is that we cannot estimate the looks of this line. This is the true relationship between the R&D intensity and Value Added. It can look like in the figure 6.1. This s-curve has some validity. Connected to the product life cycle (see figure 6.1 and follow the line backwards from right to left) with initial product development (Value Added stays very much the same) and then, as the technology matures, more manufacturing oriented R&D investments (Value Added decreases) to finally level out.

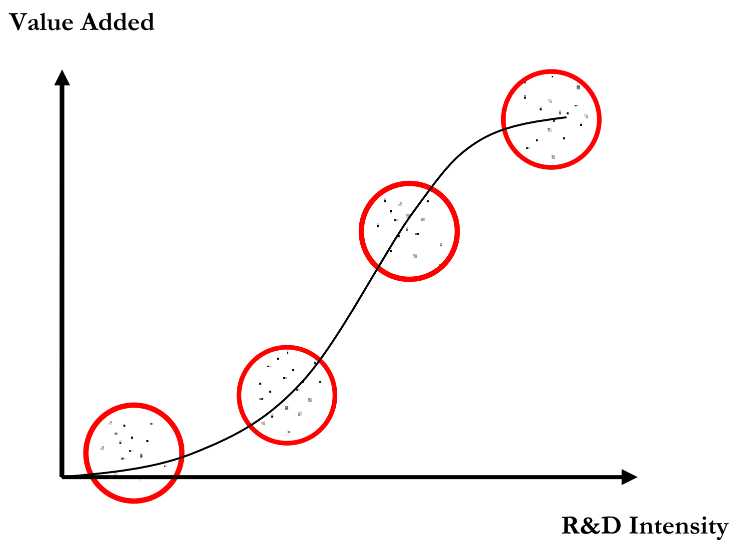


Figure 6.1 Value Added – R&D intensity relationship

If the indications that we have found regarding the dimension of Value Added are found to be true, then the model can be reduced to one dimension successfully.

But since we have not found any stronger relationships between Value Added and technological progress we let the model consist of two dimensions with the remark that the dimension of Value Added is related to the dimension of R&D intensity to some extent.

EVALUATION OF THE MODEL

Based on the hypotheses presented in the beginning of the report we have found some relationship between hypotheses (2) and (3). In figure 6.2 below, hypotheses (2) and (3) constitutes the prerequisites for hypothesis (1) and the relationship between these two sub-hypotheses is the marked area. It is not certain that the two prerequisites are the only factors for increased productivity, hence is hypothesis (1) represented by a greater area.

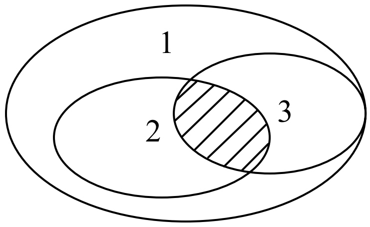


Figure 6.2 Illustration of the Hypotheses validity

This is an illustration of the evaluation of the Model. The Model does not take all factors into account that affect a company's productivity potential. The two dimensions that we have investigated seem to have a relationship to each other, which makes them not perfectly suitable to represent the dimensions in the model.

IMPROVEMENTS

As the model is illustrated today more work needs to be done to be able to fully use it for a classification of suppliers. The validity of the classification needs to be improved as well as the definition of especially the dimension of Value Added.

A more specific and definable dimension would have been to classify the products that the suppliers manufacture in different R&D intense groups according to the product approach developed by the OECD. But since only high technology products yet have been classified this was not feasible.

The relationship between Value Added and R&D needs to be further investigated for extended usage of the model.

6.2 ANALYSIS OF THE KEY FIGURES

First of all we need to clarify that the selection of suppliers is much to small to be able to draw any valid conclusions. Further notation is that the selection of suppliers is not representational for the four different business areas that VCC has divided their suppliers into.

When the suppliers have been classified according to the model we see that the medium-low technology group both has the greatest price reduction and the best economical health. The high technology group is the group that shows the worst results.

Worth to bring up is that the suppliers with the best economical health and/or highest profit margins are the ones that reduce their prices the most. (See diagram 5.1-5.3). Important to remember though is that this is only a trend among these seven suppliers and that the validity of this statement is very low.

The key figures did not show any similarities with the theories or the assumptions that we made regarding the new classification, productivity improvement potential and price development. According to the theories the validity of the model ought to be high, so with no further investigation we will have to imply that this low correlation between the theories and the key figures is due to the very small selection of suppliers.

7 CONCLUSIONS

This chapter aims to summarize the conclusions that we have drawn from this investigation. The validity in these conclusions will be discussed. Conclusions from the Theories that relates to the two dimensions aswell as the Value chain, the Model and the Key Figures are presented.

7.1 VALUE CHAIN

If VCC want prices to decrease continuously it is important to make sure that the whole supply chain is effective and constantly improving. Often the first tier supplier alone is not capable to meet VCC's demands. Some of VCC's demands are passed down the supply chain via the suppliers demands on decreased prices. This is why the supply chains total potential is more relevant than only the first tier supplier.

When evaluating the productivity improvement potential of a supplier, you get a more realistic evaluation if you include the whole value chain as mentioned earlier. This evaluation is very useful since a realistic price demand can be estimated and every supply chain can be utilized optimally. When putting the right amount of pressure on the supply chains, depending on their different potentials, sub optimizing can be avoided and the overall price development can be optimized.

7.2 THE MODEL

The conclusions that we have drawn from the model originates from the conclusions from the two dimensions that support the model. These conclusions are first presented.

7.2.1 THE DIMENSION OF R&D

We have found a way to quantify and to measure the technological progress in the classification made by OECD. Combined with the already existing classification of suppliers into the industry sectors the suppliers will be classified according to their R&D intensity. Where a high R&D intensity group implies that the supplier has a low technological maturity. This way to classify the suppliers into different technology intense groups has a high validity. Although the classification is at a rather high level it gives a good apprehension of their productivity improvement potential.

The dimension of R&D has a high validity and the relationship to productivity growth is strong. Large R&D investments are found to be made by companies situated in a less technologically matured industry sector. In a line of business that is less technologically matured there is a higher yield on R&D investments, hence more is invested in R&D. These companies have stronger prerequisites for productivity growth and thereby should be able to reduce their prices more than the ones situated in a more technologically matured line of business.

7.2.2 THE DIMENSION OF VALUE ADDED

This dimension is more theoretical than the dimension of R&D. There is a connection between them, but the strength of this relationship is not determined. We found some correlation between the technological maturity of the supplier and the amount of Value Added in the products that are manufactured. This conclusion is mainly based on theories and indications that we have gathered from the questionnaires.

The amount of Value Added per product that is manufactured can be measured, but time and resources made it impossible to do in this investigation.

7.2.3 THE MODEL

The model represents a way to classify the suppliers according to their potential for productivity growth. This classification of suppliers according to their prerequisites for productivity improvement should be seen as an explanation that renders some understanding of the varying potential for productivity growth that the suppliers have. The model also serves the purpose of a basis for extended research as the dimensions can be better evaluated and the suppliers more specifically measured.

Since we cannot determine the relationship between Value Added and technological maturity the model still consists of two dimensions.

We have not found any evidence that the model should have high validity from the key figures. On the contrary the key figures show the exact opposite relationship than the theories stated. Medium-Low and Medium-High Technology groups show most price reduction, whereas the High Technology group shows the least price reduction. The reason for this we find to be the small selection of suppliers and can therefore not make any statements regarding the validity of the model from these empirical findings.

7.3 CONCLUSIONS FROM THE KEY FIGURES

Due to the small selection of suppliers that are a part of the investigation we have not been able to draw any valid conclusions.

Key figures are also produced to satisfy the government and the stock holders and are not reliable when investigating the productivity development and productivity development potential af a company.

One indication that is worth mentioning is that the suppliers that show good economical health also are the ones that reduce their prices the most. As seen in the empirical findings, suppliers with high solidity, liquidity and profit margins are able to reduce their prices the most.

8 DISCUSSION

A brief discussion of the supplier's situation and what this might lead to and some of the indications that we have found among the seven suppliers that were a part of the study. We will further present some suggestions for extended research.

8.1 DISCUSSION

The high demands that VCC has on their suppliers might force them to adopt short-term solutions to decrease their price. One result of this can be that the suppliers do not have the means for R&D investment and thereby fails to exploit their prerequisites for productivity growth. This will in the long run result in less price reductions for VCC as the margins constantly decrease for the suppliers.

The different price development that VCC has experienced in the four different business areas during a period of time may have resulted in a mind set both with the suppliers and the purchasers. This mindset is dependant on prior price development and VCC business classification. By classifying the suppliers according to the prerequisites and potential for productivity growth VCC can avoid this mindset.

If VCC can have high demands on the suppliers that are expected to show high productivity growth and lower demands on the suppliers with less potential the company can achieve overall effectiveness and assure a more stable economic development for their suppliers. This is a way to uphold their long-term supplier relationships and to reassure future price reductions.

8.2 SUGGESTIONS FOR EXTENDED RESEARCH

There is a need to investigate the relationship of poor economical situation, the amount of R&D investments and the impact this has on productivity growth. Especially in the high technology sectors it is important that the suppliers invest in R&D to be able to exploit the possibilities of high yield on these investments.

Our investigation has been rather theoretical and we have mainly based the validity for our hypotheses on already developed theories and other investigations. It would be of great interest to make a more extensive investigation where several of the suppliers to VCC could participate.

As mentioned in the prior chapter the relationship between Value Added and technological progress e.g. R&D intensity is not clear. According to us there is a relationship or connection and this connection can be looked upon and investigated more thoroughly.

Another approach for the R&D intensity dimension is to change it to the product approach classification. When this thesis was conducted only the high technology products had been classified by Hatzichronoglou. It is not said when or even that further product classifications will be conducted. If this should come one suggestion is to use this classification for the R&D intensity dimension. This would more specifically classify the suppliers at a lower level and might increase the validity of the model.

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APPENDICES

In the first two appendices both the OECD technology classification based on ISIC rev. 2 and the updated version based on ISIC rev. 3 are presented along with a correspondence table of the two ISIC revisions. Appendix III and IV contains the questionnaire that was sent out to the suppliers and the interview sheet that was used during our preliminary interviews.

APPENDIX I

High-technology	CITI Revision 2
1. Aerospace	3845
2. Computers, office machinery	3825
3. Electronics-communications	3832
4. Pharmaceuticals	3522
Medium-high-technology	
5. Scientific instruments	385
6. Motor vehicles	3843
7. Electrical machinery	383-3832
8. Chemicals	351+352+3522
9. Other transport equipment	3842+3844+3849
10.Non-electrical machinery	382-3825
Medium-low-technology	
11. Rubber and plastic products	355+356
12. Shipbuilding	3841
13. Other manufacturing	39
14. Non-ferrous metals	372
15. Non-metallic mineral products	36
16. Fabricated metal products	381
17. Petroleum refining	351+354
18. Ferrous metals	371
Low-technology	
19. Paper printing	34
20. Textilee and clothing	32
21. Food, beverages, and tobacco	31
22. Wood and furniture	33

Table I.1 Manufacturing industries classified according their global technological intensity (ISIC Revision 2). (Hatzichronoglou, 1997, p 6)

APPENDIX II

The following notes appear in the edition 2003 of the OECD Science, Technology and Industry Scoreboard.

Technological effort is a critical determinant of productivity growth and international competitiveness. However, since it is not spread evenly across the economy, analyses of industry performance and structural change attach much importance to technological criteria. Methodological work carried out at the OECD is used to determine these criteria.

In the past, a technology classification based on ISIC Rev. 2 industry classifications was widely used. The methodology uses three indicators of technology intensity reflecting, to different degrees, "technology-producer" and "technology-user" aspects: *i)* R&D expenditures divided by Value Added; *ii)* R&D expenditures divided by production; and *iii)* R&D expenditures plus technology embodied in intermediate and investment goods divided by production. These indicators were evaluated for 1990 and for the aggregate of the ten OECD countries for which a measure of embodied technology was available, using 1990 USD purchasing power parities (see T. Hatzichronoglou, "Revision of the High-Technology Sector and Product Classification", *STI Working Paper* 1997/2). Following the adoption of ISIC Rev. 3 (NACE Rev. 1 in Europe) for collecting and presenting data on industrial activity both in national accounts (in the context of SNA93/ESA95) and industrial surveys, the 2001 Scoreboard used ISIC Rev. 3 R&D expenditure and output data to develop an updated technology classification based on an evaluation of R&D intensities for 13 OECD countries for the period 1991-97. In the absence of updated ISIC Rev. 3 input-output tables (required for estimating embodied technology), only the first two indicators could be calculated. This edition extends the analysis to cover the period 1991-99, although for only 12 OECD countries. The division of manufacturing industries into high-technology, medium-high-technology, medium-low-technology and low-technology groups was made after ranking the industries according to their average over 1991- 99 against aggregate OECD R&D intensities. Industries classified to higher categories have a higher average intensity for both indicators than industries in lower categories. Also considered were: *i)* temporal stability: for adjacent years, industries classified to higher categories have a higher average intensity than those in lower categories and *ii)* country median stability: industries classified to the higher categories have a higher median intensity than those in lower categories.

Points to note:

- This classification confirms that of the 2001 *Scoreboard* and also confirms the classification of "Medical, precision and optical instruments" (ISIC Rev. 3, Division 33) as a high-technology industry. This sector's R&D intensity continues to rise, and its inclusion complements the definition of the ICT sector (see *Measuring the Information Economy*, OECD, 2002) which includes some of its sub-divisions (notably 3312 and 3313).

- The cut-off points are clear except possibly the distinction between the medium-low- and low-technology groups.

- The low-technology group consists of relatively aggregate sectors, owing to limited detailed R&D expenditure data across countries. The few cases in which R&D intensities are available for more detailed (2-digit) breakdowns confirm the allocation of these industries to low technology.

- The classification concerns the OECD area as a whole. For individual countries, allocation to the technology groups may differ. Also, at national level, finer technology classifications may be generated from more detailed underlying data.

Annex 1.1. **Classification of manufacturing industries based on technology**[1]

	ISIC Rev. 3	1999				1991			
		R&D divided by production		R&D divided by value added		R&D divided by production		R&D divided by value added	
		Aggregate intensity[2]	Median intensity	Aggregate intensity[2]	Median intensity	Aggregate intensity[2]	Median intensity	Aggregate intensity[2]	Median intensity
High-technology industries									
Aircraft and spacecraft	353	10.3	10.4	29.1	27.5	13.9	12.9	34.7	32.1
Pharmaceuticals	2423	10.5	10.1	22.3	25.8	9.4	8.7	20.6	19.7
Office, accounting and computing machinery	30	7.2	4.6	25.8	15.1	10.9	6.4	29.4	15.2
Radio, TV and communciations equipment	32	7.4	7.6	17.9	22.4	7.9	8.2	17.0	21.5
Medical, precision and optical instruments	33	9.7	5.6	24.6	11.9	6.6	6.1	15.6	12.5
Medium-high-technology industries									
Electrical machinery and apparatus, n.e.c.	31	3.6	2.3	9.1	6.7	4.2	2.6	9.3	5.9
Motor vehicles, trailers and semi-trailers	34	3.5	2.8	13.3	11.7	3.7	3.0	14.3	11.9
Chemicals excluding pharmaceuticals	24 excl. 2423	2.9	2.2	8.3	7.1	3.4	2.8	9.8	8.0
Railroad equipment and transport equipment, n.e.c.	352 + 359	3.1	2.8	8.7	7.9	2.9	2.1	7.6	5.4
Machinery and equipment, n.e.c.	29	2.2	2.1	5.8	5.3	1.9	2.0	4.6	4.7
Medium-low-technology industries									
Building and repairing of ships and boats	351	1.0	1.0	3.1	2.9	0.9	0.9	2.8	2.6
Rubber and plastics products	25	1.0	1.1	2.7	3.0	1.0	0.6	2.6	1.5
Coke, refined petroleum products and nuclear fuel	23	0.4	0.3	1.9	2.7	1.2	0.7	5.4	3.8
Other non-metallic mineral products	26	0.8	0.6	1.9	1.3	1.0	0.6	2.4	1.5
Basic metals and fabricated metal products	27-28	0.6	0.5	1.6	1.4	0.7	0.6	2.0	1.6
Low-technology industries									
Manufacturing, n.e.c.; Recycling	36-37	0.5	0.5	1.3	1.2	0.5	0.4	1.2	0.9
Wood, pulp, paper, paper products, printing and publishing	20-22	0.4	0.1	1.0	0.3	0.3	0.1	0.8	0.3
Food products, beverages and tobacco	15-16	0.3	0.3	1.1	1.0	0.3	0.3	1.1	1.1
Textiles, textile products, leather and footwear	17-19	0.3	0.4	0.8	1.0	0.2	0.3	0.7	0.7
Total manufacturing	15-37	2.6	2.2	7.2	6.5	2.5	2.0	7.0	5.7

1. Based on data for 12 OECD countries: United States, Canada, Japan, Denmark, Finland, France, Germany, Ireland, Italy, Spain, Sweden, United Kingdom

2. Aggregate R&D intensities calculated after converting countries' R&D expenditures, value added and production using GDP PPPs

Source: OECD: ANBERD and STAN databases, May 2003

Table II.1 (left) Classification of manufacturing industries based on technology (*OECD Science, Technology and Industry: Scoreboard 2003*, annex 1 p 156)

ISIC, Rev.2	Description	ISIC, Rev.3	Description
3	Total manufacturing	15...37	Total manufacturing
31	Food, beverages and tobacco	15+16	Food, beverages and tobacco
32	Textiles, apparel and leather	17...19	Textiles, textile products, leather and footwear
33	Wood products and furniture	20	Wood and products of wood and cork **(excluding furniture)**
		361	Furniture
34	Paper, paper products and printing	21+22	Pulp, paper, paper products, printing and publishing
35	Chemical products	23...25	Chemical, rubber, plastics and fuel products
351+352-3522	Chemicals excluding drugs	24-2423	Chemicals excluding pharmaceuticals
3522	Drugs and medicines	2423	Pharmaceuticals
353+354	Petroleum refineries and products	23	Coke, refined petroleum products and nuclear fuel
355+356	Rubber and plastic products	25	Rubber and plastics products
36	Non-metallic mineral products	26	Other non-metallic mineral products
37	Basic metal industries	27	Basic metals
371	Iron and steel	271+2731	Basic metals, ferrous
372	Non-ferrous metals	272+2732	Basic metals, non-ferrous
38	Fabricated metal products		**Sum**
381	Metal products	28	Fabricated metal products
382-3825-(part 3829)	Non-electrical machinery	29	Machinery and equipment, nec
3825	Office and computing machinery	30	Office, accounting and computing mach.
383-3832	Electrical machinery excluding radio, TV and communication equipment	31	Electrical machinery and apparatus, n.e.c.
3832	Radio, TV and communication equip.	32	Radio, television and communication equipment
3841	Shipbuilding and repairing	351	Building and repairing of ships and boats
3843	Motor vehicles	34	Motor Vehicles
3845 (+ part 3829)	Aircraft	353	Aircraft and spacecraft
3842+3844+3849	Other transport equipment	352+359	Railroad equipment and transport equipment n.e.c.
385	Professional goods	33	Medical, precision and optical instruments, watches and clocks
39	Other manufacturing, nec	369	Manufacturing n.e.c.
1	Agriculture	01...05	Agriculture
2	Mining	10...14	Mining and quarrying
4+5+6+7+8+9	Total services	50...99	Service sector **(plus 40, 41 and 45)**
4	Electricity, gas and water	40+41	Electricity, gas and water supply
5	Construction	45	Construction
71	Transport and storage	60...63	Transport and storage
72	Communications	64	Post and telecommunications
8324	Commercial and engineering services		**Not compatible**
6+8-8324+9	Other services		**Not compatible**
	TOTAL BUSINESS ENTERPRISE		TOTAL BUSINESS ENTERPRISE

Table II.2 (above) Approximate correspondence between ISIC rev. 2 and ISIC rev. 3 (OECD, *Research and Development Expenditure in Industry 1987-2001*, 2003, p 14))

APPENDIX III

THE QUESTIONNAIRE (SWEDISH VERSION)

Vi undersöker de förutsättningar som leverantörer till stora tillverkningsföretag har för att kunna tillgodose deras prissänkningskrav. Då det i dagsläget är flera leverantörer som har en besvärlig situation speciellt inom bilindustrin, har vi valt att fokusera på leverantörer till Volvo personvagnar. Även Volvo ställer upp med information som vi får ta del av.

1. Övergripande information

Företag som du representerar.

Huvudsakliga produkter som ni producerar.

Vilka produkter levererar ni främst till Volvo.

Andel av total produktion som levereras till Volvo.

2. Branschspecifika frågor

Hur upplever du teknikutvecklingen i branschen som ni befinner er i?

- ☐ Stora förändringar, snabba teknikskiftningar, korta produktlivslängder
- ☐ Kontinuerliga teknikförändringar, inga överraskande teknikskift, längre produktlivslängder
- ☐ Långsam teknikutveckling, långa produktlivslängder
- ☐ Trög teknikutveckling med tendenser till stagnation

Hur upplevs Volvos prissänkningskrav med tanke på den övriga prisutvecklingen inom branschen?

3. Företagsspecifika frågor

Hur klarar ni som företag att tillmötesgå de krav som Volvo har på prissänkningar varje år?

Är det rimliga krav utifrån era förutsättningar?

Hur arbetar ni på företagsnivå med att klara av prissänkningskraven?

- ☐ Produktutveckling
- ☐ Processutveckling
- ☐ Pressar priser från underleverantörer
- ☐ Logistikförbättringar
- ☐ Större orderingångar, ökad produktion
- ☐ Annat
  Nämligen:

4. Produktspecifika frågor

Definition av råmaterial: Material som inte har genomgått någon förädling eller mycket liten andel förädling t.ex. stål, koppar, kisel och kol.

Hur stor andel av era produkters totala värde utgörs uppskattningsvis av råmaterial?
Ex. I en dator utgör värdet av råmaterial som t.ex. plast, koppar, kisel mm, en väldigt liten andel av produktens totala värde.

Hur ser prissammansättningen ut för den huvudsakliga produkt som ni levererar till Volvo med avseende på följande beståndsdelar?

– Materialkostnader	%
– Tillverkningskostnader	%
– Forskning och Utveckling	%
– Marknadsförings-och Transportkostnader	%
Totalt	100 %

Hur arbetar ni på produktnivå med att sänka priserna på de produkter som ni levererar till Volvo med hänsyn till de beståndsdelar som angavs i föregående fråga?

Tack så mycket för Er medverkan

APPENDIX IV

THE QUESTIONNAIRE (ENGLISH VERSION)

We are conducting a study where we investigate the prerequisites that suppliers to large manufacturing companies have to be able to meet the demands for decreasing prices. We have chosen to focus on the automotive industry and suppliers to Volvo Car Corporation.

1. General information

Company that you represent.

Main products that you manufacture.

Products that you mainly deliver to VCC.

Part of Total production that you deliver to VCC (in %).

2. Questions specific to your line of business

How do you experience the technological development within your line of business?

- ☐ Rapid changes, swift technological changes, short product life cycles
- ☐ Continuously improvements, no unexpected technological changes, longer product life cycles
- ☐ Slow development, long product life cycles
- ☐ Slow development with tendencies to stagnation

How is VCC´s demand for decreased prices experienced, if you take the concurrent price development within the line of business into consideration?

3. Company specific questions

How do you manage to meet VCC´s demand for decreased prices?

Are the demands reasonable if taking your prerequisites into consideration?

How do you work on company level to manage the demands on decreased prices?

- ☐ Product development
- ☐ Process development
- ☐ Higher demands on your suppliers
- ☐ Improvements of logistics
- ☐ More order intake, increased production.
- ☐ Other:

4. Product specific questions

Definition of raw material: Material that has not been refined or refined to a very little degree, for example steel, copper, and coal

How big is the part of your products total value that consists of raw material?

How is the price composed for your main products that are delivered to VCC referring to the following components?

– Costs of materials	%
– Manufacturing costs	%
– Research and Development	%
– Marketing and Transports	%
Total	100 %

How do you work on product level to lower the prices on the products that you deliver to VCC, if taking the elements in the prior question into consideration?

Thanks for your cooperation!

APPENDIX V

INTERVIEW PROTOCOL FOR INTERVIEWS WITH COMMODITY BUYERS ON VCC

Vårt mål med denna intervju är att bilda oss en uppfattning om Volvos relation med respektive leverantör, samt att få grundläggande information om leverantören och om hur Volvo uppfattar leverantörens situation.

- Hur ser köpprocessen/upphandlingsförfarandet ut?
- Hur har Volvo klassificerat leverantören? (Vi har hört talas om en s.k. Volvomatris)?
- Vad har Volvo för krav på leverantören när det gäller prissänkningar och produktivitetsökningar?
- Lyckas leverantören uppnå dessa krav (ovanstående fråga)?
- Vem står för R&D och hur utvecklas nya produkter?
- På vilken teknikmognadsnivå befinner sig leverantören?
- Har leverantören möjlighet att planera sin produktion, dvs. vet leverantören långt i förväg hur Volvos order kommer att se ut?
- Vilka faktorer ligger bakom rådande prisläge och framtida prisförändringar?
- Anser du att det finns utrymme för leverantörerna att sänka sina priser?
- Hur arbetar leverantören med att möjliggöra framtida prissänkningar?

Både jag, Joakim Herlin och Fredrik Gummesson har ingått sekretessavtal med Volvo personvagnar. Det är emellertid viktigt att vi får veta vilka specifika uppgifter som är sekretessbelagda. Detta för att vi ska kunna leverera en offentlig version av vårt examensarbete. Arbetet kommer att granskas av Anders Nyström innan det offentliggörs, för att säkerställa att inga känsliga uppgifter sprids.