MASTER

Buyer initiated non-recourse factoring of confirmed payables
a major global corporation case study

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Buyer initiated non-recourse factoring of confirmed payables: A major global corporation case study

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in partial fulfilment of the requirements for the degree of

Master of Science
in Operations Management and Logistics

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Series Master Theses Operations Management and Logistics

Subject headings: Finance, Supply Chain, Reverse Factoring
Preface

This thesis report is the result of the graduation project as a final part of the MSc. program Operations Management & Logistics at the faculty Industrial Engineering and Innovation Sciences at Eindhoven University of Technology. This experience took place at the global pharmaceutical company and substantially contributed to my experience and knowledge. Therefore I would like to express my sincere gratitude to the people that enabled and supported this project.

I am distinctly grateful to Matthew Reindorp, my first supervisor, for continuous inspiration and guidance during all phases of the project. Furthermore I would like to thank Marco Comuzzi for providing feedback during later phases of the project. Additionally I would like to thank the company supervisors at the GSCM and procurement departments of the GPC for their support and guidance within the scientific company. I would like to thank all five once again for their patience and providing the freedom to choose the setup and execution method of the research.

Additionally I would like to thank the procurement colleagues who shared an office with me, for answering more questions than I ever asked during any single project in the past and for enabling a pleasant stay. Also I would like to thank the secretaries of the procurement president and GSCM president for their organizing support.

Furthermore I would like to thank all employees I communicated with, that provided information or made my stay possible and pleasant. This holds specifically for the GPC procurement president, the API sourcing president and the GSCM SI policy coordinator.

Last but not least I would like to thank my fellow students, friends and family who supported me during my graduation and during my time as student at the university.

Erik Alferink

Eindhoven, 2010
Summary

Traditionally operations management (OM) and corporate finance are distinct research disciplines and professions focusing on a single corporation. Gradually supply chain management and later the interaction between OM and finance gained attention. Supply chain management addresses the interaction within the OM discipline between multiple links in the supply chain. Interaction between OM and financial aspects takes place when OM decisions change the working capital requirement, implying change in decision making regarding liabilities and their structure. The three elements of working capital addressed in this thesis are receivables, payables and inventory. The elements are combined with sales or purchases to three ratio’s and referred to as the cash conversion cycle. The cash conversion cycle expresses the time between disbursement and receipt of cash. The longer the cash conversion cycle the more external funding required and the higher the cost of capital expense.

This research focuses primarily on a tool called reverse factoring. Reverse factoring (RF) enables receivables term decrease for a supplier and simultaneous payment term increase for the buyer. RF is one instrument used by many banks and corporations within a range of supply chain finance (SCF) instruments. Using SCF, the financing rate to a company is based on creditworthiness information of another company. Pfohl and Gomm (2009) are among the first to quantitatively model SCF. They do however not specifically address the tradeoffs required for adequate decision making in RF. RF is offered to a supplier by a financial institution and a buyer. The supplier can discount receivables from a RF offering buyer earlier against a rate that reflects the buyer creditworthiness. The buyer can in turn extend the payment term, partly reducing the advantage for the supplier.

RF is quantitatively modeled in this research using calculation methods of three major banks that are applied to hundreds of thousands companies. Additionally a model for a price decrease instead of a payment term extension is developed. A sample from one buyer and 21 RF supplier cases in Europe is used as a basis to test sensitivity of the savings to varying input parameters, yielding the following results:

- The longer the initial payment terms and higher the purchase volumes the higher the savings potential
- If the supplier cost of capital increase or the buyer cost of capital decrease then the supplier saves more and the buyer saves less and vice versa
- A price decrease yields more savings to the buyer if the buyer values the freed cash with a lower rate than the SCF rate
- The interbank financing rate (EURIBOR) is currently at a low level and is expected to increase up to a factor four in 2013. In case of a term extension the buyer savings increase and the supplier savings decrease as a result. In case of a price decrease savings remain relatively stable.
- The longer the buyer takes to confirm an invoice the lower the savings for the supplier
- The savings rate that a company can allocate to freed cash depends on his specific financing alternatives. Neither researchers nor practitioners agree on the rate to allocate to increases or decreases in elements of working capital.

Within the same corporate holding a supplier integration strategy is prescribed. A form of supplier integration that shifts inventory from a buyers account to a suppliers account, while enabling optimized production, transportation and capacity planning for the supplier is called supplier managed consignment stock (SMCS). Increased cooperation additionally enables long
term benefits such increased service levels and sales increases. With SMCS the supplier creates the purchase orders based on the demand information exchanged by the customer and the stock of goods at a buyer is still the property of the supplier. Payment for these goods is made to the supplier at the moment when they are used/withdrawn by the buyer. Some suppliers, however, recognize only few planning and scheduling advantages and require compensation. A supplier can be compensated by a decreased payment term and/or an increased price. RF might also an alternative mean to compensate the supplier. A sensitivity analysis on the stability of compensation yielded the following results:

- The higher the item value for which SMCS is applied, the higher the quantified financial losses for the supplier and the higher the gains for the buyer
- A normal payment term decrease is substantially more expensive than RF for the buyer and only slightly more beneficial for the supplier
- For the buyer RF is the lowest cost form of providing compensation.
- RF can yield more compensation to the supplier than a price increase if demand variability is low and or supplier cost of capital are high
- The higher the required price increase and the shorter initial payment term the less able will RF be to compensate the supplier sufficiently
- With SMCS the buyer can create the invoices, implying a short confirmation time and more compensation.

RF as well as SMCS decrease the required WoC in the supply chain and provides increased visibility and flexibility in controlling inflow and outflow of cash and goods.

RF is a form of SCF with the only feature being the ability to discount receivables before maturity. Multi bank platforms with additional features including pre-order financing and inventory financing do yield higher savings and are expected to be increasingly adapted over a range of companies instead of for one buyer and its suppliers.
# Table of contents

Preface .......................................................................................................................... 3  
List of figures .................................................................................................................. 8  
List of abbreviations ....................................................................................................... 9  
List of variables .............................................................................................................. 10  
Introduction .................................................................................................................. 11  
Relevance ....................................................................................................................... 12  
1. Research design .......................................................................................................... 14  
   1.1 Research setting ....................................................................................................... 14  
   1.2 Research questions and objective ......................................................................... 15  
   1.3 Scope ....................................................................................................................... 16  
   1.4 Research method .................................................................................................. 16  
   1.5 Validation ............................................................................................................. 19  
2. Working capital management ....................................................................................... 21  
   2.1 Interrelated operations and finance decision making ........................................... 21  
   2.2 Working capital on balance sheets ....................................................................... 22  
   2.3 Cash Conversion Cycle ......................................................................................... 23  
   2.4 The cost of capital ................................................................................................. 24  
   2.5 Analysis of the scientific company working capital related strategy ................. 25  
   2.6 Decreasing the cost of working capital ................................................................. 26  
3. Supply Chain Finance .................................................................................................. 31  
   3.1 Modeling reverse factoring ..................................................................................... 33  
   3.2 Validation ............................................................................................................... 37  
4. Supplier integration ....................................................................................................... 48  
   4.1 Supplier integration at the global pharmaceutical company .................................. 48  
   4.2 Literature verification of conceptual model ......................................................... 50  
   4.3 Scientific model ..................................................................................................... 51  
5. Integrating the models ................................................................................................ 56  
6. Sensitivity analysis ...................................................................................................... 57  
   6.1 RF sensitivity ......................................................................................................... 57  
   6.2 SMI with CS sensitivity ......................................................................................... 62  
7. Implementation ............................................................................................................ 69  
   7.1 Enabling SCF ......................................................................................................... 69  
   7.2 On boarding suppliers .......................................................................................... 70  
Conclusion ..................................................................................................................... 72  
Limitations & further research ....................................................................................... 74  
Bibliography ................................................................................................................... 75  
Index .............................................................................................................................. 80  
Appendix 1 – Researchers vs. practitioners ................................................................. 81  
Appendix 2 – The scientific company’ annual KPI’s .................................................... 82  
Appendix 3 – Scientific company standardized and condensed balance sheet 2008 and 2009 ..83  
Appendix 4 – selected companies involved in RF ..................................................... 85  
Appendix 5 – Interviewees ............................................................................................. 86  
Appendix 6 – SMI & Consignment impact ................................................................. 88  
Appendix 7 – SMI & Consignment impact revised .................................................... 89  
Appendix 8 – Scientific versus conceptual model .................................................... 90  
Appendix 9 – Savings calculation per agreement ..................................................... 91  
Appendix 10 – Credit ratings compared ..................................................................... 92  
Appendix 11 – 2 and 12 month euribor ................................................................. 93
| Appendix 12 – Desired SCF information and features | 94 |
| Appendix 13 – The trade finance glossary by McKinsey (2010) | 95 |
| Appendix 14 – SCF roles per department | 97 |
| Appendix 14 – Excel spreadsheet used | 98 |
List of figures

Figure 1 – Organization chart ........................................................................................................... 15
Figure 2 – Scope of the project ........................................................................................................ 16
Figure 3 - Initial research design model Mitroff et al. (1974) .......................................................... 17
Figure 4 – Adapted research design model .................................................................................... 18
Figure 5 – Standardized balance sheet items ................................................................................ 22
Figure 6 – Condensed balance sheet items ................................................................................... 22
Figure 7 – the scientific company WACC and debt rating ............................................................. 27
Figure 8 – Factoring .......................................................................................................................... 30
Figure 9 - Initial versus RF arrangement .......................................................................................... 35
Figure 10 – DPO and cash flow ....................................................................................................... 38
Figure 11 – timeline of freed cash (example) ................................................................................... 40
Figure 12 - Supplier integration research cycle ................................................................................ 48
Figure 13 – inventory ownership: consignment vs. non consignment ............................................ 51
Figure 14 – SMI variables ................................................................................................................ 52
Figure 16 – RF savings and price decrease ..................................................................................... 58
Figure 15 – RF savings and CCC length ........................................................................................ 58
Figure 17 – RF savings and payment term extension ....................................................................... 59
Figure 18 – RF savings from payment term extension vs. price decrease ....................................... 59
Figure 19 – RF savings and purchase value .................................................................................... 59
Figure 20 – RF savings and initial payment term ............................................................................ 59
Figure 21 – RF savings and the rate allocated to freed cash .............................................................. 60
Figure 22 – RF savings and supplier tax rate .................................................................................. 60
Figure 23 – RF savings and buyer tax rate ...................................................................................... 60
Figure 24 – Euribor history .............................................................................................................. 61
Figure 25 – Rf savings and Euribor .................................................................................................. 61
Figure 26 – RF savings and buyer cost of capital changes ............................................................... 62
Figure 27 –SMI & CS savings and demand levels (ss=300) .............................................................. 63
Figure 28: SMI & CS savings and demand levels (service level =0,95) ............................................. 63
Figure 29 – SMI & CS, supplier profit and demand ....................................................................... 64
Figure 30 –SMI & CS savings and supplier order cost ................................................................. 64
Figure 31: SMI & CS savings and supplier inventory handling cost .............................................. 64
Figure 32 –SMI & CS savings and buyer order cost ...................................................................... 65
Figure 33: SMI & CS savings and buyer inventory handling cost .................................................. 65
Figure 34 –SMI & CS savings and demand coefficient of variance (CV) ........................................ 65
Figure 35: SMI & CS savings and invoice confirmation and processing time .................................. 65
Figure 36 – SMI & CS savings and supplier margin ...................................................................... 66
Figure 37 – SMI & CS savings and euribor .................................................................................... 66
Figure 38 –SMI & CS savings and supplier WACC ...................................................................... 67
Figure 39: SMI & CS savings and buyer WACC .......................................................................... 67
Figure 40 –SMI & CS savings and initial purchase price ................................................................ 67
Figure 41- SMI & CS savings and initial payment term ................................................................. 67
Figure 42 –SMI & CS savings invoicing effects ............................................................................ 68
Figure 43- SMI & CS savings and compensation ......................................................................... 68
### List of abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>B2B</td>
<td>Business to business</td>
</tr>
<tr>
<td>BAG</td>
<td>The scientific company legal entity</td>
</tr>
<tr>
<td>C2C</td>
<td>Cash 2 Cash</td>
</tr>
<tr>
<td>CCC</td>
<td>Cash Conversion Cycle</td>
</tr>
<tr>
<td>CFO</td>
<td>Chief Financial Officer</td>
</tr>
<tr>
<td>COGS</td>
<td>Cost of Goods Sold</td>
</tr>
<tr>
<td>CV</td>
<td>Coefficient of variation</td>
</tr>
<tr>
<td>DIO</td>
<td>Days inventory outstanding</td>
</tr>
<tr>
<td>DPO</td>
<td>Days payables outstanding</td>
</tr>
<tr>
<td>DSO</td>
<td>Days sales outstanding</td>
</tr>
<tr>
<td>EBITDA</td>
<td>Earnings before interest, tax, depreciation and amortization</td>
</tr>
<tr>
<td>EURIBOR</td>
<td>Euro Interbank Offered Rate</td>
</tr>
<tr>
<td>GPC</td>
<td>Global pharmaceutical company</td>
</tr>
<tr>
<td>GSCM</td>
<td>Global Supply Chain Management</td>
</tr>
<tr>
<td>HTM</td>
<td>High tech material</td>
</tr>
<tr>
<td>IFRS</td>
<td>International Financial Reporting Standard</td>
</tr>
<tr>
<td>IT</td>
<td>Information Technology</td>
</tr>
<tr>
<td>JIT</td>
<td>Just in time</td>
</tr>
<tr>
<td>KPI</td>
<td>Key Performance Indicator</td>
</tr>
<tr>
<td>LIBOR</td>
<td>London Interbank Offered Rate</td>
</tr>
<tr>
<td>MM</td>
<td>Modigliani and Miller</td>
</tr>
<tr>
<td>MSc.</td>
<td>Master of Science</td>
</tr>
<tr>
<td>OBSF</td>
<td>Off Balance Sheet Finance</td>
</tr>
<tr>
<td>OEM</td>
<td>Original Equipment Manufacturer</td>
</tr>
<tr>
<td>OM</td>
<td>Operations Management</td>
</tr>
<tr>
<td>OR</td>
<td>Operations Research</td>
</tr>
<tr>
<td>OWC</td>
<td>Operating Working Capital</td>
</tr>
<tr>
<td>R&amp;D</td>
<td>Research and Development</td>
</tr>
<tr>
<td>RF</td>
<td>Supply Chain Finance</td>
</tr>
<tr>
<td>ROI</td>
<td>Return on investment</td>
</tr>
<tr>
<td>SCM</td>
<td>Supply Chain Management</td>
</tr>
<tr>
<td>SEC</td>
<td>Securities and Exchange Commission (US)</td>
</tr>
<tr>
<td>SI</td>
<td>Supplier integration</td>
</tr>
<tr>
<td>SKU</td>
<td>Stock keeping unit</td>
</tr>
<tr>
<td>SMCS</td>
<td>Supplier managed consignment stock</td>
</tr>
<tr>
<td>SME's</td>
<td>Small &amp; Medium sized enterprises</td>
</tr>
<tr>
<td>SMI</td>
<td>Supplier managed inventory</td>
</tr>
<tr>
<td>VAT</td>
<td>Value added tax</td>
</tr>
<tr>
<td>WACC</td>
<td>Weighted Average Cost of Capital</td>
</tr>
<tr>
<td>WoC</td>
<td>Working Capital</td>
</tr>
</tbody>
</table>
## List of variables

- \( f_{o}^{s} \): actual supplier financing rate, Percentage
- \( S_{i}^{j} \): net savings, Euro’s
- \( c_{i}^{j} \): order cost, Euro’s
- \( q_{i}^{j} \): order size, units
- \( k_{i}^{j} \): order size multiplication factor
- \( z_{i}^{j} \): the average inventory level, units
- \( G_{i}^{j} \): the inventory holding cost, Euro’s
- \( D \): Annual demand, units
- \( I \): Initial investment, Euro’s
- \( r_{e} \): Euribor rate, percentage
- \( r_{f} \): Bank margin, percentage
- \( t_{b} \): Invoice confirmation time, days
- \( t_{f} \): RF invoice processing time, days
- \( T_{i} \): represents the effective tax rate, percentage
- \( t_{i} \): Payment term, days
- \( u_{i} \): unit purchasing price, Euro’s
- \( V_{i} \): Annual purchase volume, Euro’s
- \( w_{i} \): weighted average cost of capital, percentage
- \( w_{i}^{j} \): WACC, percentage
- \( y_{i}^{j} \): inventory handling cost, percentage

### Index

- \( i \in \{ s, b \} \): upper case index, where
  - \( s \): supplier
  - \( b \): buyer

- \( j \in \{ \alpha, \beta, \theta, \mu \} \): lower case index, where
  - \( \alpha \): initial situation,
  - \( \beta \): SMI situation
  - \( \theta \): RF term extension
  - \( \mu \): RF price decrease
Introduction

Operations management and financial management are traditionally two different disciplines. This is characterized by distinct lines of education and research at universities and by distinct departments in organizations. Operation managers and researchers generally have at most brief knowledge about finance and accounting. Finance managers and researchers have generally at most brief knowledge about operations management\(^1\). Yet both disciplines interact and influence operational and financial performance of organizations together. Broadly defined, operations management deals with when and how much to produce or order and financial decision making deals with how much to borrow or how much to distribute to shareholders (Buzacott & Zhang, 2004).

Effective management of operations requires adequate financial resources. Operations management does in turn change the firm's level of risk and thereby the availability of resources (Singhal, Raturi and Bryant 1994; Sinhal 1988; Sinhal and Raturi 1990). Insufficient liquidity can be a great constraint, even if a firm is profitable from an accounting perspective. When faced with increased variability of demand and/or reduced access to (affordable) credit, lack of liquidity may force businesses to operate less efficiently, e.g. reduced service levels. This is likely to decrease buyer satisfaction and long term performance or even long term existence. Since in oligopoly markets the liquidity problem can snowball and lead to risk of bankruptcy. A firm's buyers and suppliers may seek to contain their risk and do business with a competitor instead. Suppliers might offset additional risks by imposing more restrictive contracts and/or higher costs, e.g. cash on delivery. Banks may further restrict credit availability and impose higher interest rates.

An additional driver of inefficient operations and finance management is the cost of capital used for operational decision making are in practice set at some level by decree and used without acknowledging the implications of operational decisions on finance and only changed if major changes relevant to the organization take place (Silver et al. (1998) pp. 45). This begs the question to reconsider if the optimal supply chain operations design and management is also a robust optimum in a financial supply chain design perspective and vice versa.

The forces external and internal to the company and scientific knowledge available develops continuously. Therefore the answer to the above consideration develops over time as well. When organizations aim for best in class performance, the knowledge about these developments needs to be incorporated in managerial decision making.

This research does focus on the interaction of two tools in the above mentioned context, i.e. consignment stock and reverse factoring. Using consignment stock a buyer saves interest payments, since the stock is legally owned by the supplier, but held by the buyer and only invoiced after use or sale. With reverse factoring (RF), early payment is provided by a bank or factoring company to a supplier against a rate based on the buyer's creditworthiness by selling confirmed invoices from supplier to factor. After the payment term the buyer pays the invoiced amount to the bank or factoring company. Reverse factoring is one option in a range of supply chain finance (SCF) solutions. The recent developments will be discussed in the next paragraph after which the research design is discussed in Chapter 1. Once the research design is discussed some important concepts are introduced in Chapter 2 as a knowledge foundation for SCF. Using this knowledge foundation the concept of RF is introduced in chapter 3 by a case

\(^1\) Highlighted at http://www.gtnews.com/feature/441_4.cfm
study after which RF it is formulated mathematically. Chapter 4 introduces supplier managed consignment stock (SMCS) conceptually and mathematically. Once the mathematical models of RF and SMCS are established they are integrated in chapter 5. The sensitivity of the RF model is analyzed in paragraph 6.1 and the sensitivity of the integrated RF & SMCS model is analyzed in paragraph 6.2. Using these outcomes, implementation recommendations are provided as well as a conclusion after which recommendations for further research are provided.

Relevance

This chapter discusses the relevance and importance of reverse factoring and consignment stock in today’s economic environment. The 2009 recession increasingly imposed constraints on the levers of working capital, i.e. payables, inventory and receivables. It became increasingly difficult to obtain credit from banks and prospects were negative. As a result aggressive targets for all working capital levers were introduced to maintain a healthy cash flow. Progressive cash collection policies were imposed on buyers and payment to suppliers was delayed. Regarding inventories, overreaction to these negative prospects is common and named the bullwhip effect by Forrester (1961). It is elaborated on and confirmed by Sterman (1989), Lee et al. (1997) and Croson and Donohue (2006). The bullwhip effect enforces the pressure down the supply chain on the inventory lever of working capital (Fransoo et al., 2009). The impact from credit constraints and the bullwhip effect are illustrated by the outcomes of a working capital survey (Katz, 2010) using data from 2009 of 1,000 of the largest U.S. headquartered public companies. The study analyses the working capital performance by elements of the cash conversion cycle (CCC). These elements will be discussed in more detail in paragraph 2.3. According to Katz (2010) survey the average CCC jumped 8.2% in 2009, marking the largest CCC deterioration in five years. More important than the CCC as a whole are the elements of the CCC. The changes in values of these elements illustrate the effects of the bullwhip effect in working capital figures and depict a chain reaction on payable and receivable terms. I.e. days sales outstanding (DSO) performance deteriorated by 10.4%, implying buyers pay later and the days payable outstanding (DPO) increased equally by 11.4%. Additionally days inventory outstanding (DIO) increased by 8.8%, implying an average lack of ability to sell products. This effect is severe at the beginning of the operational supply chain. The weighted average CCC of companies producing chemicals increased 14%, construction materials 19%, metals and mining 38% and oil 113%. Under the few industries showing a decreased CCC are many consumer products, e.g. food (-7%) and personal products (-15%).\(^2\) To diminish these effects three policies are discussed.

The first policy starts with a practical example followed by its solution, the second policy is consignment stock and the third policy is reverse factoring. The first policy is addresses DPO and DIO introduced using a chemical company case study. Once executive explained their success of applying different accounts-payable strategies for low- and high-volume suppliers. I.e. infrequent, low-volume vendors are paid with extended terms as new purchases are made and high volume, high frequency suppliers are offered increased volume for better payment terms. Additionally to better manage inventory, the company divided its various products into low- or high-volume sellers. Managers then made decisions about which products to stock and which to make to order based on recent and expected sales volumes. The companies CCC decreased by 24% at the moment of review, but are not likely to sustain when sales increase. At the moment of review the bullwhip effect was

\(^2\) U.S. headquartered public pharmaceutical companies face a weighted average CCC increase of 7%, including two outliers Merck & co (+150%) and Pfizer (+89%).
fully apparent and thus are inventory and expected sales volumes likely to be set at inadequate levels. If sales increase this implies increased financial performance, but the companies’ service level is likely to decline by a lack of available inventory, caused by the bullwhip effect. It is therefore likely to be unable to realize as much sales as it would when inventory was kept up to pre-crisis levels and unable to serve customers well. Keeping inventory at pre crisis levels is discussed and implemented as a remedy by Fransoo et al. (2009). This was only possible since “Royal DSM is a financially solid mother company” DSM management, 2009 in (Fransoo et al., 2009). While this might hold for some companies, many others would find it very expensive if possible at all to finance inventory that seems to be at abnormally high levels in times of crises. Mid 2010 the lack of access to financing and aggressive working capital targets are still apparent. This is highlighted by a survey among 400 U.S. SME’s of which 41% is unable to obtain adequate financing, which is more severe than in the past 17 years. SME’s generally need to obtain financing from banks or other risk averse financial institutions while large companies can go directly to the capital markets. Nevertheless out of 168 CFO’s in U.S. companies with revenues over $500 billion 81% stated in September 2010 that working capital reduction is a high priority. 73% of these 168 CFO’s stated supplier relationships are also a top priority. In a German and UK survey in 2009 among 1000 executives 88% of UK companies and 55% of German firms recognize that some of their key suppliers will not be able to sustain further lengthening of payment terms (Demica, 2009). As a solution companies might consider supplier managed consignment stock and reverse factoring.

Supplier managed consignment stock (SMCS) combines two stock points into one stock point - managed by the supplier - with less stock than the accumulation of the two separate stock points. This way it sustainably decreases the cost of capital in the supply chain in two ways. First of all, the total inventory buffer size decreases by replacing two stockpoints with demand uncertainty by one stockpoint with accurate demand forecast. Second, the supplier does not need to invest his own margin in inventory like the buyer does. This decreases inventory value from a buyer and supply chain perspective. The extent to which the increase of working capital at the supplier is a drawback is discussed in chapter 4. Anyway can the supplier be compensated for consignment stock by reverse factoring, which is discussed in paragraph 6.1.

Reverse factoring (RF) was already mentioned in the introduction. Following Kramer (2010) “reverse factoring allows suppliers to get paid whenever they choose. Suppliers can access low cost financing on demand over the web, thus eliminating the negative cash flow impact of a terms extension. Costs are reduced and cash flow improved throughout the supply chain rather than simply shifting the burden from buyer to supplier.” This cheaper source of financing offered by the buyer to the supplier might be used to compensate the supplier for SMCS.

These solutions are not only valuable in times of crisis, but also valuable in regular and healthy supply chains and even if cash flows are abundant. Freed cash can be used to fund business-development opportunities without having to rely on the capital markets or banks for funding (Jeff Edwards, 2010, CFO of Allergan in (Katz, 2010)). Grant Barber, CFO of Hughes Communications adds: “The more one can finance that from internally generated funds, the better ones business model will be going forward.” (Katz, 2010)

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4 http://www.primerevenue.com/about/pdfs/PrimeRevenue_Executive_Summary.pdf
1. **Research design**

On the timeline of this research, the reverse factoring option was first analyzed by a literature review. This review can be found in paragraph 3.1 and indicated that reverse factoring involves generally three kinds of organizations: (1) A financial institution (2) a payment receiving organization (3) a payment making organization. Given RF research is in exploratory stage a systematic in depth and focused research to RF is valuable. Given the MSc. thesis timeframe it is infeasible to choose multiple organizations as the research setting for in depth and focused research. In order to systematically investigate the dynamics of reverse in an operation planning accounting and control setting the latter two organizations are most suitable with regard to the topics studied in the MSc. program by the nature of these organizations. The initial literature review has also shown that generally multiple payment receiving organizations are involved in one reverse factoring program with one payment making organization. Therefore a multiple case analysis is more likely to be possible at an RF payment making organization.

1.1 **Research setting**

When considering a research setting the author acknowledges that management research is subject to considerable distinctions between researchers and managers. Following Shrivastava and Mitroff (1984) researchers and managers differ by the nature of the task in which each is involved brought forward by the kinds of institutions in which they practice (elaboration in Appendix 1). Ackoff (1979) even stated “the future of operations research (OR) is past”, expressing his frustration about the weak relationship of OR to real-life practice. Later, Shrivastava and Mitroff (1984) provided three criteria for scientific research that should yield sustainable results for science and practice. First, the extent to which the results capture the organization’s particular reality. Second, descriptive adequacy and third, politically and ideologically feasible recommendations. Bertrand & Fransoo (2002) are more OR specific on the first criteria, arguing that models should be studied which can be validated as real-life processes and also the results of the analysis should be tested in real life. These criteria are met naturally by the researchers physical presence in the organization while carrying out the research. This physical presence implies a motivation to relevance, creating a risk for a lack of focus on generic contribution. After the introduction of the research setting, questions and objective, the method section will discuss the procedure yielding generic contribution, balancing rigor and relevance. As stated before the three generic contribution criteria will naturally result from physical presence in an organization. Obviously a RF payment making organization supports the research to the largest extent as described in the previous paragraph.

One such RF payment making organization is a scientific oriented company with core activities in pharmaceuticals, nutrition and high-tech materials. It aims to create value through innovation, growth and high earning power in research intensive areas. In 2009 the company employed 108,400 people and had sales of €31.2 billion. Of which 46.5% in pharmaceuticals, 23.5% in nutrition and 26.6% high tech materials. An overall EBITDA margin before special items of 21% indicates a relatively high earning power indeed. Its capital expenditures amounted to €1.7 billion and R&D expenses to €2.7 billion.

The corporate holding defines common values, goals and strategies for the entire group. Hereby considerable attention is paid to reduce working capital. The subgroups operate independently and are led by the management of the holding company, as depicted in Figure 1. Departments ‘Supply Chain Management’ and ‘Procurement’ or equivalent are present in every subgroup.
The corporate center supports the group management board in its task of strategic leadership. Supportive departments such as ‘Finance’ and ‘Accounting and Control’ are positioned within the corporate center, supporting any subgroup. In line with this structure the financial and operational strategies and policies are described for the company as a whole and are disaggregated into executable policies for the global pharmaceutical company (GPC). The position of the departments ‘Finance’ and ‘Accounting and control’ in the corporate center contributes to results that are at least generalisable over the subgroups.

![Organization chart](image)

**Figure 1 – Organization chart**

Within the subgroups the attention for working capital reduction is structured by various well managed improvement processes. In the subgroup high tech materials RF is one line of improvement since early 2010. In the pharmaceuticals subgroup supplier integration is a line of improvement. Additionally in the pharmaceutical subgroup RF might be beneficial. The responsible departments for this line of development are Procurement and Global Supply Chain Management (GSCM).

The project group of this research exists out of three employees within the pharmaceuticals department, the researcher and the first and second assessor at the TU/e. The employees are the senior vice president in global supply chain management, the procurement performance manager and payment term performance coordinator.

### 1.2 Research questions and objective

In the high tech materials subgroup numerous suppliers are invited to adapt RF. The number that finally adopted RF versus the suppliers introduced to RF is one of the motivations for the first research question. Furthermore the supplier base of the pharmaceuticals subgroup is considerably different from the high tech materials subgroup. The first research question is defined as follows:

1. What supplier selection criteria should be adopted for a RF agreement?

This question incorporates the identification of advantages, disadvantages and their drivers for the supplier as well as for the buyer. A prerequisite for an RF agreement between a supplier and buyer is that the advantages should outweigh the disadvantages for both parties. Therefore the answer to question 1 should also include information about the structure of variables driving advantages and disadvantages. To decide on a robust scenario the variation of these variables
need to be known. If the above research question is answered it is by no means a guarantee for financial performance improvement. The missing link is effective implementation of RF, which leads to research question 2:

2. What knowledge should be present at which positions in the organization in order to implement RF effectively?

The departments Procurement and GSCM also contribute to working capital decreases using a strategy of supplier integration to save inventory costs. Supplier managed consignment stock (SMCS) is one option within the range of supplier integration options. Supplier integration might interact with RF, since there is a case in which a supplier requested a price increase simultaneously with the implementation of consignment stock. This leads to the final research question:

3. How do supplier integration (SI) and RF interact?

This question does not only provide the structure of variables that overlap. I.e. that are influenced by RF as well as SI. It also serves as input for a model to investigate robust scenarios for a combination of RF and supplier integration.

### 1.3 Scope

The scope of this research is depicted by the gray area in figure 2. It is limited to the moment of finished product at the supplier up to the moment of usage of products at the scientific company. Additionally the financial flow with regard to this product flow is investigated, including the financial impact. Comments on the implementation and legal aspects are provided, but the operational impact is not considered in this project. Also the variables of the financial institution are assumed as a given and the impact on the financial institution is not explicitly discussed. This discussion can be found in Hurtrez & Salvadori (2010) and Siddall (2010).

![Figure 2 – Scope of the project](image.png)

The scope includes the supply of products, services and their related financial flow as well as the financial related information flow. This scope will be narrowed down further in the subsequent chapters.

### 1.4 Research method

The research method is defined by following general empirical descriptors from Cooper & Schindler (2009) and operations management (OM) modeling specific definitions from Bertrand & Fransoo (2002). Thereafter the research procedure is discussed using Mitroff et al. (1974).
As will be indicated paragraph 2.1 ‘Interrelated operations and finance decision making’, there has not been much attention for interaction of operational and financial decision making. Existing literature is in a descriptive state and therefore the research questions are defined for explorative and model building research. This research is not primarily driven by an idealized model itself and cannot be defined as axiomatic Meredith et. al. (1989). In fact this research does not even mainly aim to test a quantitative model at all, it aims to identify relationships among variables to ultimately propose a model on RF and SMCS. The scientific strengths of empirical case studies like these are novelty, testability, and empirical validity, which arise from the intimate linkage with empirical evidence (Eisenhardt, 1989). Following Bertrand and Fransoo (2002) empirical quantitative model based research has not been very productive from a scientific point of view by its specified conditions and lack of description of measurement methods. Despite this research is not mainly quantitative model based, but rather develops the model it is important to pay considerable attention to description of measurement methods in to enhance the ability for cross case validation possibilities for subsequent research and to avoid constraints on generalization.

Figure 3 - Initial research design model Mitroff et al. (1974)

Following Bertrand & Fransoo (2002) this research is empirical normative, since it does follow the whole cycle of research by Mitroff et al. (1974) as depicted in Figure 3. Empirical descriptive research would only follow the upper side of the model, and validate the model with reality, but not provide a solution. The four phases of this research are depicted by the connectors between the nodes in Figure 3. In the first phase a conceptual model of the problem and system under study is made. In this conceptualization phase, the scope of the model, the variables to be included and their measurement are determined. In this research this phase is extensive as depicted in Figure 4. At first working capital management in practice will be confronted with literature to provide the contextual concept given the scope. This provides the context for investigating the RF strategy within the high tech material division and health care division are confronted with each other and with RF literature, in order to provide a conceptual RF model. In the same context, the supplier integration strategy is confronted with supplier integration literature. These two parallel confrontations yield conceptual models.

In the second phase a quantitative model is build, defining the nature of relationships between the variables. Given the conceptual models the variables and their relationships will be quantified for RF as well as supplier integration. While this quantification takes place, the
models will be integrated. This is an iterative process, since models on RF as well as supplier integration must represent the relevant truth and being able to be solved separately, while having the possibility to be integrated and being solved. It is also iterative for validation purposes as will be explained in the next paragraph.

In the third phase ‘Model solving’ the researcher aims to solve the model using mathematics, answering research question 3. The models on RF or supplier integration serve as a comparison base for a situation in which neither RF nor supplier integration is used.

The final phase consists of implementation of the model results. Although research can start from any state, this research starts with a reality, problem situation. i.e. a lack of in depth understanding of the dynamics of RF. For a thorough discussion on this model I refer to Mitroff et al. (1974) and Bertrand & Fransoo (2002).
Data collection
The data collection in the company relies on communication rather than monitoring, since no direct observations are included in this research. Interviews are roughly designed in two ways (1) the subject matter is introduced by the interviewee and only briefly re-questioned by the interviewer (2) the findings of previous interviews and theory are verified without mentioning a source. The exact design depends on the phase of research and purpose and will be indicated before its findings are discussed. A complete list of interviews is included in appendix 5. The forthcoming negative effects of interpretation and perception are limited by the method discussed in the next paragraph. Data collection took place cross sectional and ex post facto, within the first six months of 2010.

1.5 Validation
Despite empirical validity is an important strength, Mitroff et al. (1974) state there is usually an over-concern on validation in one research when reviewing a line of development for an issue. When limiting validation the role of interpretation increases from a scientific perspective and the relevance decreases from a practical perspective. As a consequence the importance of measurement method description increases for a second line of development as far as generalization is the aim of multiple lines of development. Furthermore limited concern for validation is insufficient for this research, since implementation and subsequent performance improvement is an aim. Therefore three kinds of validations are used: external, internal and face validity. If conflicts in findings occur, then first the findings of one case will be verified with the interviewee of another case and vice versa. If the conflict in findings still occurs it will be discussed in the project group and appropriate action will be taken. This might include further investigation of other cases or the decision to continue using a specific interpretation or setting.

External validity (Cross-case analysis and replication strategy)
As far as the RF research concerns, suppliers of the high tech material subgroup serve as cases. Twenty-one cases of RF are analyzed. This number of cases allows for testing whether the findings of one case make sense beyond its own specifications. To enhance external validity further Miles and Huberman (1994) refer to the replication strategy advocated by Yin (1984). This strategy uses a theoretical framework as generated from the literature review to study one case in depth. Thereafter successive cases are examined to see whether the pattern found matches that in previous cases. Ultimately the first RF contracts within the pharmaceuticals division could be analyzed to increase the generalizability. This prolonged generalizability cannot be used for decision making on the feasibility of implementation of RF for the GPC. It does nevertheless yield insight. This insight can be used to increase the implementation effectiveness and efficiency by increased generalizability. The implementation phase within the pharmaceuticals subgroup will be studied closely.

As far as the supplier integration research concerns, the cross case analysis is prolonged, using forty supplier integration cases within the pharmaceuticals subgroup.

This strategy for RF as well as supplier integration aims to find out where the same variables have the same effect to enhance the understanding of variables on the total impact of a concept. This does not yet contribute to understanding the interaction in practice directly, since only cases of either RF or supplier integration are available. The number of cases and information per case available for RF as well as supplier integration is expected sufficient to propose a valid model. Additional to the cross case replication strategy the literature reviews provide an external perspective on the subject matter and opinions from RF experts outside the scientific company are gathered to contribute to external validity.
Internal validity (triangulation)

Triangulation aims at confirming a finding by showing that independent measures of it produce generally converging conclusions (Miles and Huberman, 1994). There are different kinds of triangulations available. Denzin (1978) classifies triangulations into four types: data source triangulation (which include persons, times, places, etc.), researcher triangulation (multiple investigators for a research), method triangulation (using more than one method to collect data, e.g., observation, interview, documents or questionnaires), and theory triangulation (which involves using more than one theoretical scheme to interpret the phenomenon). In this research all four kinds are used.

Data triangulation

Multiple interviewees are contacted multiple times each. By this iteration the researcher understands the subject matter more in depth, verifies his understanding and thereby gains a better understanding after which the cycle starts again. This rules out misinterpretation and identifies changes in perspective over time. Depending on the subject investigated the number of iterations can be up to ten times or more with one interviewee about one issue. Furthermore a wide range of perspectives on a single issue is gained by data gathering from varying hierarchical levels, varying departments and varying subgroups. This does especially hold among other issues for the value of freed cash in paragraph 3.2.1.

Researcher triangulation

Triangulation takes place by comparing the understanding of one piece of information gathered between multiple persons, yielding to a converging conclusion. In this research once every month the data gathered is verified with the project team. Furthermore there are approximately once per two weeks verification moments between the researcher and the TU/e professor and more often between the researcher and a procurement employee equipped with the execution of the RF implementation and payment term performance. This procurement employee was also present in several interviews together with the researcher besides the interviewee.

Method triangulation

Besides interviews, this research also adopts other methods for data collection such as reviewing company documents and system data. Secondary materials (documents) from the case company include company websites and shared folders on intranet. The findings from interviews are mostly qualitative, while the data collected from company documents regarding RF and SMI cases provide quantitative complements to the qualitative findings. The research does not use direct observation according to the definition by Cooper & Schindler (2009), but uses multiple methods, data sources and researchers to obtain data instead.

Face validity (Utilization)

This research is designed to serve the project group in the case company. The researcher therefore validates the models in various states to the relevant stakeholders. As indicated once every month the models that are developed will be validated in a meeting with selected stakeholders. Finally, the research results, i.e., the supplier selection decision making framework is presented to procurement and supply chain management employees. Hence the framework is explained to the potential users and feedback on the practicalities will be incorporated in the final framework. The context in which these models are developed will be explained in the next chapter.
2. Working capital management

This chapter starts with the review of interacting operations and finance modeling attempts. Thereafter it creates a framework of relevance by confronting topics in literature with the GPC practices. This provides the context for the introduction of options to improve the working capital (WoC) situation by RF and supplier integration.

2.1 Interrelated operations and finance decision making

Operations management and financial management are traditionally two distinct research disciplines. Financial models treat operations frequently as a black box and set harmful constraints (Reason, 2005). On the other hand operational models frequently ignore financial constraints, e.g. assuming the cost of capital as an unlimited exogenous variable (Hopp and Spearman 1996; Silver et al. 1998). Inventories do however change the firm’s level of risk and thereby the availability of resources (Singhal, Raturi and Bryant 1994; Sinhal 1988; Sinhal and Raturi 1990). But many of the OM models ignore these interactions and constraints for the sake of optimality, which is thus likely to be sub-optimality. At most the authors discuss how to deal with these shortcomings when using the models (Silver et al., 1998).

Buzacott and Zhang (2004) argue a similar ignorance holds for financial literature. From a financial perspective, the treatment of operations as a black box is highlighted by the Modigliani and Miller (MM) (1958) proposition. Videlicet in perfect and competitive markets, financing decisions (the mix of debt and equity) are irrelevant to operational decisions (e.g., the level of capital, labor, output, accepting or rejecting a project) of a firm, and hence can be made independently. Subsequently Modigliani and Miller (1958) argue, in case of market imperfections (e.g., there are tax advantages of debt, bankruptcy cost, information asymmetry, conflicts of interest among managers, bondholders, and stock-holders on investment and financing decision, and so on) are introduced, the irrelevance no longer holds. Following Protopappas and Seifert (2010) the black box perception does not always hold since an increase in the level of working capital allowance: (1) increases in the return on working capital investment when operating under a very constrained scenario, and (2) decreases the return on working capital investment when operating under a less constrained scenario.

After 1990 the attention for the interaction of operations and financial management increased (Buzacot & Zhang, 2004) while simultaneously a shift of attention took place from single company approach to supply chain approach (Williams and Tokar, 2008). From a single company perspective Li et al. (1997) seek to model the relationship between production decisions, borrowing and dividend policies under demand uncertainty with no restrictions on the amount of borrowed. With a dual company perspective Lederer and Singhal (1994) consider the joint financing and technology choices when making manufacturing investments, showing considerable value can be added to investments through financing decisions. Other single company perspectives include Birge (2000), who adapts option-pricing methods for incorporating risk into capacity-planning models, and Birge and Zhang (1999), who apply the risk-neutral pricing arguments from option theory for incorporating risk into an inventory problem. Thus while there seems to be interrelated modeling literature on single company short term operations decisions (i.e. production and inventory) and single and multiple interrelation modeling literature on long term operations and finance (investment) decisions (i.e. company capacity, investment planning), there seems to be no interrelated modeling literature on dual company current assets and financing problems (Fellenz et al., 2008). Furthermore does existing literature aim to model a traditional operational and financial structure, not taking new and
important financing and inventory options explicitly into account, despite a strong correlation between integrative information technologies, supply chain integration, buyer service and financial performance (Vickery et al. 2003).

Before an RF and SI model can be developed and validated, the theoretical and practical background relevant to the problem will be discussed to avoid contradicting interpretations of the final model and its results. The concepts working capital, operating working capital, cash conversion cycle and capital structure play a role.

### 2.2 Working capital on balance sheets

This paragraph will discuss the position of working capital management as part of total financial performance management in general, using the scientific company holding as an example. In total financial performance, asset turnover is a driver of a companies’ return on equity. It is decomposed in two areas of management, i.e. working capital management and management of noncurrent assets. Several aspects of the first area (working capital management) are discussed in this paragraph, i.e. its relative position on financial statements, the cash conversion cycle and the costs of working capital.

**Figure 5 – Standardized balance sheet items**

**Figure 6 – Condensed balance sheet items**

Working capital is defined as the difference between a firms current assets and current liabilities (Palepu et al. et al. 2007). This definition does not distinguish between operating components and financial components. The operational components are trade receivables, inventories and trade payables. The financial components are cash, marketable securities and notes payable. These operational and financial components interact as will be discussed in ‘the cost of capital’ paragraph 2.4. The operational components do influence the weighted average cost of capital (WACC) and the WACC does in turn influence decision making on operational working capital components. The performance of the operational components of working capital can be expressed using the definition operating working capital (OWC), which excludes the financial items cash and marketable securities. When rearranging a standardized balance sheet (depicted in Figure 6) to a condensed balance sheet (depicted in Figure 5) one obtains the OWC (Bauwhede, 2009).

Managing working capital (WoC) is subject to a complex set of trade-offs between the liquidity and profitability of a firms current assets given uncertainty. The three WoC items analysts
primarily focus on are trade payables, inventories and trade receivables. Regarding the latter, credit and distribution policies determine the optimal level of trade receivables. The second item is described in a rich body of literature on supply chain strategy and operations planning achieving target buyer service levels or fill rates\(^5\), often assuming financial parameters. The latter two items require a certain amount of capital. The first item, trade payables is a routine source of financing for the latter two. The normal level of payables is determined by industry practices (Palepu \textit{et al.}, 2007). For the scientific company holding (given the standardised balance sheet in appendix 3) the current assets are approximately 1/3\(^{rd}\) of the total assets at the financial year ends 2008 and 2009\(^6\). From the condensed balance sheet, the OWC portion of net assets was 25\% in these years. (See appendix 3)

The working capital element numbers on balance sheets do not provide much information about performance by themselves. Therefore they are often used in a ratio as a nominator with sales or purchases, whichever relevant as a denominator, as depicted in appendix 2. Changes in this ratio are compared over time to track performance. Note that the working capital numbers from the balance sheet are snapshots opposed to sales and purchase numbers from the income statements, which are accumulations over time. It is commonly assumed that the assets at the beginning of a period create the sales and purchases for the period.

### 2.3 Cash Conversion Cycle

The information gathered from these ratio’s can be expressed in another way, e.g. by the cash conversion cycle (CCC), indicating the average number of days between the moment of payment for incoming products and the moment of receipt from sold products. This is sometimes referred to as cash to cash (C2C) cycle as well. It aims to represent: days receivables + days in inventory – days payables. Equation 1 corresponds to one of these options and to the scientific company measurement system of CCC elements\(^7\).

\[
CCC = \frac{1}{365} \left( \frac{\text{net trade receivables}}{\text{sales}} + \frac{\text{(net inventories – trade payables)}}{\text{COGS}} \right) \quad \text{(Equation 2.1)}
\]

In financial literature various alternatives to obtain the CCC are mentioned (Palepu \textit{et al.}, 2007). The shorter the CCC, the shorter the period between disbursement of cash and collection of cash. Consequently, ceteris paribus, the need for working capital financing by debt and/or equity decreases. E.g. if trade payables remain equal or are extended (as discussed in chapter relevance) while the other items remain equal or decrease they provide an increasing percentage of the working capital financing. When extrapolating this effect even a negative CCC is possible in theory and practice, in this sense the company Dell serves as an example.

In case of a very short or even negative CCC a firm can still face illiquidity or insolvency. It can face insolvency e.g. if it faces high indirect costs and low profit margins, slowly leading to bankruptcy. It can face Illiquidity for example if it purchases vast quantities on short payment terms and plans to sell these in the long term. Adequate WoC management is therefore a prerequisite, explained in paragraph 2.5. named ‘analysis of the scientific company working capital related strategy’. At the scientific company holding the CCC KPI weights the absolute magnitude of receivables, inventories and payables by estimation\(^8\), aiming at representing the impact on cash flow.

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\(^5\) For definitions of fill rate and buyer service level readers are referred to (Silver \textit{et al.}, 1998)
\(^6\) Calculation is provided in appendix 3.
\(^7\) Source: the scientific company manual for Operative planning 2011 - 2013
\(^8\) As depicted in appendix 2.
Payables are not the only way of financing WoC as depicted in appendix 3, i.e. a portion of debt and shares are used as well. These debt and shares are also used to finance fixed assets and require an interest rate by creditors and investors. This rate depends to a considerable extent on the risk of default of the borrowing company, e.g. the chance that the external investor or creditor will not get paid. This thesis does not focus on fixed assets investment, but on OWC. It does however take the liabilities of OWC into account.

Longer CCC’s, ceteris paribus, increase the cost of these liabilities in two ways. (1) It increases the capital required to fund OWC and thereby increases the absolute amount of capital required. When the cost of capital would remain equal this would already increase the absolute amount of capital cost. But the cost of capital are likely to increase as a result of an increase in required capital, assuming equal revenue and COGS. Furthermore (2) the more inventories and receivables, ceteris paribus, the higher the risk of inability to capitalize inventories or trade receivables, increasing the write offs, implying increased cost.

2.4 The cost of capital

The CCC length is not the only factor influencing the costs of capital. It is one out of multiple aspects that indicate the extent of risk a company faces. The higher this risk the higher the rate of return required by investors and creditors. This risk is compared with alternative investment opportunities by creditors and investors after which the required rate of return is determined. The weighted average rate of return equals the WACC of the scientific company. This rate covers at least for inflation. The add up of the rate is often determined using at least a debt rating, indicating the risk of loss arising from a borrower who does not make payments as promised. This is also called a default and therefore another word for credit risk is default risk.

Debt ratings

Debt ratings are a primary source of information for investors and creditors. These ratings vary from AAA (prime investment grade) to D (high likelihood of bankruptcy) (See Standard & Poors, 009; SEC9, 2010 and appendix 10). Generally the better the rating, the lower the cost of capital. There are of course rate differences driven by varying conditions and characteristics of financial instruments. The rating of the scientific company is depicted in the following table. The scientific company’ aim is to get a single “A” rating, requiring improvement as will be explained in paragraph 2.6 ‘decreasing the cost of working capital’.

<table>
<thead>
<tr>
<th>Rating Agency</th>
<th>Long term rating</th>
<th>Short term rating</th>
<th>Outlook</th>
<th>Last update</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moody’s</td>
<td>A3</td>
<td>P-2</td>
<td>Stable</td>
<td>August 4, 2010</td>
</tr>
</tbody>
</table>

Debt rating agencies have complex policies and frequently analyze rated companies’ strategy and business planning. These policies are tried to capture by several researchers in models aiming to predict the rating by publicly available financial figures (Palepu et al., 2007). The well known Kaplan-Urwitz model was used to predict Standard & Poors ratings for 251 European companies in 2006. It predicted 55% of the categories right, 41% one category off (e.g. AA instead of AAA) and 4% were two categories off. These debt ratings were primarily driven by firm size, profitability, riskiness of the profit stream and leverage (in order of statistical significance) (Altman, 1968). The latter three drivers are influenced by the CCC when debt is paid off by free

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9 US Securities and Exchange commission
Riskiness of the profit stream may impose too little cash inflow and too much cash outflow resulting in bankruptcy.

In the case of the scientific company, every percent OWC decrease can contribute to approximately 0.45% decrease in net debt according to the balance sheet of 2009 as depicted in appendix 3. Instead of decreasing debt other investment opportunities can arise as well, as mentioned at the end of the chapter ‘Relevance’. Paragraph 3.2.1 ‘the value of freed cash’ elaborates on this discussion.

**Weighted average cost of capital**

A debt rating is one aspect taken into account by creditors to determine the required interest rate (Standard & Poors, 2009). Besides debt bears interest cost, equity providers require a return on their investments in equity. The total cost of debt and equity can be calculated with the weighted average cost of capital (WACC) formula as in equation 2 (Palepu et al., 2007). The relation between debt ratings and WACC will be explained in paragraph 2.6 ‘Decreasing the cost of working capital’

\[
w = \frac{C}{C + E} C' (1 - T) + \frac{E}{C + E} E'
\]

(Equation 2.2)

In this equation C represents the market value of debt and E represents the market value of equity. C' represents the cost rate of debt and E' the cost of equity. Additionally T represents the effective tax rate. This equation applies to any firm and is also used within the scientific company. The most difficult part is to appropriately determine the return on equity (E'). For more information about this topic readers are referred to (Palepu et al., 2007). The allocation of internal interest rates for increases or decreases in working capital elements will be discussed in the paragraph 3.1 ‘modeling RF’

### 2.5 Analysis of the scientific company working capital related strategy

The importance of CCC decreases in general was discussed in the relevance chapter. Before discussing the options available to the scientific company, its situation and strategy are discussed, providing a frame of relevance for the review of options to improve WoC performance. The primary objective of financial management (in which WoC management plays a role) at the scientific company is twofold. I.e. to secure liquidity and to increase the enterprise value of the scientific company. Securing liquidity is an enabler for increasing the enterprise value, since it protects against bankruptcy. Following Kaplan and Norton (1996), these objectives hold in general. This general aim is specified in financial and operational value drivers at the scientific company. Financial value drivers are a sustained reduction in capital costs and an improvement in financial cash flows.\(^{10}\) Important operational value drivers are the improvement of the three CCC items, while maintaining service levels and ensuring an agile, robust and sustainable supply chain. E.g. by flexible capacity, or higher inventory levels. Besides aiming for sales growth, the reduction of debt (introduced in paragraph 2.6 ‘Decreasing the cost of working capital’) is of considerable importance. The operational value driver ‘CCC reduction’ will now be discussed from a cash flow perspective.

The CCC changes can be derived from a cash flow statement. At the top of this statement the items that add up to gross cash flow are listed. For the scientific company this amounts

\(^{10}\) Source: General Guidelines for Financial Management at the scientific company
approximately 5 billion per year in 2008 and 2009\textsuperscript{11}. Listed below gross cash flow on the cash flow statement are changes in cash from operating activities, as depicted in table 2. In case of positive changes (black numbers), cash requirement is reduced, providing the opportunity to pay off debt or invest in business opportunities. Ceteris paribus, cash is required for negative changes (red numbers). This limiting effect had a magnitude of 15\% on gross cash flow in 2008, as depicted in Table 2. A recovering effect took place a year later.

Table 2 – Cash flow changes by inventories, trade accounts receivables and trade accounts payable

<table>
<thead>
<tr>
<th>Cash flow item</th>
<th>2008</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross cash flow</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Decrease (increase) in inventories</td>
<td>(13%)</td>
<td>13%</td>
</tr>
<tr>
<td>Decrease (increase) in trade accounts receivables</td>
<td>(3%)</td>
<td>(1%)</td>
</tr>
<tr>
<td>(Decrease) increase in trade accounts payable</td>
<td>0%</td>
<td>5%</td>
</tr>
<tr>
<td>Net change in cash provided by WoC items</td>
<td>(15%)</td>
<td>17%</td>
</tr>
<tr>
<td>Net change in cash provided by WoC items</td>
<td>$-810$</td>
<td>$+811$</td>
</tr>
</tbody>
</table>

Further down the cash flow statement investing activities required 3 billion in 2008 and 1 billion in 2009. In the coming years the scientific company’ debt matures on average with 1.57 billion per year, varying between 0.6 and 2.5 billion. A simplified worst case cash flow scenario, in sequence of the above text would be (in billions): 5(gross) – 3(investment) - 2.5 (debt retirement) = -0.5 billion, i.e. shortage cash implies illiquidity. Note that this does not even take a change in CCC - e.g. like in table 2 - into account. Therefore it can be concluded that a CCC change having a cash flow impact of 0.81 billion is a considerable impact. The amount financed by payables was approximately 8\% of the amount financed by debt and equity in 2008 and 2009. The options available to decrease working capital related interest payments are discussed in the next paragraph.

2.6 Decreasing the cost of working capital

At least three options are available to decrease the cost of working capital without destabilizing the supply chain, i.e. modification of capital structure, increasing the profit margin and decreasing the CCC. The first option will be discussed in depth, second option will be discussed briefly, the latter option is subdivided in three policies and discussed more in depth, which eventually leads to the options supplier integration and reverse factoring.

2.6.1 Modification of capital structure

A first option would be to decrease the WACC by changing the capital structure. This option is related to modeling in the subsequent chapters.

Taking the tax shield of debt in consideration, debt bears generally a lower rate than equity. Within the debt range, short term debt bears generally a lower rate than long term debt (Cox et al., 1985). From a single firm perspective, this rate varies not only for different times to maturity, but also depends on the collateral available (Palepu et al, 2007). The option of financing with collateral is not considered within the scope of this research. For more information on this topic readers are referred to an interrelated financial and operational performance model by Buzacot.

\textsuperscript{11} Source: the scientific company annual report, 2009, pp. 141
& Zhang (2004). This leaves the maturity structure of debt and tradeoff between debt and equity as discussions for this paragraph. These will be introduced here and elaborated on in the modeling chapter. The first topic discusses replacement of long term debt with short term debt. The second topic discusses replacing equity with debt. Since long term debt bears generally higher costs than short term debt the first topic might sound as an attractive option. However, replacing long term debt with short term debt causes debt to mature before the cash flows arrive from investments and this debt must be refinanced at terms that depend on a firms future credit rating (Diamond, 1991). The dependence on the future credit rating would impose a considerable interest rate cash flow risk if a substantial amount of long term liabilities is replaced with short term debt\(^\text{12}\), since a company cannot any longer negotiate about funding when it can, but now it must negotiate when it has to. Additionally Barclay and Smith (1995) provide a meta review on three groups of hypotheses, i.e. contracting cost hypotheses, signaling hypotheses and tax hypotheses. The scientific company takes these four considerations into account in deciding on the optimal maturity structure of debt.

\[\text{Figure 7 – the scientific company WACC and debt rating}\]

The second topic of potential improvement is the replacement of equity with debt to decrease the cost of capital. Following Guerard and Schwartz (2007) if the borrowers risk increases too much by overleveraging with debt, the market may set a lower price for shares than it would give for similar shares with smaller earnings but a more “conservative” financial structure. The companies equity value would decrease as a result. Replacing equity with debt does additionally increase the cost of capital by a decreased credit rating. Investors consider the financial risk of the firm's capital structure and the intensity of the economic or operating hazards typically faced by the industry (Guerard and Schwartz, 2007). The total impact from a change in the debt/equity ratio is depicted in figure 7. This figure takes Hamada's equation (1972) and proceedings into account. The optimal leverage prefers equity, since the hazards faced by a company can be buffered with having access to a reasonable amount of incremental debt in varying economic and capital market conditions. Additionally unused debt capacity provides the opportunity to obtain capital on a very short term – perhaps with just a phone call. Additionally unused debt allows a company to take advantage of unusual major opportunities (e.g. acquisitions) or avoid being forced to take actions it deems undesirable. If shareholders share this view, then unused debt capacity adds to share price (Groth and Anderson, 1997). Thus by deviating from the optimal liabilities structure a company would be less able to act

\(^{12}\) Source: Scientific Company Corporate Financial Controlling

\(^{13}\) Source: Scientific Company Corporate Financial Controlling
adequate to market opportunities or threads when desired. Additionally a deviation would be enforced by shareholders and lead to a deviation with a larger magnitude.

2.6.2 Increasing profit margin
A second option is to increase the profit margin. Following an economic approach, the extent to which this is accepted by buyers could be modeled by a price (P) - quantity (Q) elasticity curve. This option and any cost reductions in production process are outside the scope of this research.

2.6.3 Decreasing CCC
The third option is a sustainable CCC (equation 2.1) decrease. Hereby the difference between OWC and the CCC should be taken into account. Assuming a linear sales growth rate, payables and inventories grow with an equal rate to meet demand, ceteris paribus resulting in an equal receivables growth rate. Furthermore sales and COGS increase with the same rate. This altogether results in an unchanged number for the CCC.

If the CCC increases substantially, then liquidity is at risk. E.g. if sales suddenly decline and substantial amounts of cash locked in inventory, not being able to be capitalized, as discussed in the chapter ‘relevance’. Therefore not only agility in the supply chain is important to keep the CCC steady, but also a continuous focus on means to decrease the CCC. Note that this does not imply OWC reduction is achieved, since sales growth is aimed for.

There are roughly three ways of decreasing the CCC, i.e. paying later, advancing receivables and reduce the time of an item in inventory. The reduction of inventory value in the supply by optimizing inventory levels elsewhere in the supply chain than at the point of exchange between a supplier and buyer is outside the scope of this research. The three options will be discussed in the remainder of this paragraph.

I Increasing payment terms
Unilateral payment delay is, as described in the chapter ‘Relevance’, an option harming the supply chain, since the payment term for one company is the receivables term for another company. Within the scope of this research, it harms the supplier. Furthermore annual supply contracts – commonly used within the scientific company - specify a payment term. Unilateral deviation from these contracts can not only lead to a destabilized relationship with the supplier, it could eventually lead to a court case increasing the costs of supply.

Extending a payment term by bilateral agreement is an option. Such a payment term is, by its ability to finance business, also referred to as trade credit. Hereby the interest is implicitly incorporated in the purchase price. Petersen & Rajan (1995) and Wilson & Summers (2002) argue that trade credit is a mean to show financial health. Demirguc-Kunt and Maksimovic (2001) add that in 39 countries around the world, trade credit use was higher relative to bank credit use in countries with weak legal environments. Later, Fisman and Raturi (2003) and Van Horen (2004) argue that trade credit is used as a competitive tool, particularly for small and young firms. The extent to which payment term extension is possible depends on two of the five forces described by Porter (2008), i.e. the bargaining power of buyers and suppliers. These forces are obviously not equal for each item to be sourced (Kraljic 1983). Despite all this the longer the payment term the more capital the supplier needs to fund this payment term. Essentially a payment term increase can be seen as a shift in working capital from the buyer to the supplier.

II Decreasing inventory
A voluminous body of OM research describes the options to decrease inventory, while achieving desired service levels. Buffering with capacity or lead times instead of inventory is described by Hopp and Spearman (1996). Within the scope of this research lies the decrease of inventory between the moment of finishing a product at a supplier and using it at a buyer. A review of the extensive body of literature will be confronted with the strategy of supplier integration of the GPC in chapter 4 ‘supplier integration’. In this chapter the argument for preferring working capital on the suppliers account from a supply chain perspective will be motivated while developing the supplier integration model, this argument holds for payment/receivable terms as well.

III Advancing buyer payments
Various methods to advance buyer payment – given the scope, from a supplier perspective - are discussed in this chapter. The simplest option is to decrease the receivables term, opposite to option 1 (increasing payment terms). This option essentially shifts working capital from the buyer to the supplier, which is a win-lose option. Three alternatives are available:

Advancing buyer payments: Discounts on early payments
Discounts on early payments are a common practice in B2B payments, which holds for the scientific company as well. An example is 2% discount for payment within 10 days and no discount for payment between 10 and 30 days. First of all does this not guarantee payment within 10 days since the buyer can decide to pay on day 30. Smith and Schnucker (1994) argue that the discount offered provides information about the supplier’s financial situation, i.e. higher discounts, ceteris paribus, imply higher supplier WACC. Assuming the supplier would be willing to offer the WACC rate as a discount for the receivables term decrease, then equation 2.3 should be able to calculate the supplier WACC.

\[
\frac{(\text{days per year}) \times (\text{discount rate})}{(\text{term without discount (in days)} - \text{term with discount (in days)})} \quad (\text{Equation 2.3})
\]

In the example above this implies the supplier believes 36.5%\(^{14}\) is an attractive financing rate. While offering a discount is common, the financing rate according to the equation 2.3 is not. Following Kramer (2010) suppliers primarily accept these terms offered by procurement departments to win business. He furthermore states: “It enables the supplier to offer a price discount to favored buyers without impacting list price. Further, most procurement departments are incented to obtain discount terms because their compensation is based on price rather than working capital and cash flow.” From the buyers finance perspective such terms are likely to be accepted, since 36% is generally approximately a factor 3 or more higher than an investment grade company WACC rate. Ironically, a study of Bartolini (2009) reveals less than half the companies with revenues over 1 billion US dollar are able to pay within 10 days. This implies taking the discounted early payment is infeasible. Ethically, taking the discount and paying after the discount term would not be right. Concluding, there should be a better alternative for decreasing receivables than discounts on early payments.

Advancing buyer payments: Factoring

\[^{14}\text{Calculation: } (365/(30-10)) \times 2\% = 36.5\%\]
Factoring is an interesting opportunity if a firm is financial distressed but has financially healthy buyers. In a factoring arrangement a supplier sells its receivables to a third party (the “factor\(^{15}\)). The factor makes an interest charge (based on the time to maturity), may impose a transaction fee and pays the remaining value of receivables in cash. Figure 8 depicts the process of factoring. This extent to which receivables might be included in a factoring program depends on the customer’s creditworthiness.

![Figure 8 – Factoring](image)

1. The buyer places an order to the supplier
2. The supplier supplies goods or services and issues the invoices
3. Supplier firm requests financing and provides the debtor book (Sales Ledger)
4. The factor investigates the creditworthiness of the buyer
5. The factor pays the supplier the receivable related to the order minus charges
6. After the payment term has expired the buyer pays the factor

Factoring can take place either with or without the transfer of default risk from the supplier to the factor. If the default risk is not transferred and factor is not able to collect payment from the buyer, then it recoups the payment from the supplier. This is referred to as recourse factoring. Following Klapper (2006), in Italy 69% of all factoring is done on a nonrecourse basis. Similarly, a study of publicly traded firms using factoring in the U.S. found that 73% of firms use non-recourse factoring. However sellers with poorer quality receivables as well as sellers who, themselves, have a higher debt rating were more likely to factor with recourse (Sopranzetti 1998). Non-recourse factoring is also preferable from an IFRS accounting perspective, since it is classified as a sale of receivables, whereas recourse factoring is classified as borrowing, since the eventual recoup is a liability to the supplier.

Both factoring variants have one aspect in common; the financing rate depends on the creditworthiness of buyers, rather than the firm requiring financing. This drives the success of factoring for illiquid companies that supply to creditworthy buyers, despite factoring companies can estimate the alternative financing choices before offering a discount rate to the supplier. The “Factor” is generally willing to finance up to 99% of accounts receivable (Soufani, 2002) whereas banks are generally not willing to finance more than 50-60% of accounts receivable. The development of conducive and responsive legal environments in the beginning of the twenty-first century has contributed to a worldwide application of factoring. Furthermore the increase of global competition has contributed to the increased use of factoring. I.e. suppliers offering trade credit increase their volume of accounts receivables. These accounts receivables are the market for factoring and have grown considerably (Wilson and Summers, 2000). In order

\(^{15}\) The term ‘factoring’ is derived from Latin and was used historically to refer to a mercantile agent who aided a business in its trade by buying and selling distant lands, taking goods on consignment and advancing money.
to access this financing firms are sometimes prepared to out-source their credit management administration (Wilson and Summers, 2000). These additional services include collection, credit protection, cash management and debtor administration (Wilson and Summers, 2000 and Beuving, 1996). For elaboration on the market of factoring products readers are referred to Beuving (1996). These services are not just outsourced to obtain financing according to Smith and Schnucker (1992). They argue that economies of scale at factoring companies providing these services decrease the cost of these services. Particularly firms with geographically dispersed buyers and few repeated sales to any given buyer have high cost of information and monitoring. In these settings factors combine information about buyers and sellers about product risk and credit risk at lower costs than could individual firms given the international expertise of factoring companies on rules, regulations, languages and creditworthiness investigations (Smith and Schnucker, 1992 and Klapper, 2000).

Wilson and Summers (2000) argue that seasonality and variability in demand does not significantly motivate companies to use factoring. According to them the opposite is true. Stability of demand is positively correlated with the use of factoring. Highly variable demand is more suitable for ad hoc factoring than contract factoring, since a factor prefers a stable income. Additionally in low demand season the supplier would need additional financing for fixed cost, but receivables are on a lower level then when demand is high and thus the larger the seasonality effect less beneficial factoring can be.

Downsides of factoring are the interest rates and charges from a factor may be close to the cost of direct loans or a line of credit, depending on the receivables portfolio. Klapper (2004) argues that fraud in developing countries made factoring unprofitable in these countries for factors. Additionally some countries allow interest payments from banks to be tax deductible do not apply the same deduction to the interest on factoring arrangements. VAT taxes may be charged on the entire transaction (not just the service fee), and stamp taxes may be applied to each factored receivables (Klapper 2004) For a discussion on the legal perspective on factoring see (Beuving, 1996 and Ruddy, 2006).

Elaborations on single factoring are accounts receivables exchange trading (Schmidt, 2009 and appendix 4) and reverse factoring. Accounts receivable trading is particularly suitable as new source of capital for SME suppliers, particularly given that banks are more reluctant to extend financing to SMEs and those companies in countries that may be deemed high risk. While this might be a solution to suppliers of the GPC, it is not beneficial in a direct financial sense to the scientific company and will therefore be disregarded as an option. Reverse factoring will be described in the next chapter as part of a broader approach called supply chain finance

### 3. Supply Chain Finance

Supply chain finance (SCF) is a broad definition addressing financial aspects in the supply chain. It can include non-current and/or current items of assets and/or liabilities of multiple firms in a single or in multiple supply chains or supply networks. All papers studied by the author have at least one aspect in common, i.e. the use of financial related (often creditworthiness) information from other links in the supply chain than the link requiring financing. For a discussion of definitions, including aspects of operations and information management readers are referred to Pfohl and Gomm (2009). In management literature the broad definition ‘supply chain finance’ is often used when a specific aspect or development within the range of financial supply chain
developments is meant. The case studied is a specific form of SCF, i.e. buyer initiated non recourse reverse factoring of confirmed payables. Reverse factoring can be defined as follows:

“the electronic presentment of approved payables from the buyer to the supplier with the supplier having the opportunity to discount those payables to cash earlier than the payables maturity date.” (Financial Times Lexicon)

Ironically the keyword for the above definition is ‘supply chain finance’. In RF programs a large corporate buyer is an integral part of the arrangement. This concept is “A big opportunity” according to Atkinson (2008). An online portal of RF to which suppliers can easily connect and decide on the moment of discounting any invoice is increasingly adapted. Large corporate buyers have essentially two options. (1) A multi financial institution platform with competitive rates and a relatively high initial investment. Or (2) a single financial institution platform with a lower initial investment, but rates are dictated by the financial institution. The HTM group chose for option 2. According to a procurement manager, this relatively simple option supported a quick start. The chosen RF provider experienced almost a factor 1000 growth of invoice volume through RF in the past 17 years from 61 million to 43 billion, offering services now to over 200,000 companies (under which over 20 from appendix 4), settling more than 55 thousand invoices daily. In a 2006 survey by Aberdeen research group 70 out of 100 companies spread over industries and geographies indicated they had either implemented or were evaluating SCF programs. The attention for RF is additionally highlighted by a survey in 2009, i.e. out of 1000 British and German firms 61% of British firms and 43% of German companies are planning to monetize their receivables or utilize payables financing (Demica, 2009). And mid 2010 a survey among 168 senior finance executives in U.S. companies with more than $500 million in revenues revealed that 21% participates in SCF as a buyer, 9% as a supplier and 35% as both. Another 17% considers starting. The remaining 18% had no plans for SCF of which 65% argued they did not know enough about any of its benefits\(^\text{16}\).

For suppliers the benefits of RF are closely related to the disadvantage. The financial institution monitors only the corporate buyer creditworthiness continuously instead of the suppliers whole buyer portfolio, which is the case when normal factoring is used for all receivables of a particular supplier. The high credit rating and single company investigation decreases the cost of information for the factor. Furthermore, by the active participation of the large corporate buyer factors obtain better information and can release funds earlier (Seifert and Seifert, 2009). The downside is that only receivables from buyers offering RF can be used as a financing source, whereas in case of normal factoring the receivables from most buyers can be used.

For financial institutions RF is interesting since the amount of payables from multinationals are substantial and the cost of obtaining (credit) information are relatively low. The downside is dependence of the financial institution on the buyer creditworthiness. This might involve lengthy credit insurance negotiations for financial institutions (Volcke, 2006). Therefore only investment grade companies are attractive for financial institutions to establish a RF agreement with and SME’s are generally not. This holds obviously only if suppliers regularly choose to discount their receivables soon after confirmation by the buyer.

The advantage for corporate buyers, supporting financial institution’ income is the extension of payment terms in turn for offering the RF option to suppliers. By extending the payment term the supplier is still able to discount the amount directly after the invoice is confirmed, but the payment term extension increases the discount rate to be ‘paid’ by the supplier. Since it is still

\(^{16}\) http://www.primerevenue.com/about/pdfs/PrimeRevenue_Executive_Summary.pdf
cheaper for the supplier to accept this higher rate, rather than using other sources financing during the initial payment term the supplier is likely to discount the receivables early. RF provides the option for the corporate buyer to strengthen the supplier base or decrease purchase prices. The added value of RF for a company is investigated in a review by Seifert and Seifert (2009). They interviewed 23 large corporate buyers on the success of RF. By implementing RF on average a 12% working capital reduction for large corporate buyers and 13% working capital reduction for suppliers is achieved according to large corporate buyers. Additional advantages mentioned by the buyer are standardization of payment terms, improvement of supplier relations, reduction of prices and information gain about suppliers' finances. Disadvantages are, 44% reported reduced credit availability, 31% reported pressure to guarantee payments, and 25% reported other drawbacks. According to them choosing the right banking partner is of considerable importance. Proposed relevant criteria for the banking partner are a wide geographic reach, legal expertise and financial muscles. This is elaborated in chapter 7 ‘implementation’. RF is still not as common as debt, since one executive reported that suppliers would rather accept late payment than be involved in a seemingly complicated program that they do not understand.

Applications of RF are not in all cases initiated by the buyer. Besides suppliers, governments also developed RF platforms to support economic development and export in developing countries (Klapper, 2006) and export via SME’s in developed countries (Policelli, 2010). Additionally Hofmann (2005) describes a concept in which a logistic service provider initiates SCF.

Multiple researchers aim to model SCF as a tool to finance inventory, but they lack to describe RF as a possibility. This statement is highlighted by Pfohl and Gomm (2009). They review the literature on RF and conclude that the research gap for RF lies in the supply chain perspective on reducing the costs of capital. As a consequence they propose a model in which a project (e.g. inventory) of one tier in the chain can be financed by another tier in the chain (e.g. with buyer initiated RF) as an alternative for external investors. They do however lack to describe elaboration on the financing practice for this project, on the impact on credit ratings and the legal (im)possibilities. Without an in depth investigation of practicalities their model contributes more to academic rigour than relevance. Buyer initiated RF programs cannot be modelled accurately with this model, since there not necessary a project available. It does also lack to model variability in the freed cash, which is assumed a fixed amount equal to project size.

The next paragraph is devoted to modelling RF, i.e. an option that decreases the costs for suppliers and buyers in the supply chain without any negative impact on operational factors of the supply chain. In chapter 4 the supplier integration strategy of the scientific company will be confronted with literature and modelled quantitatively. These models will be tested for sensitivity and interaction in chapter 6.

### 3.1 Modeling reverse factoring

The first step in modeling is a conceptual description as a result of investigation of RF practices at the scientific company in cooperation with the financial institution and suppliers, which will be modeled scientifically afterwards. Thereafter the scientific model will be validated for the HTM group and for the GPC. The information for the conceptual model and verification of the scientific model is received from two procurement managers within the HTM group and one finance manager. The communication methods used are interactive verbal, i.e. interviews and telephone conversations, written text, PowerPoint and Excel files by e-mail and intranet.
3.1.1 RF concept

The HTM group initiated a single bank platform primarily to quick start improving their working capital situation by increasing payment terms. Simultaneously suppliers can decrease receivables to reduce their utilization of existing financing by flexible low cost refinancing. Additionally does RF aim to strengthen the ties with suppliers and decreases the illiquidity risks at suppliers increasing supply certainty. Indirect results are RF driven process improvements. The implementation started with a banking partner selection. The banking partner was selected for its “longest experience with RF” and “best expertise”, the implementation process included the departments procurement, treasury, accounting, IT and the following steps:

1. Gaining CFO commitment
2. Preparation for and discussion with banking partner
3. Verification of the accounting treatment
4. Investigation system impact and feasibility
5. Definition of Pilot Suppliers
6. Accounting process re-design
7. Treasury process redesign
8. System programming
9. Supplier communication concept
10. Preparation workshop with suppliers
11. Feedback with participating suppliers
12. Start pilot
13. Evaluation of broader roll out

The legal process steps are (1) A contract between the scientific company’ receiving legal entity and the RF bank (2.1) A contract between the supplying legal entity and the RF bank (2.2) A contract between the goods supplying entity and the scientific company’ goods receiving entity. Then application of RF can start. The supplier and buyer will only accept RF if the benefits are larger than the cost in strategic, operational and financial terms. Therefore the supplier selection criteria can only be described if the cost and benefits in strategic, operational or financial terms, their structure and stability over time are known.

First the operational process and financial impact of RF will be conceptually described. The strategic motivations have been introduced in the paragraph ‘Relevance’ on page 12 and in chapter 2 ‘Working capital management’. The implications of decisions within the RF framework will be described during the model development and tested for their sensitivity in paragraph 6.1 ‘RF sensitivity’. The operational process of RF is similar to factoring as depicted in figure 8. It is compared with an initial arrangement in figure 9.

As one can see is the initial term ($t_a$) shorter than the new term ($t_b$). At the buyer, as a consequence of paying later, cash is held for a longer period. The supplier is able to collect payment earlier than after $t_a$ i.e. after notification from the bank ($t'f$). The RF model assumes one can earn a return on this freed cash. The cost of RF for the supplier arise at invoice settlement before extended maturity. When the bank purchases the receivable from the supplier the time value of money and risk of buyer payment default decrease the amount received by the supplier.
The financial gain for the buyer are the interest savings on released cash, minus any fixed (IT platform) or variable (negotiation and education) cost. The financial savings for the supplier are the interest on released cash minus the interest paid for the advanced payment. The operational impact will be discussed in the chapter 7 ‘implementation’.

**Figure 9 - Initial versus RF arrangement**

### 3.1.2 Scientific RF model for payment term extension

The payment term extension savings model is elaborated on a bank savings calculation spreadsheet using interviews with procurement managers at the high tech material department. It is verified with the calculation method used by Deutsche Bank, CityGroup and Santander. It models the annual benefit based on the cost of capital rate difference, assuming suppliers discount payables directly after $t^{b} + t^{f}$ using the following variables. Unless explicitly mentioned, the following indexes for variables apply. Superscript with $i \in \{s, b, f\}$ where $s = \text{supplier}$ $b = \text{buyer}$ and $f = \text{financial institution}$. And indexed with subscript $j \in \{\alpha, \beta, \theta, \mu\}$ where $\alpha$ is for initial situation, $\beta$ is for SMI situation, $\theta$ is for RF term extension and $\mu$ is for RF price decrease. The following variables are used.

- $w^i$ WACC percentage (see equation 2.2)
- $r^e$ Euribor rate percentage
- $r^r$ Bank margin percentage
- $t^p$ Payment term days
- $t^b$ Invoice confirmation time days
- $t^f$ RF invoice processing time days
- $V_j$ Annual purchase volume Euro’s
- $l^i$ Initial investment Euro’s
- $S^i_j$ net savings Euro’s
If the payment term would not be extended, the net savings for the supplier can be calculated with equation 3.1, subject to the constraints 3.1 and 3.2. Note that $V_j = D \times u_j$.

$$S^s_v = V_v \times (w^s - r^o - r') \times \frac{(t_o - t^b - t')}{365}$$  \hspace{1cm} \text{(Equation 3.1)}

$$w^s > r^o + r'$$  \hspace{1cm} \text{(Constraint 3.1)}

$$t_o > t^b + t'$$  \hspace{1cm} \text{(Constraint 3.2)}

If the payment term is extended and $V_v = V_o$, constraints 3.1 and 3.2 must hold and constraint 3.3 must hold as well for the supplier savings in term extension case $S^s_v$ to be positive. Additionally, the buyer savings $S^b_v$ to be positive, constraint 3.4 must hold. If constraint 3.3 does not hold, the supplier pays more interest to fund the buyer's new term $(t_o)$ than he can save by the released cash from the discounted term. The derivation of constraint 3.3 is depicted in appendix 14.

$$t_o < \frac{w^s(t_o - t^b - t')}{(r^o + r')} + t^b + t'$$  \hspace{1cm} \text{(Constraint 3.3)}

$$t_o > t_a$$  \hspace{1cm} \text{(Constraint 3.4)}

Thus in order for RF to yield savings for the supplier and the buyer, the feasible range of $t_o$ is bounded by the above constraints. A method to determine if $t_o$, appropriate for the supplier is to express $t_o$ in the actual supplier financing rate $f^s_o$ when RF is used for term extension using equation 3.2. Note that $t_o$ and $f^s_o$ are independent of $V_i$.

$$f^s_o = \frac{(r^o + r')(t_o - t^b - t')}{t_o - t^b - t'}$$  \hspace{1cm} \text{(Equation 3.2)}

$f^s_o$ is relevant as will be explained in paragraph 3.2.1, i.e. using WACC as a savings rate is not that obvious.

The feasible region for $t_o$ was defined by constraints 3.3 and 3.4. The maximum extension within the feasible region is set by equation 3.3.

$$\max \{t_o\} = \frac{w^s(t_o - t^b - t')}{(r^o + r')} + t^b + t'$$  \hspace{1cm} \text{(Equation 3.3)}

At $\max \{t_o\}$, $f^s_o = w^s$ and $S^s_v = 0$, which is referred to as break even term extension for the supplier. $S^s_v$ can be obtained using equation 3.5 using $\max \{t_o\}$. Vice versa using $t_o = t_a$ as
input, one obtains $S^e_\theta$ and $S^b_\theta = 0$, hereby equation 3.4 is reduced to equation 3.1. For any $t_\theta$, $S^i_\theta$ can be calculated using equation 3.4 or 3.5.

$$S^e_\theta = \frac{V^a}{365} \left( w^s (t_\alpha - t^b - t^i) - (r^e + r^i)(t^e - t^b - t^i) \right)$$ (Equation 3.4)

$$S^b_\theta = \frac{V^a w^b (t_\theta - t_\alpha)}{365}$$ (Equation 3.5)

So far, the model describes a single term extension for a single supplier. RF does however allow for multiple payment term extensions per - or at multiple - suppliers. Therefore every unique combination of $(V^a, t_\alpha, t_\theta, t^b)$ is allocated an index number by variable $x$. With $i = 1, 2, 3, \ldots X$. In case of multiple term extensions per supplier the net savings can be calculated with equation 3.6, assuming some $t^i$ for each combination.

$$A^s_\theta = \frac{1}{365} \sum_{i=x}^{x} V^a_{\alpha x} \left( w^s(t_\alpha - t^b - t^i) - (r^e + r^i)(t^e - t^b - t^i) \right)$$ (Equation 3.6)

Additionally one could calculate the accumulated savings for all first tier suppliers using an index for $A^s_{\theta x}$ e.g. $z$ (with $z = 1, 2, 3, 4 \ldots Z$) and use equation 3.7.

$$\bar{g}^s_\theta = \sum_{i=z}^{z} A^s_{\theta x}$$ (Equation 3.7)

The accumulated savings for the buyer can only be calculated by taking the initial expense into account using equation 3.8. The $(1-T^b)$ transfers the before tax expense into an after tax impact. The most important argument to do this is to obtain market values of financial impact.

$$\bar{g}^b_\theta = \left( \frac{w^b}{365} \sum_{x=1}^{N} V^a_{\alpha x} (t^b - t_\alpha) \right) - I^b (1 - T^b)$$ (Equation 3.8)

A RF implementation does yield capital savings for all involved suppliers and the buyer if constraint 3.3 and 3.4 hold for every $x$.

### 3.2 Validation

The model is verified in three ways (1) on using the right variables (2) on representing the complete impact of RF (3) on the ability to obtain accurate values as input variables, i.e. measurement methods. These topic will be discussed per aspects and practicalities are elaborated on in chapter 7 ‘implementation’.
3.2.1 The value of freed cash

Equations 3.4 and 3.5 can be used to calculate the average annual savings for suppliers and buyers, based on increases of cash. In order to be able to achieve these savings, every euro of freed cash should be able to yield a return at WACC rate level. Bear in mind that WACC (equation 2.2) is an after tax rate. Since suppliers were not available as a research sample this assumption is tested within the scientific company holding and literature. It is assumed the result of the following discussion holds for suppliers as well as buyers.

Initial perspectives from two managers were non converging (in the sense of a distinction explained in this paragraph), therefore the sample was increased to seven interviewees, spread over four hierarchies, three subgroups and three functional departments. The questions asked were “what is the rate for freed cash from working capital?” and after providing alternative perspectives “would you be able to comment on alternative perspectives?”. This yielded essentially two groups of answers. The financial perspective answer and the operational perspective answer. Multiple managers showed understanding for both perspectives.

The financial oriented answer links back to paragraph 2.6 ‘decreasing the cost of working capital’ and is unlikely to allocate a rate as high as WACC to freed cash. This is supported by the RF model from Deutsche Bank (Philipps, 2009), using the suppliers short term financing rate instead of WACC as a trade off. Volume and variance of freed cash play an important role in this argument:

Once DPO increases and cash is freed it can be used to invest or to decrease debt. The freed cash should be tested for two criteria:

1. The inflow criterion: the mean cash level must substantially increase (depicted by arrow 1 in figure 10).
2. The outflow criterion: there must be an opportunity at hand to use the cash for with a return at WACC rate (arrows 2,3,5 and 6)

Examples of outflow are an investment opportunity (arrow 2) or debt available that can be paid off (arrow 3). If the DPO level decreases (arrow 4), the cash must be gained by divesting (arrow 5) or increasing debt (arrow 6).

\begin{center}
\begin{tikzpicture}
  \node (DPO) at (0,0) {DPO};
  \node (cash) at (2,0) {Cash pool};
  \node (Inv) at (4,0) {Investment};
  \node (Debt) at (6,0) {Debt};
  \draw[->,thick] (DPO) -- (cash) node[midway,above] {1};
  \draw[->,thick] (cash) -- (Inv) node[midway,above] {2};
  \draw[->,thick] (Inv) -- (Debt) node[midway,above] {3};
  \draw[->,thick] (Debt) -- (DPO) node[midway,above] {4};
  \draw[->,thick] (DPO) -- (cash) node[midway,above] {5};
  \draw[->,thick] (Inv) -- (Debt) node[midway,above] {6};
\end{tikzpicture}
\end{center}

Figure 10 – DPO and cash flow

Divesting or increasing debt when one has to is, as explained in paragraph 2.6, likely to be an unfavorable deal. Thus the cash should be freed for a lengthy period of time in order to be able to yield investment or long term debt rates at WACC level. The inflow and outflow criterion will be taken into account implicitly in the following three arguments:
(1) **Relative amount:** Given the end of year cash amounts at the scientific company in 2008 was 2 billion and 2.7 billion in 2009\(^{17}\), the cash freed must be sufficient to be able to invest or decrease debt without increasing the cash flow risk. I.e. if it does not increase the mean or decrease the variance significantly, then it is too risky to use the freed cash for this option, because of the cash inflow and outflow variance. At the moment of writing this thesis RF is in very early stage (less than a year experience within the HTM group). The impact of RF on variance and average an its sustainability cannot yet be determined with sufficient reliability. Based on information available mid 2010 and taking into account that the time length of supply contracts is usually one year, a combination of short and mid term debt could be decreased yielding a rate lower than WACC.

(2) **Alternatives:** The second inflow criterion argument is most related to suppliers. I.e. small amounts of cash by RF can alternatively be gained by offering commercial paper or short time financing, since the amounts are small it would not increase the interest cash flow risk significantly and rates are likely to be lower than \(f^s\). If amounts become larger, which is possible if the amount of receivables from the RF offering as a percentage of total assets increases, then RF becomes more beneficial and can be assigned a higher savings. This option does generally not hold for SME’s and a drawback is, when the amount financed via RF becomes substantial the dependence on the buyer credit rating increases. If the credit rating of the buyer deteriorates, than \(r^f\) will increase. If a cheaper financing option than \(f^s\) is available, then payments can be taken at maturity or the RF contract can be terminated anytime. Both alternatives do not necessarily undo the term extension agreement.

(3) **Variability:** This argument is relevant for the supplier and buyer and will be explained using an example depicted in figure 11. Assuming monthly orders and the payment term for the supplier (buyer) would be decreased (increased) by 40 days using RF yielding a substantial cash increase as depicted in figure 11. Then to be able to decrease long term debt or invest, the current cash levels must be exactly the inverse so that the accumulation of initial and freed cash equals a constant cash level. This is very unlikely since supply is decided on by operations, not finance. As an alternative financial solution debt can be decreased by the average freed cash level, i.e. € 86 in this example. Now this implies a shortage of cash whenever freed cash is below €86. Then only if short term financing is available when freed cash is below € 86, at a rate lower than the return on cash when freed cash is above € 86 a rate close to WACC can be assigned to the freed cash. This seems highly unlikely, moreover can the extent to which this is possible only be assessed if accurate cash flow forecasts for non RF cash flow are available.

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\(^{17}\) Source: Annual Report 2009
Thus not only seems the rate of WACC unlikely high, it is also unlikely that the supplier will advance payment when he does not yet need the cash, as will be discussed in the next paragraph, after the operational perspective has been introduced.

The operational perspective is less comprehensive and consists out of three arguments as well. The first argument germinates out of two calculation methods within the GPC and related consistency of policies. The second from a finance profession point of view and the third from a scientific point of view.

1. **Inter company consistency of policy:** This argument involves a decision tool for choosing between a discount or a payment term, which is used when a supplier offers a discount. This tool uses equation 2.3 (p 27): if the implied rate is higher than the buyers WACC rate, then the discount is taken. If the result is lower the invoice will be paid at maturity. The second method concerns the calculation of inventory holding cost. The working capital element in these holding cost equals WACC\(^{18}\). These two methods suggest that if cash is used or freed, the WACC rate applies. Bear in mind that all accumulated reductions in working capital by reducing inventory and increasing payment terms are estimated to be permanent and substantial. Table 2 (p 24) indicates that it is indeed substantial. Some managers go even further in their argument and prefer a rate higher than WACC, because it is believed to encourage reductions in inventory. The drawback of using a higher rate than WACC is discourage for projects with an ROI just above WACC.

2. **Cross company consistency of policy:** The RF concept at the scientific company holding is intended to be a long-term financing alternative. It is not established for the next two months but intend to implement RF as a long-term way of paying suppliers. Therefore, the relevant financing costs which should be compared to RF are the total average financing costs of the supplier, as the supplier will be able to fundamentally change his financing. Consequently for the extension of payment terms is also a long term extension and with similar arguments the WACC rate should be assigned to freed cash at the buyer.

3. **Scientifically:** The operational perspective is supported by scientists Modigliani & Miller (1958) and Schwartz (1959). From an academic perspective in making real investment decisions, all three agree that the appropriate discount variable is not the immediate financial source, but the overall cost of capital (Guerard & Swartz, 2007). Consequently other capital uses must on average be allocated an overall cost of capital rate as well.

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<table>
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<tr>
<th>Month</th>
<th>Order Amount</th>
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<tr>
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<td>€ 40</td>
</tr>
<tr>
<td>December</td>
<td>€ 30</td>
</tr>
</tbody>
</table>

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\(^{18}\) It uses WACC before tax, but this topic discusses after tax rates.
since otherwise the weighted average allocated cost of capital rate on all assets would not equal the overall corporate WACC. Consequently RF should be allocated the WACC rate.

Concluding, freed cash from RF at buyers and suppliers can replace at least short and mid-term debt and might be used (in combination with freed cash from other sources) to decrease longer term debt or invest\textsuperscript{19}. Thus the currently used rate (WACC) in the RF model might be too high, based on the arguments so far. For the purpose of consistency RF freed cash should be allocated the WACC rate.

3.2.2 Completeness of the model
The second topic of verification concerns the extent to which the model provides a complete representation of the expected RF impact in operational, financial and strategic sense. Obviously, following Bertrand and Fransoo (2002) a model cannot capture the full extent of reality. This RF model lacks the representation of the following:

a) Accounting-, debt rating implications and the suppliers perspective on the value of off balance sheet financing.

b) The suppliers perspective on the value of knowing when cash will flow in and having the possibility to sell a receivable on any moment before maturity to accelerate inflow when required, since a company does generally not notify a supplier when he will exactly get paid.

c) The extent to which RF is able to stabilize the supply base by saving suppliers from bankruptcy

d) The tradeoff for buyers and suppliers, between using RF for a price decrease and the current model for payment term extension.

e) The interaction with supplier integration and in particular consignment stock

f) Implementation difficulties and secondary improvements, e.g. decreasing the invoice confirmation time ($t_{bc}$), working capital awareness at purchasers and sales persons, legal awareness and cash flow control at suppliers.

In this chapter topics a-d will be discussed in the above sequence. Topic e will be discussed in chapter 5 and 6. Topic f will be discussed in chapter 6.

Off balance sheet financing
From a supplier perspective RF is a form of off balance sheet financing (OBSF). Following Law and Smullen (2008) OBSF is a method of financing a company’s activities so that some or all of the finance and the corresponding assets do not appear on the balance sheet of the company. In case of RF this holds for receivables by which a supplier can enhance its accounting ratios, such as the gearing ratio and return on capital employed. It can furthermore avoid breaking any agreements it has made with the banks in respect of the total amount it may borrow. This structure may enable the supplier to access more funding than would be possible on a standalone basis. OBSF gained a negative image since it has been possible, by drawing up complex legal agreements, to conduct off-balance-sheet finance and thus mislead the user of the accounts. This is highlighted by the scandal surrounding the collapse of the energy-trading giant Enron in 2002. Thereafter Standard & Poor’s updated its rating criteria for off-balance sheet items\textsuperscript{20}. Rating agencies would however, not view a buyer driven receivables program such as RF as detrimental to other ratings of the buyer so long as the programme does not

\textsuperscript{19} This assumes that RF is not already part of existing financing.

\textsuperscript{20} Source: Factoring off-balance sheet financing into the rating process 1-2 (April 15, 2002) http://www.standardandpoors.com
increase their debt capacity or put another way ‘so long as it used as a trade creditor for supply chain stabilizing purposes’ (Siddal, 2010). Accounting standards do however require at least a note on off balance sheet financing and depending on criteria such as control and risk over assets even capitalization might be required. Despite factoring without recourse - as used in RF described here – is treated as a sale of receivables in each accounting system identified by the researcher, companies might still be reluctant to use RF. The fact that non-recourse factoring does not qualify as liability for the supplier, because the risk is transferred to the factor that bought the receivable does not mean it is a cheaper source of financing than variants with liabilities on balance sheets. Nevertheless might the off balance sheet property of RF be valued by suppliers, particularly when their liabilities judgments are not publicly available, e.g. when they are not rated by rating agencies.

Selling a receivable any time versus traditional financing
As introduced in the discussion of the financial perspective on the rate of return on freed cash, RF can serve another purpose for the supplier than decreasing debt and investing. Faster invoice approval enhances cash flow visibility and cash flow predictability. This deterministic cash inflow replaces uncertainty. And the uncertainty is usually buffered with a cash pool or credit line which requires interest payment even if credit lines are not used, but only serve as a backup. This eliminates a credit line already, but additionally can serve to decrease the impact of cash flow variations that are either expected or not. These continuous short term additional features of RF provides value for any supplier regardless of their cost of capital. Additionally RF can serve to build up cash in case of infrequent exceptional expenses, e.g. for large bond payments due or for building up cash for an acquisition Striano (2010). These three important motivate the use of RF regardless of the cost of capital. Towards quantification of these features, alternative financing methods (e.g. credit lines or commercial paper) imply an interest with a term or value that might exceed the period in which cash is required, implying unnecessary interest payments. In case of RF ‘interest’ is only paid for the time to maturity21. Hereby there is a tradeoff between the expected expense by RF from advanced payment on the one hand and continuous interest payment of an alternative financial instrument (e.g. a credit line or commercial paper) on the other hand. This principle will be explained using a metaphor to enhance understanding of this topic for operations managers:
Cash flow can be compared with the flow of goods throughout a trading company holding inventory. The difference is that cash flows in the opposite direction. Demand and/or supply of goods have a certain variability and so does that of cash. Cash is like inventory, essentially a buffer and is thus required in smaller amounts if variability and/or uncertainty of its inflow and/or outflow decreases. Using RF the variability of inflow will be made visible reducing the uncertainty and controllable reducing the variability.22. This way emergency supplies (of cash or goods) might be costly when used, but cheaper in terms of total cost than interest expenses of continuously holding large buffers (of cash or goods).
Taking an operational perspective, this has no implications on the initial model. Furthermore neither Deutsche bank, nor Santander or Citibank quantifies this argument in their value proposition of RF towards suppliers. However, taking the financial perspective, visibility and flexibility have two implications on the initial model, i.e. (1) not every invoice is discounted in advance of maturity, i.e. invoices are on average discounted by the supplier after t'* and (2) the alternative for RF has a higher value r' and eventually a longer term d', as in constraint 3.5. Consequently if \((r'' + r') > w^*\) equation 3.4 can be replaced by equation 3.9. This number will only be positive if constraint 3.6 holds.

---

21 No interest expense, but a decrease in revenue
22 Up to the extent to which RF is offered for all receivables.
A similar reasoning does hold for the buyer, except that the buyer cannot decide on paying earlier or later, i.e. the buyer has to pay later and thus the buyer cannot decide when to free the cash. For the buyer however freed cash is except the initial IT expense for free.

For both the supplier and the buyer any savings are highly depended on the financing policies and alternative financing possibilities of the finance and treasury departments. An in depth analysis of the daily practices of a finance manager would be required to yield a rate to be allocated to RF savings.

Following Mitroff et al (1974) this model extension might be an expression of over validation resulting in unnecessary complexity for buyers and sellers with little financial knowledge and decreased generic contribution. I.e. the first element of equation 3.9 would continuously vary over time for a supplier and buyer. Of course one can evaluate RF with this model, but that is not the aim of this extension, the aim is to predict the advantage savings rate and therefore it would be better to use one rate for freed cash and the three above mentioned features in the initial model, rather than facing the following seven disadvantages by adding this extension:

1. Estimating the weighted average of at least five extra variables \((d, \tau, r, t^s, V_a)\)
2. The model is less recognized by banks and finance professionals in the RF industry
3. The model is inconsistent within a company over multiple policies in departments such as procurement, sales, operations and supply management and as a consequence, since these models use \(w\)
4. Because of internal inconsistency the model is difficult to justify
5. Because of additional variables the model is less explainable
6. (4) and (5) might imply a loss of credibility of the employees implementing RF
7. The previous six arguments limit the possibility of successful implementation

For these reasons the model extension is not very suitable for quick practical savings calculations. Nevertheless would it be wise to bear in mind that three additional features exist for suppliers.
Supplier stability and liquidity risk

The initial model represents RF as a mean to decrease the interest expense. The previous paragraph discussed RF as a cash flow forecasting and controlling tool. Additionally there are situations in which critical suppliers are about to go bankrupt. Hereby a multinational like the scientific company might be able to acquire the supplier, which can be a very expensive and strategically undesired option. RF might be an alternative to save a supplier from bankruptcy and thereby ensure supply. The larger the share of receivables from the RF providing buyer as part of total assets the more substantial these impacts can be. The prevention of supplier bankruptcy by RF by enables the supplier to pay its financial obligations. Otherwise bankruptcy proceedings may be started by the suppliers’ insolvent debtor or by its unpaid creditors.

In theory a possession of assets in excess of a firm’s liabilities implies solvency. Where the assets are either cash or marketable securities it may be obvious that a supplier is solvent. If assets are not as liquid as cash or marketable securities a supplier may have problems over meeting its obligations because, although it believes itself to be solvent, this view need not be shared by credit institutions. The information leading it to feel solvent, for example confidence in new products, may be private and not convincing to creditors. Insolvency however, is a symptom rather than a root cause for bankruptcy. RF is not a long term cash generator, but can once provide an increase in cash flow at an average level as can be calculated with equation 3.10. Frequent orders of similar size and a high share of receivables in RF as part of total assets imply a relatively higher likelihood that RF is able to substantially support the supplier. This support is twofold, i.e. (1) the freed cash can be used to pay off any financial obligations and (2) the interest rate using RF is lower than alternative sources of financing. The latter does less increase the financial burden and probability of default, if alternatives are available at all.

\[
\delta^e = V_a (1 - r^e - r') \left(\frac{t_a - t^b - t'}{365}\right)
\]

(Equation 3.10)

But even if the supplier is not about to go bankrupt RF can serve as a mean to decrease risk of the supplier itself, e.g. following Striano (2010) if a supplier realizes that it has a receivables concentration risk (affecting liquidity risk) with one particular buyer. It can for example do three things:

I. fund at LIBOR plus one to increase liquidity
II. participate in RF at LIBOR plus two
III. insure the receivables and pay a premium

In case of (III) it does not gain liquidity and in case of (I) it does not decrease the concentration risk. Selling receivables (II) provides liquidity and decreases the concentration risk resulting in meeting risk management or portfolio balancing objectives, rather than meeting a pure DPO or cost containment objective.

RF for a price decrease

RF can also be used by the buyer as a mean to decrease the purchase price instead of increasing the payment term. The situation in which the purchase price is decreased is noted by ‘μ’. Arcelus and Srinivasan (1990) developed a model describing the tradeoff for buyers between a price decrease and term extension for additional purchases. Although not explicitly stated, their model assumes before tax interest rates. Furthermore are the savings generated by economies of scale at the supplier and only the impact on the inventory value of the buyer is incorporated. The ‘RF price decrease model’ assumes constraint 3.1 holds. If not, then another tradeoff (a conversion of equation 3.9) should be made. The decision variable introduced instead of \( t^b \) is the discount \( \mu \), which can be calculated with equation 3.11
\[ \mu = \frac{V_a - V_\mu}{V_a} = 1 - \frac{V_\mu}{V_a} \]  
(Equation 3.11)

Hereby \( V_i \) can be replaced by \( u_i \) since \( D \) is assumed constant. Besides a profit impact of at least \( V_a - V_\mu \), a price decrease also impacts the interest expense of the supplier and buyer. For the supplier the savings can be calculated by subtracting the initial arrangement net income from the new arrangement net income, as shown initially in equation 3.12.

\[
S_\mu^a = \left( V_a (1 - \mu)(1 - T^a) - \frac{V_a (1 - \mu)(r^a + r^f)(t_a - t^b - t^f)}{365} \right) - \left[ V_a (1 - T^a) - \frac{V_\mu w^a (t_a - t^b - t^f)}{365} \right] \\
= V_a \left( (1 - \mu)(1 - T^a) - \frac{(1 - \mu)(r^a + r^f)(t_a - t^b - t^f)}{365} \right) - (1 - T^a) + \frac{w^a (t_a - t^b - t^f)}{365} \\
= V_a \left( \mu(T^a - 1) - \frac{(1 - \mu)(r^a + r^f)}{365} \left( t_a - t^b - t^f \right) \right)
\]  
(equation 3.12)

The last term does not include \((1 - \mu)\) since there is no real change in interest expense over \((t^b + t^f)\) for any \( \mu \). Hereby \( S_\mu^s \) is an after tax figure like \( S_\mu^i \). In order to obtain this figure, the pre tax non interest profit impact will be corrected for the effective tax rate \( T^i \). Hereby the model assumes an equal valuation of net profit after tax via less interest payments or increased profit of the supplier and buyer. This way \( S_\mu^j \) can be compared for any combination of \( i \) and \( j \). Bear in mind that in the second year in case of a price decrease \( S_\mu^b \), adds up to the first year savings, so \( S_\mu^{(y-2)} = 2S_\mu^{(y-1)} \) whereas \( S_\mu^{(y-2)} = S_\mu^{(y-1)} \). In other words, if the contract will be undone, cash saved by a price decrease remains, whereas cash freed by a payment term extension is used again. In an infinite timeline a price decrease will always outperform a term increase.

The feasible region of discount \( \mu \) is bounded on the one hand at \( \mu = 0 \), yielding \( S_\mu^{s^*} = S_\phi^{s^*} \) equal to equation 3.1, and \( S_\mu^b = 0 \). On the other hand the maximum discount \( \max\{\mu\} \) can be calculated using equation 3.13 and implies \( S_\mu^{s^*} = 0 \) (break even for the supplier). Using the result of 3.13, \( S_\mu^{b^*} \) can be calculated with equation 3.14.

\[
\max\{\mu\} = \frac{(w^a - r^a - r^f)(t_a - t^b - t^f)}{(1 - T^a)365 - (r^a + r^f)(t_a - t^b - t^f)}
\]  
(equation 3.13)

From the buyer perspective one could argue that if a price over the whole payment term decreases then payables decrease, so does the DPO ratio and as a consequence the buyer CCC is increased implying increased interest payments. This might appear correct, but in
practice it is incorrect, since a price change implies no change in interest expense with regard to payables period for the buyer. It implies the opposite effect, i.e. a lower purchase price decreases the real interest expense over the purchase price value of inventories and receivables until buyer payment is received. Subsequently the buyer savings can be calculated by subtracting the old CCC expenses from the initial CCC expenses of a particular SKU, as in equation 3.14, using two additional variables. The latter term reflects the interest savings on inventory value and increase in available cash after sales (1/2).

\[ \gamma \text{ Time of holding a purchased item in inventory (in days)} \]
\[ \zeta \text{ Time of having an item as a receivable (in days)} \]

\[ S^b_\mu = V_a \mu \left( (1 - T^b) + W^b \left( \frac{\gamma + \zeta - 2t_a}{365} + \frac{1}{2} \right) \right) \]

(equation 3.14)

**Tradeoff between price decrease and term increase**

It has been discussed in the previous paragraph and by introducing equation 3.4 and 3.5 that \( S^{b^*}_j \) and \( S^{s^*}_j \) cannot be obtained in one agreement. By keeping the financial impact on the supplier equal, the buyer might switch from a term increase to a price decrease or vice versa to increase his net savings, while keeping the impact on the supplier equal. Hereby every \( \mu \) has its ‘equal impact on supplier counterpart extension’ \( l_j \) and vice versa. Or formally \( S^s_\theta (t_\theta) = S^s_\mu (\mu) \). Where \( \mu (t_\theta) \) can be obtained with equation 3.15 and \( t_\theta (\mu) \) can be obtained by using equation 3.16. These equations are obtained by equalizing equation 3.4 and 3.12.

\[ \mu(t_\theta) = \frac{(r^s + r^t)(t_\theta - t_a)}{(1 - T^s)365 - (r^s + r^t)(t_a - t^b - t^t)} \]

(equation 3.15)

\[ t_\theta (\mu) = \frac{(1 - \mu)(r^s + r^t)(t_a - t^b - t^t) - \mu(T^s - 1)365}{r^s + r^t} + t^b + t^t \]

(equation 3.16)

As expected does \( w^s \) not play a role, since the interest over \( t_a \) is saved in both cases. Once the counterparts have been determined the buyer can choose for his maximum savings amount, formally: \( \max (S^b_\mu) \) i.e. \( \theta \in \{\theta, \mu\} \).

In the sensitivity analysis we will investigate the sensitivity of choosing for a price decrease or a term extension to input parameters variation. Additionally a combination of \( \mu \) and \( \theta \) is possible in one arrangement, but not useful, since given the linear nature of the equation either \( \mu \) or \( \theta \) will yield maximum savings for the buyer, while keeping the impact on the supplier equal.

In a case close to indifference \( S^t_\theta \approx S^t_\mu \), it is wise to consult a sensitivity analysis to obtain an indication of the robustness of the savings over time. Additionally KPI’s or strategic considerations can influence this tradeoff. Given \( S^s_\theta = S^s_\mu \) it follows that \( S^t_\theta > S^t_\mu \).
An alternative way to increase $S_j^b$ if is to purchase a payment term via RF, which is only beneficial if $w^b > r^e + r'$. Without RF purchasing a payment term is only beneficial if $w^b > w^e$. In case of using RF however, usually $w^b < w^e$. Purchasing a payment term via RF can be done as follows: e.g. the buyer and supplier agree $t_0 = 45$ instead $t_0 = 20$. Now if the buyer would like an additional term extension of 30 days, i.e. $t_0 = 45 + 30 = 75$ and compensate the supplier with a price increase, i.e. $\mu < 0$. The required price increase can be calculated using equation 3.15 with $t_0 = 30$. Using the negative $\mu$ in equation 3.11 the corresponding $V_\mu$ can be obtained for which it holds that $V_\mu > V_0$. Despite this yields a higher net savings after tax, it is an inefficient policy from a finance perspective, since (1) it decreases financial result of operations by an increased purchase price, which is a bad sign for investors and (2) usually other means of financing are available (e.g. commercial paper) that can be timed and have a lower interest rate. Furthermore (3) with purchasing a payment term via RF the buyer would have to renegotiate the terms when debt must be decreased. Therefore purchasing a term is very uncontrollable mean of long term financing. And if a relationship with a supplier ends, and the new supplier does not agree to this policy, the finance department is in a bad position, since they then urgently need financing. Consequently the GPC has a policy that prohibits purchasers to increase the price in order to pay later.
4. Supplier integration

In the past decade OM research has focused on how collaborative inventory programs can make inventory commitment more efficient and improve buyer service (Williams and Tokar, 2008). In an examination of the discipline of logistics and logistics research Davis-Sramek and Fugate (2007) revealed that leading discipline visionaries feel that one area in which logistics researchers must focus is coordination and collaboration. This focus started already in the past decade (Williams and Tokar, 2008). Collaboration with suppliers is applied to share accurate sales and production forecasts to decrease response and lead time, while shifting inventory upstream to reduce inventory levels (Goldsby et al. (2006); Erlebacher and Meller (2000) and Dixon (2001)).

The research method with regard to supplier integration has been described in chapter 1 and is depicted in figure 4. More specific, first the supplier integration strategy of the scientific company will be analyzed (arrow 1 in figure 12). Second, the criteria for compensation according to this literature are verified with the cases in the GPC (arrow 2 in figure 12). Third, if literature and cases do not converge, an explanation is provided by the GPC employee that implemented the case. This explanation is verified with literature (arrow 3 in figure 12). Thereafter the financial supplier integration impact on the supplier and buyer will be modeled scientifically and verified. In chapter 5 the scientific supplier integration model will be integrated with the RF model.

4.1 Supplier integration at the global pharmaceutical company

The supply chain management strategy at the scientific company aims at evolving the supply chain into a sustainable agile asset light supply chain, achieving high buyer service levels. Agile refers in this sense to flexible capacity and sustainable refers to the endurance of the supply chain status in the future. This strategy supports outperforming competition and company value maximization. Following Uquillas (2010) there are essentially three lines of development in GSCM: 1) Enabler projects, to create transparency along the supply chain and build a fundamental basis. 2) Inventory optimization projects which consider key inventory reduction levers. These key levers are: safety stock optimization, lead time reduction, forecast accuracy, and centralized determination of delivery volumes. 3) Mid and long term optimization approach which uses best practices and lessons learned from 1 and 2 to share over various units, the decrement of the portfolio complexity, and increment of levels of coordination.
Within the supply chain strategy a supplier integration strategy uses aspects of all three lines of development expressed in one out of four options per stock keeping unit (SKU):

I. Supplier managed inventory (SMI) with consignment stock (CS) at the site of GPC
II. SMI with consignment stock on an external site
III. SMI without consignment stock
IV. make just in time (JIT) to order with reduced lead time

In academic literature and practice vendor managed inventory (VMI) and SMI are often perceived as synonyms and consignment stock is sometimes implicitly assumed. VMI and SMI are indeed similar, i.e. both incorporate management of inventory based on the demand information exchanged by the buyer. The difference lies in the party that manages the inventory, i.e. a supplier or a vendor. The supplier is generally more upstream in the supply chain than a vendor. And the word ‘vendor’ is commonly used for companies supplying consumer goods retailers\(^\text{23}\). Pohlen and Goldsby (2003) reveal that the essences of VMI and SMI are identical and therefore SMI impacts can be derived from VMI models if the assumptions apply to the particular case. For an in debt comparison between VMI and SMI readers are referred to Pohlen and Goldsby (2003). The other part of the preferred option, consignment stock, is the stock of goods at a buyer which is still the property of the supplier. Payment for these goods is made to the supplier at the moment when they are used/withdrawn by the buyer\(^\text{24}\).

The four options above are mentioned in decreasing order of robustness and inventory reduction potential and increasing order of intensity of information sharing. Clearly SMI with consignment stock (SMCS) at the GPC is the option that is most robust, has the largest potential for inventory reduction and smallest intensity of information sharing and is therefore preferred if the criteria the following criteria apply:

- a) high inventory volume,
- b) low demand volatility,
- c) reliable supplier,
- d) a long term future relationship with the supplier is desired
- e) the supplier is willing to participate
- f) there are no limitations in the sense that inventory should be kept on own stock for strategic purposes.

These converge with the adoption determinants from Dong, Xu and Dresner (2007). An aggregation of the financial impacts for buyer as well as the supplier is depicted in appendix 6. Some suppliers argue that the impact of SMCS on their profit is negative, since the additional interest expense on holding inventory at the buyer site is larger than the supplier’s savings. Consequently they asked for compensation. This request is driven by consignment stock expenses, not by SMI expenses, since SMI provides accurate demand forecasts enhancing supplier operations and logistics efficiency, as depicted in appendix 6. Furthermore, given criterion ‘a’, the annual extra interest expense for the supplier is substantial in relation to the SMI costs. The inventory value satisfying criterion ‘a’ is multiple millions of raw material inventory per SKU. Even if the supplier WACC is only 5% this would imply interest expenses of 50,000 per million inventory value, annually. Given WACC is often higher than 5%, inventory levels are multiple millions and the arrangements are implemented to last multiple years the IT share of total costs is not considered an obstacle and sometimes even sunk given lines of development 1 and 2 Uquillas (2010).

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\(^{23}\) The first VMI arrangement was implemented by WalMart.

The buyer can calculate the extent to which RF can provide the requested compensation. But given a high inventory volume and the explanation in the previous paragraph the supplier can argue to require any level of compensation, despite SMCS is a collaborative development. In fact both parties are tempted to exaggerate their cost components and understate their gain components. It is therefore important to assess the financial impact with a complete and correct framework of financial impact on the supplier and buyer. And even if the supplier does not require compensation, it is wise to investigate the impact on the supplier and buyer as a mean to assess the extent to which the negotiated benefits from the arrangement are off from the maximum achievable benefit by the arrangement. This maximum achievable benefit for the buyer is achieved if savings are maximized without financially harming the supplier and thereby increasing the supply risk. I.e. a supplier can be eager to ‘win’ a supply agreement (for multiple years) by providing consignment stock without compensation and grow revenue. This is however at cost of increased interest expenses which might imply an interest snowball effect leading to bankruptcy.

The next step is the verification of the conceptual model in appendix 6, as depicted by arrow 2 in figure 12. This will be done in three steps. First the financial impact on a multinational IT company as described by Waller, Johnson and Davis (1999) will be compared with the reality in the GPC (as modeled in appendix 6) to enhance external validity. Then other conceptual models will be confronted with the reality within the GPC and last quantitative models will be confronted with the GPC reality. Finally a scientific model will be built and validated with the GPC. Thereafter arrow 3 starts to provide feedback on empirical results.

4.2 Literature verification of conceptual model

Appendix 6 will be verified with research on SMI and VMI in two stages, i.e. the SMI and the consignment stock stage. First the SMI aspect (colored blue in appendix 6) will be verified with literature. Then the consignment stock aspects (colored green in appendix 6) will be verified.

VMI and SMI literature

Waller, Johnson and Davis (1999) provide practical insights in addition to the SMI aspects. These practical insights yield a conclusion that shorter planning terms decrease efficiency of operations, warehousing and transport and sometimes even lead to unavailability of operations or transport capacity, except against very high prices. With VMI/SMI, however the supplier typically schedules production and transport in advance, hoping to ensure more predictable and feasible production and transport delivery schedules. This shift from reactive to proactive planning helps to reduce the bullwhip effect, i.e. large order fluctuations can be perceived by sales and production employees as changes in long term average demand, which led to fluctuation in orders. By replacing perception with forecasts accurately representing demand, there is no place for the essence of the bullwhip effect: misperception. Additionally Waller, Johnson and Davis (1999) argue that multiple buyers enforce the positive impact of SMI, since a non-critical delivery can be diverted for a day or two to enable a critical delivery to another buyer. Similarly, a smaller than usual replenishment to one buyer may enable a larger than usual shipment to a buyer in dire need. This ability of balancing buyer needs can improve the supply chain performance without jeopardizing any individual buyer. Buyers benefit from the assurance that they are assured that their most critical needs will get the most attention. Without the accurate forecast and inventory level information the supplier has a difficulty in prioritizing
buyer shipments effectively. These additions do impact the magnitude of the benefits, but do not change the components or their structure in appendix 6.

Additionally Claassen, van Weele and van Raaij (2008) interviewed purchase managers revealing perceived VMI impacts: cost reductions in administration, transportation, inventory and materials handling, improved buyer service levels, supply chain control, in terms of less stock-outs and prevention of the bullwhip effect. Despite the impact on cost reductions is weak administration cost of the buyer is an addition to the model in appendix 6. This will be added to the model, so we derive the model in appendix 7. Following Claassen et al (2008) a reduction in administration cost is possible since extensive materials requirement planning is not necessary anymore, i.e. whereas individual purchase orders are replaced by blanket purchase orders and furthermore does backorder administration no longer exist for the VMI SKU. In addition to management perception of VMI Vereecke & Muylle (2006) measure performance by balance sheet figures from collaboration with suppliers and buyers and find only weak evidence of financial performance improvement as well. Petersen, Ragatz and Monczka (2005) find evidence of the impact from effective collaborative planning efforts with suppliers on supply chain performance and, only indirectly, on a firm’s financial performance. This converges with appendix 7.

Consignment stock literature

The concept of consignment stock has been explained in the first paragraph of this chapter and is depicted in figure 13, where color represents ownership. Corbett (2001) provides a theoretical analysis suggesting that consignment stock helps reduce cycle stock by providing the supplier with an additional incentive to decrease batch size, but simultaneously gives the buyer an incentive to increase safety stock by exaggerating backorder costs. It can be derived from Corbett’s model that in practical absence of a central planner with full information, no party can induce jointly optimal behavior from all parties in the supply chain without sacrificing his own profits. Subsequently following Corbett (2001): “if long supplier production cycles are the key driver of inventory, the supplier should be made to bear the costs of the resulting cycle stocks, e.g., through a consignment scheme. Conversely, if uncertainty about down-stream demand is the main driver, the buyer should bear the costs of the resulting safety stock”. Valentinia and Zavanella (2003) add that consignment stock also enables complementary intangible advantages, e.g. a higher degree of flexibility, increased service levels in turbulent environments and reinforced reliable relationships between buyers and suppliers. These intangible benefits from CS are also recognized by authors arguing CS to be harmful for the supplier from an economic point of view (Valentinia and Zavanella, 2003). The positive effects increase more than proportionally when incorporating more buyers in the program, as is usually the case in VMI and arrangements (Zavanella and Zanoni, 2009). From their 2009 article we can derive that the complementary intangible advantages mentioned in the 2003 article are related to SMI, not to consignment stock. Therefore no additional changes to appendix 7 are made.

### Figure 13 – inventory ownership: consignment vs. non consignment

4.3 **Scientific model**

The research discussed on VMI/SMI so far has been able to verify the components leading to financial impact as depicted in appendix 7. Some studies provided the magnitude of the impact,
but lack to provide the measurement and calculation method, so it cannot be checked if the assumptions hold. Measurement and calculation methods are necessary to translate the conceptual model to a scientific model. The assumptions of the VMI model of Çetinkaya and Lee (2000) do not match the reality of the GPC SMI system. Neither do the assumptions of the model of Dong and Xu (2002) hold. Primarily since the model assumes that the buyer company is the "leader" in their model, i.e. it specifies order quantity according to its own cost characteristics, and determines purchase prices, which is not the case at the GPC. Some researchers investigated the impact of specific aspects of VMI/SMI, i.e. the bullwhip effect (Disney and Towill, 2003), transport (Disney, Potter and Gardner, 2003) or in specific supply chains, i.e. VMI in the retail supply chain (Kiesmuller and Broekmeulen, 2010) or both, i.e. batch size impact in a supplier job shop environment in an OEM supply chain (Nyen et al, 2009).

The model that fits the GPC situation best is from Yao, Evers and Dresner (2007). They discuss a single supplier and a single buyer model, assuming a single stock-keeping unit is transacted between the supplier. This is generally the case at the GPC SMI cases, despite multiple SKU’s are possible. Consumer demand is assumed to be deterministic and known to the buyer under normal (non- SMI) operating procedures and known to both the buyer and supplier under VMI, which holds, since production schedules are consumer demand in this case and known in advance. These schedules are accurate, since otherwise SMI does not make sense. In an SMI situation the following variables are used in the setting depicted in figure 13 where they buyer order from the supplier as depicted in figure 2.

\[
\begin{align*}
q'_i & \quad \text{order size} \quad \text{units} \quad \rightarrow \quad q'_i \\
c'_i & \quad \text{order cost} \quad \text{Euro's} \\
y'_i & \quad \text{inventory handling cost per Euro} \quad \text{percentage} \\
w'_i & \quad \text{weighted average cost of capital} \quad \text{percentage} \\
T'_i & \quad \text{represents the effective tax rate} \quad \text{percentage} \\
z'_i & \quad \text{the average inventory level} \quad \text{units} \\
G'_i & \quad \text{the inventory holding cost} \quad \text{Euro's} \\
D & \quad \text{annual demand} \quad \text{units}
\end{align*}
\]

Figure 14 – SMI variables

With \( i \in \{s, b\} \) where \( s = \text{supplier} \) and \( b = \text{buyer} \) and \( j \in \{\alpha, \beta\} \) where \( \alpha = \text{initial situation} \) and \( \beta = \text{SMI situation} \). Furthermore the cost rate of holding inventory (\( h' \)) can be calculated using equation 4.1.

\[
h' = w' + y'
\]

(equation 4.1)

Yao, Evers and Dresner (2007) calculate the savings assuming deterministic demand before and after SMI implementation. At the GPC accurate forecasts provided to suppliers is implemented as part of the arrangement, providing deterministic schedules. Furthermore do Yao, Evers and Dresner (2007) not take the consignment stock impact into account. This research does take the consignment stock savings into account as well as the savings from SMI as far as they are incorporated in Yao et al. (2007).
SMI and consignment impact on the buyer

First the impact of consignment stock and SMI for the buyer will be calculated. For the buyer the cost of holding raw material inventory before SMI $G^b_a$ can be calculated with equation 4.2.

$$G^b_a = z^b_a \times u^b_a \times h^o$$

(equation 4.2)

After SMI is implemented material is still in the warehouse of the GPC and handled by the GPC employees, but owned by the supplier. Therefore the holding costs for the buyer after SMI will be as equation 4.3. Since the handling cost do not increase if the purchase price increases, the initial purchase price is taken as a multiplication factor for handling cost for the buyer.

$$G^b_p = z^b_p \times u^b_p \times y^o$$

(equation 4.3)

Where $z^b_p = \frac{q^*_p}{2k_p} + \text{safty stock (ss)}$. Safety stock (ss) is a requirement by the GPC in the four cases investigated, despite deterministic demand is a reasonable assumption according to Yao, Evers and Dresner (2007). This results in the total savings from inventory reduction according to equation 4.4.

$$G^b_a - G^b_p = z^b_a u^b_a h^o - y^o u^b_a \left( \frac{q^*_p}{2k_p} + \text{ss} \right)$$

$$= u^b_a \left( z^b_p h^o - y^o \left( \frac{q^*_p}{2k_p} + \text{ss} \right) \right)$$

(equation 4.4)

Initially one additional savings effect has been modeled, i.e. the invoicing frequency savings ($F^b$). The moment production requires material and consequently takes material out of the warehouse is given by production schedules. The moment of taking a product out of the consignment warehouse is referred to as the moment of usage. The invoicing frequency effect became apparent after the researcher wondered what the difference of impact on cash flow would be between (1) being invoiced and pay every item directly after usage and (2) being invoiced and pay once per year for all items. It was hypothesized that the less often an invoice is received, the longer cash will be hold, the larger the savings are. For this explanation we assume $t^o_p = t^o_p = 0$. Now, the average days supply on hand (DSOH) can be calculated using equation 4.5, representing the average time between receipt and usage of material at the buyer site. Hereby ‘D’ represents the annual demand in units.

$$\text{DSOH}^b = \frac{365 z^b}{D}$$

(equation 4.5)

After implementing SMI, if items are counted, invoiced and paid directly after usage then equation 4.4 represents the savings. If the buyer would be invoiced once per year, the savings for the buyer are as follows. Assuming one item is used per day, then the first item used in a year is paid 365 days after usage and the last item used is paid 0 days after usage. With time between invoicing ‘a = 365’ the invoicing frequency savings can be calculated using equation 4.6.

$$F^b = \frac{a V_w^b}{2 \times 365}$$

(equation 4.6)

If usage is not equally distributed between two counting periods, then a number other than 2 should be used in equation 4.6 to represent the impact, i.e. smaller than 2 for skewed to direct
after counting usage and larger for skewed to before counting usage. The exact number can be obtained using the material requirements distribution from production.

After validation it became apparent that another savings effect should be incorporated, i.e. the counting moment savings \((X^b)\). Items can be counted directly after taking an item out of raw material inventory as assumed so far, but alternatively they can be counted after production, or even after sales. Using ‘x’ for the average time between usage and counting, the counting moment savings can be calculated using equation 4.7.

\[ X^b = \frac{x V_u w^s}{365} \]  
(equation 4.7)

The total cost impact of the arrangement can be calculated with equation 4.8.

\[ S^b = G^b - G^b + F_b + X_b = u^b \left( Z^b h^b - y^s \left( \frac{q^s}{2k^s} + ss \right) \right) + \frac{\left( \frac{a + x}{2} V_u w^s \right)}{365} \]  
(equation 4.8)

**SMI and consignment impact on the supplier**

Following Yao, Evers and Dresner (2007) the supplier’s optimal order quantity before the SMI is according to equation 4.9, which is similar to the EOQ formula (Silver et al, 1998). In equation 4.9 \(m^s\) represents the profit margin on the SKU considered. The profit margin can be subtracted from the unit price in interest calculations, since no interest is paid on the profit margin of inventory.

\[ q^s = \sqrt{\frac{2c^s D}{h^s u^b (1 - m^s)}} \]  
(equation 4.9)

The total costs of the initial situation are as in equation 4.10.

\[ TC^s = h^s u (1 - m^s) q^s \]  
\[
(1 - 2h^s u (1 - m^s) q^s = \sqrt{2c^s D h^s u (1 - m^s)} \]  
(equation 4.10)

In the new situation the order quantity for the supplier is likely to be an integer multiple of the buyer’s replenishment quantity, i.e. \(q^s = q^b k^b\) where \(k^b\) is a positive integer (Silver et al, 1998). Hereby the optimal \(k^b\) and order sizes are as follows (Yao, Evers and Dresner, 2007), given \(c^a = c^s\).

\[ k^b = \sqrt{\frac{2c^s h^s u^b (1 - m^s)}{c^s h^s u^b (1 - m^s)}} = \sqrt{\frac{c^s}{c^b}} \]  
(equation 4.11)

Equation 4.11 is different from equation 7 in Yao et al (2007) since it uses the suppliers holding cost for the buyers stock, because of the consignment stock case. Similarly equation 4.12 corresponds to equation 9 in Yao et al (2007), defining the optimal buyer order size decided on by the supplier.
\[ q_{\beta}^{*} = \sqrt{\frac{c_{\beta}^{s} D}{h^{s} u(1 - m^{s})}} \]  

(ecuation 4.12)

And the last decision variable is the order quantity of the supplier corresponding to equation 8 in Yao et al (2007).

\[ q_{\beta}^{s*} = \sqrt{\frac{2c_{\beta}^{s} D}{h^{s} u(1 - m^{s})}} \]  

(ecuation 4.13)

To calculate the total cost of the arrangement the impact of the invoicing frequency and the moment of inventory usage counting at the supplier have to be taken into account as well. This results in equation 4.14.

\[
S_{\beta}^{s} = \sqrt{2c_{\alpha}^{s} D h^{s} u(1 - m^{s}) - \frac{c_{\beta}^{s} D}{q_{\beta}^{s*}} - h^{s} u(1 - m^{s}) \left( q_{\beta}^{s*} - \frac{k_{\beta} - 1}{2} q_{\beta}^{b*} \right)} \\
- w^{s} (1 - m^{s}) \left( \frac{q_{\beta}^{s*} u}{2K_{\beta}} + ss + \frac{1}{2(a + x)} V_{a} \right) \\
= \sqrt{2c_{\alpha}^{s} D h^{s} u(1 - m^{s})} - \frac{c_{\beta}^{s} D}{q_{\beta}^{s*}} \\
- u(1 - m^{s}) \left( h^{s} \left( q_{\beta}^{s*} - \frac{k_{\beta} - 1}{2} q_{\beta}^{b*} \right) - w^{s} \left( \frac{q_{\beta}^{s*} + ss + \frac{1}{2(a + x)} D}{365} \right) \right) 
\]  

(ecuation 4.14)

The first term of the equation equals the total cost of the initial arrangement, the second term represents the supplier ordering costs in the SMI case, the third term refers to the supplier holding cost on the supplier side in case of SMI, the fourth term refers to the supplier holding cost on the buyer side in case of SMI, including the impact of invoicing frequency and counting moment (i.e. equation 4.6 and 4.7).

**Validation**

This model has been validated with four implemented SMI cases at the GPC and fitted the case situations. In one case the GPC takes only whole batches out of inventory and does not use them to the full extend. In this case \( a = 0 \) can be used. In many cases \( S_{\beta}^{s} < 0 \), but according to literature and interviews within the GPC the supplier values the guaranteed future demand, especially if it faces high fixed costs. Additionally some aspects of the conceptual model have not been included in the quantitative scientific model. Appendix 8 provides an overview of the items included and excluded. Only if \( S_{\beta}^{s} + \text{intangible advantages} < 0 \), the supplier requires compensation. In the paragraph 6.2 it will be verified if RF can provide this compensation.
5. Integrating the models

The RF model and SMI with consignment stock model are developed in a way such that by using both agreements the values for $S_j$ can be accumulated for the buyer or supplier. Hereby the input values for variables used in both arrangement should be equal, except for changes in these variables as a result from an implemented arrangement. E.g. a decreased payment term or increased purchase price after the implementation of SMI and consignment stock should be incorporated when calculating benefits of RF.

Note that the inventory handling cost ($y_i$) are independent of price changes and are therefore used in relation to $u_\alpha$ rather than $u_\beta$ in the SMI and consignment stock model.

From figure 20 it can be derived that it is wise to start implementing RF before SMI with consignment stock since compensation for SMI and consignment stock might be provided by a decreased payment term, resulting in less savings potential for RF.
6. Sensitivity analysis

This chapter assess the savings related to a particular contract versus continuing with the current contract. The current contract involves neither RF nor SMI & consignment stock. Hereby one input variable at a time will be varied over a range of plausible values, keeping other input variables constant. These plausible values can be established in two ways (1) by initial selection and (2) as a change over time. I.e. the value for \( t_0 \) is established by selection only and the value of \( r^e \) will change over time only, but the purchase price \( u_\alpha \) is subject to both. The impact of (1) is explicitly depicted in graphs in this chapter, i.e. the difference on the vertical graph axis between 0 and the objective value \( S_j \). The impact of (2) can be obtained by comparing the difference on the vertical axis between objective values for two or more input values on the horizontal axis. The formula's used in this chapter are depicted in appendix 14.

6.1 RF sensitivity

In order to assess the impact from changes in input variables on total savings, a base case is required, providing realistic variables. This base case is established using the averages at the HTM division calculated from 21 RF contracts in Europe. The weights from this average are used to calculate the weighted average payment term extension. The values for \( w^b \) and \( r^f \) are realistic, but not real for confidentiality reasons. The value for \( r^e \) is made publicly available by the ECB and is an annual figure, converted to invoice the time to maturity. Additionally averages for \( t^b \) and \( t^f \) are obtained from interviews and internal HTM presentations. The base case is defined as follows:

\[
\begin{align*}
V_{t_0} & = 12.7 \quad \text{million euro's} \quad (CV = 0.14) \\
t_0 & = 42.4 \quad \text{days} \quad (CV = 0.33) \\
t^b_{t_0} & = 63.8 \quad \text{days} \quad (CV = 0.31) \\
w^b & = 8.0 \quad \text{percent} \\
w^e & = 10.0 \quad \text{percent} \\
r^b & = 1.5 \quad \text{percent} \\
r^f & = 0.5 \quad \text{percent} \\
t^b_{t_0} & = 2.0 \quad \text{days} \quad (\text{varying between 0 and 5}) \\
t^f_{t_0} & = 0.5 \quad \text{days} \quad (\text{varying between 0 and 1})
\end{align*}
\]

Given the input from the HTM group case it can be checked that constraints 3.1 till 3.4 hold. Subsequently the potential savings of RF can be calculated. Note that \( S_j \) in this sensitivity analysis is per contract in thousands euro's. First, it follows from equation 3.1 that \( S_j = 109 \). Furthermore using equation 3.3 it follows that \( \max \{ t_0 \} = 200 \) days and, using this outcome in equation 3.5 it follows that \( S^b_{t_0} = 439 \). The cases above yield \( t^b_{t_0} = 63.8 \), resulting in \( S^b_{t_0} = 96 \) and \( S^b_{t_0} = 16 \). The sensitivity will be tested per variable or in case of similar impact per set of variables. Hereby we treat the weighted average input variables of 21 contracts as were it a single contract.
RF for a price decrease

If RF would be used for a price decrease, then given $S^i_j = S^i_j$, the financial impact for the buyer depends on $\gamma + \zeta$, since other input values are given. E.g. $T^i = 30\%$, but will be varied later in this chapter. If we vary $\gamma + \zeta$ between 0 and 400 the resulting savings are depicted in figure 15. Using RF for a price decrease with these input variables is not more beneficial than using RF for a payment term extension, despite $S^b_\mu$ increases slightly and linearly as $\gamma + \zeta$ increases, i.e. $S^b_\mu > S^b_\mu$ given the case input parameters with $t_\theta$ and $\mu$ subject to $S^i_j = S^i_j$. When $w^b$ varies $S^b_\mu > S^b_\mu$ does no longer hold as we will see in figure 21. Therefore the sensitivity of savings depending on $\mu$ is relevant. Furthermore does varying $\mu$ yield insight for cases with other input values. Similar to deciding on $t_\theta$, deciding on $\mu$ is a conflict of interest as depicted in figure 16.

![Figure 15 – RF savings and CCC length](image1)

![Figure 16 – RF savings and price decrease](image2)

New term ($t_\theta$)

RF can be a mean to provide a solution for the conflict of interest between the buyer (preferring a DPO increase) and supplier (preferring a DSO decrease) since both are possible within one RF contract. Deciding on $t_\theta$, however is a similar conflict of interest. For the case $t_\theta = 63.8$ days, varying $t_\theta$ changes the impact on the buyer and supplier substantially, as depicted in figure 17. Despite $S^b_\mu - S^i_j$ increases as $t_\theta$ increases, the buyer purchasing a payment term is not considered an option for the reasons explained in the last paragraph of chapter 3 ‘Tradeoff between price decrease and term increase’. By integrating figures 16 and 17 using equation 3.15, figure 18 is obtained, where the blue line disappears behind the red line as is the case in figure 15, since $S^i_j = S^i_j$. Figure 18 also supports figure 15 by illustrating $S^b_\mu > S^b_\mu$ in the feasible regions of $t_\theta$ and $\mu$. 

58
From figure 18 it can be derived that, holding supplier savings constant buyer savings are more sensitive to a payment term extension than a price decrease.

**Purchase value (V\textsubscript{α})**

From appendix 9 we derive that \( V\alpha \) has a linear effect on \( S'_i \), which is depicted in figure 19. Note that the axis scales are both logarithmic, e.g. \( V\alpha = 10^6 \) = 1 million euro’s yields \( S^b \approx 10^3 = \) thousand euro’s \( (S^b \approx 4 \times S^p) \). From figure 19 it can be derived that higher purchase volumes will yield higher savings. Therefore it is wise to take \( V\alpha \) into account while prioritizing supply agreements for RF adoption.
Initial term ($t_\alpha$)

From the equations in chapter 3 we can derive that an increase in $t_\alpha$ increases the maximum potential savings $S^*_i$. To illustrate this effect we depict $S'_i$ and $t_\alpha$ subject to $S'^b_\mu = S'^s_\mu = S'^s_\mu$ in figure 20. Hereby the results of equations 3.4, 3.5 and 3.12 are equal. And indeed it can be seen that larger values of $t_\alpha$ yield higher savings.

Savings rate ($w^i$)

So far we assumed the savings percentage to be at the level of WACC. In paragraph 3.2.1 ‘the value of freed cash’ arguments have been provided for a lower savings percentage than WACC. A lower value than WACC does yield less savings from the same agreement. The impact of the rate allocated to freed cash from RF on $S'^i_j$ is depicted in figure 21. This is once more subject to $S'^s_\mu = S'^s_\mu$.

![Figure 21 – RF savings and the rate allocated to freed cash](image)

From this figure two conclusions can be drawn. First it makes sense for the buyer to convince the supplier of a high savings rate, since this increases $S'^s_\mu$ and thus increases the chances on an increase of $S'^i_j$. Second, if the buyer allocates $w^b \leq r^e + r'$, then $S'^b_\mu \geq S'^s_\mu$ and hence the buyer will save at least as much when he chooses for a price decrease.

![Figure 22 – RF savings and supplier tax rate](image)

![Figure 23 – RF savings and buyer tax rate](image)
Consequently higher values of $\gamma$ and $\zeta$ become relevant, since they increase $S^b_\mu$. Furthermore e.g. if at $T^i = 30\%$ we have $w^b = 2,1\%$, $w^s = 4,6\%$, $t_0 = 63,8$ and $\mu = 0,17\%$. Then by varying $T^b$ while keeping $t_0$ and $\mu$ fixed figure 23 can be obtained. When $T^b$ increases the absolute difference between $S^s_\mu$ and $S^b_\mu$ becomes smaller for any value of $w^b$. But $T^b$ will not cause a preference for either a price decrease or a payment term extension. This does not hold for the buyer savings and tax rate, i.e. it can be concluded from figure 22 that higher supplier tax rates motivate towards RF for a price decrease. Note that the tax rate is a selection variable and moderator variable.

**Economic changes**

Macroeconomic or microeconomic changes can impact $S^i_j$. Macroeconomic changes can impact the Euro Interbank Offered Rate (EURIBOR) at which the bank borrows. An increase in EURIBOR will directly increase the cost of RF via $r^e$ with the same magnitude, i.e. $w^r = r^e + x$. In figure 24 the Euribor history is depicted and in figure 25 the impact of $r^e$ on is $S^i_j$ depicted. We can conclude that changes in $r^e$ will impact $S^i_j$ substantially and $S^s_\phi$ hardly. For $r^e$ a linear increase to 2,6% in 2013 is forecasted by Bloomberg. Based on figure 25 renegotiation initiated by the supplier can be expected in case of using RF for a term extension.

On the other hand can micro economic changes impact $S^i_j$. If the suppliers cost of capital changes, the impact on $S^s_\phi = S^s_\mu$ can be derived from figure 21. If the cost of capital of the buyer change, then $r^i$ will change as well, consequently changing the supplier savings as well as the buyer’ savings. Hereby the relationship between $r^i$ and $w^b$ is unknown, therefore two plausible scenario’s are depicted in figure 26, which both assume $w^b = WACC$ of the buyer, but this assumption is not relevant for the problem. Furthermore once again $S^s_\phi = S^s_\mu$.

For figure 26 the relation of buyer cost of capital and the RF rate was required. Two plausible scenario’s haven been developed and are depicted by the purple and green line. We can conclude that if the agreement is not changed the supplier savings will decrease if the buyer creditworthiness deteriorates and the buyer savings will increase in case of a term extension. In case of a price decrease there is no change in the buyer savings.
6.2 SMI with CS sensitivity

At the GPC approximately forty cases of supplier integration are in various stages of development. Only four cases are fully implemented SMI and consignment stock cases. All four cases have been used to validate the model. In this chapter one case will be used to illustrate the ability to compensate the supplier with RF or two alternative compensation methods and to illustrate the sensitivity of compensation. The following input variables apply to the case.

- \( z_a \) = 450 units
- \( D \) = 900 units
- \( u_a \) = 2500 euro
- \( y \) = 5.5 percent
- \( ss \) = 300 units

Furthermore \( c_i = 100 \) is assumed. Since this model does include 15 relevant variables to test the sensitivity it is split up in three paragraphs, i.e. operations and planning variables, financial variables and contractual variables. The impact of variability in each of the 15 variables on total savings will be compared over four scenario’s per graph:

1. SMCS without compensation \( (S_{ij}^b) \)
2. SMCS with compensation by RF \( (S_{ij}^b + o) \)
3. SMCS with compensation by a price increase \( (S_{ij}^b + \delta) \)
4. SMCS with compensation by a normal payment \( (S_{ij}^b + t) \)

Scenario 1 has been discussed in the previous chapter. In scenario two \( t\theta = t\alpha \) and \( S_{ij}^b + S\theta = S\theta + S\theta \) resulting in \( S\theta + \theta = S\beta \). Scenario three was initiated by the supplier, it implies a price increase of 12 month EURIBOR + 5% over the safety stock value\(^{25} \). Scenario three and four are formally described in appendix 8. In scenario four the new payment term will be \( t\theta = t\beta \)

\(^{25}\) i.e. \( u\beta = u\alpha \left( 1 + \frac{ss\left( o + r^{e(12m)} \right)}{D} \right) \) with \( o = \) compensation rate, \( r^{e(12m)} = 12 \) month euribor rate

---

*Figure 26 – RF savings and buyer cost of capital changes*
days. The supply chain savings \((S^b_j + S^s_j)\) are hardly discussed, since this is not a relevant topic of discussion in negotiations. Especially since if a scenario is chosen based on maximal supply chain savings, then it might not be optimal for both the supplier and buyer. As a consequence of a non optimal contract the exchange of cash to split savings equally will eventually take place in a scenario similar to scenario 2,3 or 4. The supply chain optimum is therefore already implicitly included in the sensitivity analysis. It can be observed that the tradeoff between scenarios 2 or 4 versus 3 is similar to equation 3.15 versus 3.16.

6.2.1 Operations and planning variables

In this paragraph the sensitivity of inventory handling cost rates, ordering cost, time to confirm an invoice and service & safety stock level on total savings is discussed. In the case discussed it holds that if the buyer would not implement SMI, then a linear price discount from 0% at \(D \leq 100\) to 25% for \(D \geq 1200\) can be provided with a base price of 2680 euro. The impact of SMI and consignment stock without compensation is depicted in figure 27. Savings are in this chapter, like in the RF chapter expressed in thousands euro’s. RF does not harm the buyer, but does increase the savings of the supplier.

\[
\begin{array}{c|c|c|c|c|c|c|c}
\hline
\text{S}^b_{\beta} & \text{S}^s_{\beta} & \text{S}^b_{\beta+\theta} & \text{S}^s_{\beta+\theta} & \text{S}^b_{\beta+p} & \text{S}^s_{\beta+p} & \text{S}^b_{\beta+t} & \text{S}^s_{\beta+t} \\
\hline
\end{array}
\]

Figure 27 – SMI & CS savings and demand levels (ss=300)

In figure 27 the safety stock remains 300 regardless of the demand, therefore RF becomes a more attractive option at higher demand values. In figure 28 the safety stock is set according to Silver et al. (1998) using \(CV=0.05\). By adaptive ss levels, RF does no longer provide higher savings than a price increase to the buyer. Furthermore is the savings trend for the supplier negative. The supplier does offer a discount since, if the supplier margin is only 10%, then the profit \(\Pi^s_j\) is as depicted in figure 29. Furthermore might there be additional savings related to increased utilization of capacity enabling a quantity discount up to 25%.
Further in this chapter, demand will be fixed to 900 and the impact of other variables on the savings are discussed, i.e. the impact of variations in ordering cost and inventory handling cost. Yao et al (2007) show that a decrease of ordering cost increases the savings, which is confirmed for the supplier by figure 30. As a result of an increase in buyer order cost, the optimal order quantity increases, this does not only increase the cost of handling inventory for the buyer, but also increases the cost of holding consignment inventory (CS) for the supplier, which is depicted in figure 32.

Furthermore does each company still handle inventory on its site, thus a change in inventory handling cost does not decrease these cost when SMI or CS is implemented. When inventory increases (decreases) the inventory that is (is not) present the site, does (does not) need to be handled with cost (savings) as a result.

The extent to which demand forecast and production planning are accurate determines the required level of raw material safety stock. If the CV of demand is high and demand is met by
flexible capacity rather than finished goods inventory buffers, then figure 34 indicates that a price increase does harm the supplier (buyer) less (more) than compensation via a term decrease.

But since a low CV is a prerequisite for SMI, compensation via RF is more attractive for the buyer and supplier. This effect is caused the price increase related to safety stock as described in footnote 24 and the term decrease related to demand level

Another negative impact on the supplier is created by increased time spend to confirm an invoice at the buyer and process an invoice at the bank. During this time the supplier lacks the opportunity to use the option to free cash and save interest, as depicted in figure 35.
6.2.2 Financial variables

The savings for the supplier and buyer are subject to the supplier margin as depicted in figure 36. If the margin is high, then the cost of holding the same amount of inventory with the same purchase price for the buyer is lower than when the margin is low. Thus when applying SMI with the same amount of compensation than at other margins, the total savings for the supplier increase.

For the buyer a high supplier margin is not only positive since the supplier may demand less compensation. If the margin is very high then the optimal replenishment quantity (q) increases, implying an increased inventory level at the buyer site and consequently increases the buyer absolute amount of handling cost. For a decision on the compensation scenario the supplier margin does not play a role.

The impact of the euribor on RF is the same as in paragraph 6.1. For SMI & CS compensation the 12 month euribor is used as a base for the price increase. The relation between these euribor rates is established in appendix 11. The impact of the 2 month euribor increase does have a linear impact on the buyer and supplier savings as depicted in figure 37. The shift of inventory from the buyer to the suppliers account results in the negative trend for the buyer and positive trend for the supplier.

Another financial variable is the WACC. If the suppliers cost of capital increase, then a term decrease does provide more savings to the supplier than a price increase as depicted in figure 37. The lower the inventory level and the longer the initial payment term the greater this effect.
If the cost of capital for the buyer increase, the cost of RF increase\textsuperscript{26} and the buyer savings will increase, because inventory is shifted to consignment stock as depicted in figure 38. In this figure it can be observed that the supplier savings using RF decrease if the buyer cost of capital increase. Other compensation methods than RF do not impact the supplier savings if the buyer cost of capital change.

\subsection*{6.2.3 Contractual variables}

This paragraph will discuss the impact of the initial term, frequency of invoicing, moment of invoicing, level of compensation and product price on annual savings.

\textsuperscript{26} Using $r' = \left( \frac{w^b - r^e}{5} \right)$
The higher the initial purchase price the higher the buyer’s savings and the supplier’s losses as depicted in figure 40. If the initial term is large and sacrificed as compensation by the buyer then longer initial terms decrease savings for the buyer, but increase savings for the supplier. In case of RF there is no loss for the buyer, but the supplier benefits less than in case of a normal term decrease, since the cash is not obtained for free but at a rate as depicted in figure 41.

When establishing an agreement on SMI and CS four impacts should be incorporated:
1. The supplier and buyer agree on the frequency of receiving invoices (equation 4.6)
2. as well as the moment in the production process at which will be counted (equation 4.7)
3. The time between counting and invoicing
4. A change in the payment term
The accumulated impact of 2,3 and 4 are represented in figure 42. Impact 1 has a similar effect with approximately half the magnitude of impact 2,3 and 4. Increasing these times does have a positive effect on the buyer and a negative effect with a smaller magnitude on the supplier. The magnitude is smaller since the supplier does not need to invest only \((1-m^s)u_o\), where the buyer invests \(u_o\) in these terms. On the other hand, if 1,2,3 are equal to 0 and 4 is negative, then the supplier saves \(u_o\) when getting paid earlier. Therefore \(t_o\) has an important role.

![Figure 42 - SMI & CS savings invoicing effects](image1)

![Figure 43- SMI & CS savings and compensation](image2)
7. Implementation

This chapter describes recommendations for implementing SCF. Note that SCF is a broader term than RF, e.g. it can also include financing of inventory or receivables funding before an invoice is confirmed. Implementation of SCF consists of three aspects. First establishing the infrastructure that enables SCF which is briefly described in paragraph 3.1.1. for the HTM group. Second the supplier on boarding, i.e. the first contact up to a satisfactory supplier using SCF. And third the results and satisfaction of internal and external stakeholders must be monitored on a continuing basis and acted upon.

7.1 Enabling SCF

The team that leads and manages the SCF is the lever to its success. Following (Kramer, 04/2010) the CFO takes the lead in aligning incentives between functional groups and procurement takes the lead in selecting the technology/services provider. Seifert & Seifert (2010) argue that implementations are two times as successful when the CEO rather than the CFO leads them. Additionally functional group members of treasury, IT and invoice processing should be present in SCF teams. Seifert & Seifert (2010) add eventually legal and SCM to the functional team, but address that teams existing out of finance and procurement only are almost as successful. See furthermore appendix 14. According to 3 interviewees at the GPC buying employees are traditionally extrinsically motivated to achieve discounts, not to increase DPO. If working capital improvement is a goal, this motivation is essential. (Kramer, 05/2010)

Before implementation starts the goal that is eventually to be achieved with SCF is to be set, e.g. (a) working capital reduction, (b) reducing supply chain risk or (c) supporting low cost country sourcing. The next step is establishing the SCF criteria that enable achieving the goal, e.g. following (Kramer, 2010) a quantification of benefits and time frames, the type and number of suppliers involved, geographies (i.e. there are banks that do not fund suppliers below a certain credit rating, in certain geographies or with a high concentration of revenue with the buyer legal and accounting standards in many countries do not recognize e-invoices and other electronic documents as legally binding (Mckinsey, 2010) And additionally following Richman & Schmand (2010) structuring and on-boarding experience, risk management, extended services (e.g. analytical tools for credit scoring, supplier risk assessment, and the analysis of how using trade discounts and receivables/payables financing can impact the working capital balance (Aberdeen, 2007)), technology and operations infrastructure. Additionally currencies, ability of handling credit/debit memo’s and length and flexibility of finance tenors are criteria. In 2007 the most desired features & information were as depicted in appendix 12. Once the criteria have been established the type of product can be chosen. The traditional single bank confirmed payables programs are suitable when there are no plans to expand or change objectives. The requirements for larger corporate buyers will often exceed the capacity of any one bank or even a few big banks put together. This is unlikely to change in Europe, i.e. there are approximately 7500 banks, where 200 would be sufficient, but the European regulators would perceive such a decline as a tread to competition. In many cases, large corporate look to a few banks to set up a larger and more flexible open technology platform with multiple banks. Since multiple banks join in an open platform competition decreases the offered interest rates, enhancing the potential savings.

Once the type of product is determined a provider can be chosen. Herein the on-boarding time and effort plays a considerable role as well as the initial investment cost and time to value.

27 A proprietary bank platform that syndicates the amount of credit is not considered a multi bank platform
Following Seifert and Seifert (2010) 44% of their sample reported reduced credit availability. Kramer (2010) explains, credit provided to suppliers will reduce the bank’s credit capacity with the buyer. Appendix 4 includes a list with SCF providers in both categories. Once the provider has been chosen the implementation can start.

A topic discussed only briefly so far are the cost of a program. Three cost factors are important (1) the initial technology investment. Second (2) the program management (0.5 to 2 fte’s) by the SCF team. And (3) the fte’s of implementation in each department, e.g. time of invoice processing, the successfully introduce RF to suppliers and successfully negotiate with suppliers. The Aberdeen group (2007) measured SCF success by several performance metrics. Laggard performers invested on average $ 65.000 and best in class performers invested on average $350.000. Best in class performers process twice as much volume by three times as many invoices trough SCF than the rest of the respondents resulting in a DPO advantage of 9 days and DSO advantage of 22 days. The additional reward is according to Seifert and Seifert (2010) improvement in Purchase-to-Pay, Order-to-Cash and Record-to-Report processes.

Following McKinsey (2010) the next generation SCF will provide full transparency into each transaction. This enables liquidity providers to apply dynamic pricing in purchasing outstanding invoices (e.g., the closer the goods to destination, the lower the pricing) allowing corporates to unlock trapped liquidities through automated financing at lower rates and attract the critical mass. Next generation indeed, since as of today, no bank has achieved such a fully integrated supply chain solution. Most are still busy migrating their traditional domestic platforms to cross-border standards, as far cross border standards exist, since there is no common standard to enable the exchange of data among different technology platforms (McKinsey, 2010). In the long term, a SCF working group thought of asset (receivables) backed commercial paper as a standard tradable instrument (Siddall, 2010).

7.2 On boarding suppliers

Onboarding suppliers has proven to be difficult, leading to some low adoption rates (Seifert & Seifert, 2010) and firms specialized in on boarding suppliers (See appendix 4). It is therefore important to prioritize suppliers based on the goal, e.g goal (b) motivates a ranking based on combination of strategic importance, insolvency risk and the impact of working capital on demand responsiveness. Goal (c) justifies prioritizing based on geography and payment methodology. Goal (a) justifies a ranking based on potential for term extensions and price decreases. The remainder of this chapter focuses on achieving goal (c).

Seifert & Seifert (2010) argue that successful implementations include at least 60% of the supply base in the first wave, but companies face difficulties in convincing suppliers to participate in SCF programs. Kramer (2010) explains the right value proposition to suppliers is essential to convince the supplier. This involves preparation of procurement, i.e. payment terms benchmarking and supplier negotiation strategies training. Payment terms are benchmarked since the initial term tₐ is not necessary the maximum working capital amount a supplier can or will be providing to the buyer by payment terms. Inventory days, industry averages and commodity class averages might yield information about the potential. The European Payment Index and Factors chain International are sources that can be used. Despite benchmarking payment terms is done by only 20% of the large multinationals in the U.S. it can yield valuable information about the potential, especially in negotiations.²⁸

²⁸ http://www.primerevenue.com/about/pdfs/PrimeRevenue_Executive_Summary.pdf
Conclusion

In order to provide an answer to the research questions, an in depth analysis of RF and SMCS is conducted. It can be concluded that traditionally operations management (OM) and corporate finance are distinct disciplines focusing on a single corporation. Gradually attention for interaction between (OM) and finance increased and supply chain management gained attention, supported by IT developments. Operational and financial aspects interact with one and another. Adequate management of either aspect requires understanding of the interaction with the other aspect. A decrease in liabilities or their structure can affect the allowed WoC level and vice versa. RF as well as SMCS decrease the required WoC in the supply chain by increased visibility and flexibility in controlling inflow and outflow of cash and goods.

By combining practical and theoretical insights two models have been formulated and validated as a basis for answering the research questions. A sensitivity analysis has been conducted to investigate the supplier selection criteria and assess the interaction between RF and SMCS. By reviewing the insights gained RF knowledge can be allocated to relevant positions in a the GPC.

Research question one can only be answered after the model has been setup and was stated as follows:

“What supplier selection criteria should be adopted for a RF agreement?”

Within the range of supply chain finance instruments RF is a popular upcoming instrument used by various multinationals. It can be used to increase financial performance, stabilize the supply chain and to enable low cost country sourcing. The potential financial performance improvement of RF is promising, particularly if initial payment terms are long, purchase values are high and the time to confirm an invoice is short. The extent to which suppliers will accept the value proposition depends on the suitability of the value proposition to the supplier. SME’s with high cost of capital will particularly value the low costs of capital, provided that the demand to the GPC is a substantial share of their total demand. Larger and creditworthy corporations will value the additional source of off balance sheet liquidity.

Research question two can best be answered after research question three. Research question three was stated as follows:

“How can supplier integration (SI) and RF interact?”

Supplier managed consignment stock is a form of supplier integration that requires the highest expense by the supplier, while it is generally the most beneficial form for the buyer. Except if the supplier does not value the intangible benefits indirectly leading to increased supplier firm value and the supplier receives substantial amounts of compensation. Minor compensation by a price increase or term decrease has a negative impact on the buyer, but it will leave the arrangement generally still beneficial for both. Alternatively compensation might be provided by RF, which is beneficial for the buyer, since RF investments can be perceived as sunk cost. RF can only provide more compensation than a price increase or term decrease if (1) the price increase is minor, e.g. because supplier recognizes intangible benefits, if (2) variability of raw material requirements is low implying low safety stocks and accurate forecasts, if (3) the suppliers cost of capital is very high or if (4) initial payment terms are very long.
In the cases studied, either the payment term decreased or the price increased. In the first case the potential for RF decreases and therefore RF should not be implemented after SMCS, since a term decrease decreases the potential savings to share between the supplier and buyer.

The final research question addresses the allocation of knowledge over various positions to enable RF and is stated as follows:

“What knowledge should be present at which positions in the organization in order to implement RF effectively?”

Many researchers commented on the importance of commitment by multiple departments to cooperatively implement reverse factoring. First of all should purchasers be aware of the new performance metric related to WoC. Additionally purchasers should have a brief understanding of the benefits of RF in order to be able to get finance experts of the buyer and supplier at the table.

Subsequently finance experts should be aware of the value of features they can offer by RF depending on the suppliers financial situation as discussed by answering the first research question. Additionally cash flow visibility and control can play an important role, while payment terms benchmarking is an important preparation. If the Euribor increases as expected or the buyer creditworthiness deteriorates, the savings for buyer and supplier decrease. If this does happen, than still the principle does remain valid and savings can still be achieved. In the case studied a payment term increase is generally more beneficial for the buyer than a price decrease, while leaving the impact on the supplier equal. Only if the buyer values the freed cash with a rate less than the cost rate of RF it becomes beneficial to use RF for a price decrease. Companies that invested more in SCF generally achieve better results up to substantial cost decreases and working capital reduction. Particularly investment in an IT enabled broader range of features (i.e. inventory and pre-order financing), easier use and multi bank platforms can motivate the critical mass of suppliers to use SCF, which benefits the buyer in return.

Additionally legal knowledge such as validity of digital data, maximum payment terms in France, Spain or even the EU is a prerequisite. Furthermore accounting should be aware of the extent to which payment terms while not being perceived as corporate debt by credit rating agencies and accounting standards. Roughly stated, if RF is used to support the supply chain stability it is not perceived as debt.

Finally, both tools replace uncertainty with certainty from a supplier perspective. This does not decrease variability, but provides the opportunity to act adequate upon variability. The further in advance inflow and outflow can be controlled, the more time to act and the better the quality of decisions. In this sense both RF and SMCS are essentially tools to improve cooperation with suppliers.
Limitations & further research

The reverse factoring model has been used by at least three major banks and is accepted by many suppliers and buyers. The model has been used to establish contracts of 21 cases included in this research. In order to comment about the developments of RF within the European markets of the HTM group this provides an indication. In order to test if these results, the findings of Seifert & Seifert (2010) or the Aberdeen group (2007) converge in other industries and geographic regions the sample should be diversified. Additionally qualitative and quantitative evidence for higher returns form more comprehensive SCF platforms would be valuable information for industry professionals in their consideration for a SCF platform. Additionally to be able to expand the knowledge and gain from SCF, research from the financial perspective of a supplier on especially the features cash flow visibility and cash flow control would be valuable. Expanding and diversifying the sample can also provide valuable information about quantification of these features and/or about the rate that can be allocated to freed cash. If SCF remains to be beneficial as a contract over the coming years, than a higher rate can be assigned at least from the buyer perspective.

Regarding SMCS four cases is a rather limited number. The model should therefore be validated using more and diversified SMCS cases. This holds especially for the counting/invoicing frequency and moment effects since no researcher has commented on these impacts.

For both SCF and SMCS a corporate and/or supply chain valuation model would be valuable, since this can provide insight in the long term benefits in terms of added corporate value. This holds especially for the choice between a price decrease and payment term extension within reverse factoring. Most recommendations should be feasible and valuable, since the scientific developments on the area of SCF specifically are recent and limited. The practical developments are nevertheless abundant.
Bibliography


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Index

Agile, 46
Cash conversion cycle, 21
Commodity inventory financing, 93
Consignment stock, 9
Consignment stock, 47
Credit insurance (CI), 93
Documentary collections (D/C), 92
Export financing, 92
Factoring, 92
Financing decisions, 19
Forfaiting, 92
Letter of credit (L/C), 92
Letter of guarantee (L/G), 92
Market imperfections, 19
Open account, 92
Operating working capital, 20
Operational decisions, 19
Reverse factoring, 9
Supply chain finance (SCF), 93
Sustainable, 46
Trade credit, 26
Trade-receivables-backed financing, 93
WACC, 23
Working capital, 20
Appendix 1 – Researchers vs. practitioners

<table>
<thead>
<tr>
<th>Elements of FOR</th>
<th>Researchers' FOR</th>
<th>Decision Makers' FOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Cognitive elements</td>
<td>Preference for objective, measurable, verifiable data. Intellectual commitment to (a) some notion of &quot;truth,&quot; (b) providing incremental, rational improvements to existing knowledge, (c) construction of explanatory theories and empirical discovery.</td>
<td>Preference for subjective, experiential data. Intellectual commitment to (a) organizational and personal goals, (b) incremental improvement of practice, (c) problem solving.</td>
</tr>
<tr>
<td>3. Reality tests</td>
<td>Empirically observable and experimentally verifiable proofs. Consensus among experts. Conceptual adequacy and theoretical consistency. Discipline or field of research. Preferred research tradition or paradigm. Relevance to the problem.</td>
<td>Pragmatic value or workability. Issues are &quot;real&quot; if they can influence situations. Reality is embedded in personal experience.</td>
</tr>
<tr>
<td>4. Domain of Inquiry</td>
<td>Implicit articulation of FOR through institutional means such as professional bodies' regulations, editorial policies. Explicit articulation in specific research reports through a description of methodological assumptions.</td>
<td>Department, division, field organization, or the economy as the boundary for inquiry. Low degree of articulation, FORs are implicit in decisions. Explicit articulation via organizational policies, norms, and decision making practices.</td>
</tr>
<tr>
<td>5. Degree of Articulation</td>
<td>Scientific vocabulary, technical jargon. Theories as metaphors.</td>
<td>Professional jargon. Metaphors used for personal &quot;sense-making&quot; and explication of FOR.</td>
</tr>
</tbody>
</table>
Appendix 2 – The scientific company’ annual KPI’s

Cash conversion cycle (CCC) = 0.4*DOH + 0.4*DSO - 0.2*DPO

Days inventory on hand (DOH) = \frac{Net inventories end of year}{External CoGS} \times 360

Days payables outstanding (DPO) = \frac{Trade accounts payable end of year}{External annual CoGS} \times 360

Days sales outstanding (DSO) = \frac{Trade accounts receivable end of year}{External annual net sales} \times 360

Weighted Average Payment Term (WAT) = \frac{\sum_{i=payment\ terms} Annual value of invoices * payment term}{Annual value of invoices received}

Source: the scientific company manual for operative planning 2011 - 2013
Appendix 3 – Scientific company standardized and condensed balance sheet 2008 and 2009\textsuperscript{30}

<table>
<thead>
<tr>
<th>Standardized balance sheet</th>
<th>2008</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>non current assets</td>
<td></td>
<td></td>
</tr>
<tr>
<td>goodwill</td>
<td>8.647</td>
<td>8.704</td>
</tr>
<tr>
<td>Other intangible assets</td>
<td>13.951</td>
<td>12.842</td>
</tr>
<tr>
<td>Property, plant and equipment</td>
<td>9.492</td>
<td>9.409</td>
</tr>
<tr>
<td>Investments in associates</td>
<td>450</td>
<td>395</td>
</tr>
<tr>
<td>Other financial assets</td>
<td>1.197</td>
<td>1.200</td>
</tr>
<tr>
<td>Other receivables</td>
<td>458</td>
<td>549</td>
</tr>
<tr>
<td>Deferred taxes</td>
<td>1.156</td>
<td>950</td>
</tr>
<tr>
<td><strong>total non-current assets</strong></td>
<td><strong>35.351</strong></td>
<td><strong>34.049</strong></td>
</tr>
<tr>
<td>% of total assets</td>
<td>67%</td>
<td>67%</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>shareholders equity</th>
<th>2008</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital stock of Holding</td>
<td>1.957</td>
<td>2.117</td>
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<tr>
<td>Capital reserves of Holding</td>
<td>4.028</td>
<td>6.167</td>
</tr>
<tr>
<td>Other reserves</td>
<td>10.278</td>
<td>10.613</td>
</tr>
<tr>
<td>Equity attributable to non-controlling interest</td>
<td>77</td>
<td>54</td>
</tr>
<tr>
<td><strong>total shareholders equity</strong></td>
<td><strong>16.340</strong></td>
<td><strong>18.951</strong></td>
</tr>
<tr>
<td>% of total liabilities</td>
<td>31%</td>
<td>37%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>non current liabilities</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Provisions for pensions and other post-employment benefits</td>
<td>6.347</td>
<td>6.517</td>
</tr>
<tr>
<td>Other provisions</td>
<td>1.351</td>
<td>1.516</td>
</tr>
<tr>
<td>Financial liabilities</td>
<td>10.614</td>
<td>11.460</td>
</tr>
<tr>
<td>Other liabilities</td>
<td>432</td>
<td>415</td>
</tr>
<tr>
<td>Deferred taxes</td>
<td>3.592</td>
<td>3.210</td>
</tr>
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<td><strong>total non-current liabilities</strong></td>
<td><strong>22.336</strong></td>
<td><strong>23.118</strong></td>
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<tr>
<td>% of total liabilities</td>
<td>43%</td>
<td>45%</td>
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<table>
<thead>
<tr>
<th>Current assets</th>
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<th></th>
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</thead>
<tbody>
<tr>
<td>Inventories</td>
<td>6.681</td>
<td>6.091</td>
</tr>
<tr>
<td>Trade accounts receivable</td>
<td>5.953</td>
<td>6.106</td>
</tr>
<tr>
<td>Other financial assets</td>
<td>634</td>
<td>367</td>
</tr>
<tr>
<td>Other receivables</td>
<td>1.284</td>
<td>1.357</td>
</tr>
<tr>
<td>Claims for income tax refunds</td>
<td>506</td>
<td>347</td>
</tr>
<tr>
<td><strong>cash and cash equivalents</strong></td>
<td><strong>2.094</strong></td>
<td><strong>2.725</strong></td>
</tr>
<tr>
<td>Assets held for sale and discontinued operations</td>
<td>8</td>
<td>-</td>
</tr>
<tr>
<td><strong>total current assets</strong></td>
<td><strong>17.160</strong></td>
<td><strong>16.993</strong></td>
</tr>
<tr>
<td>% of total assets</td>
<td>33%</td>
<td>33%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>current liabilities</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Other provisions</td>
<td>3.163</td>
<td>3.089</td>
</tr>
<tr>
<td>Financial liabilities</td>
<td>6.256</td>
<td>1.489</td>
</tr>
<tr>
<td>Trade accounts payable</td>
<td>2.464</td>
<td>2.735</td>
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<tr>
<td>Income tax liabilities</td>
<td>65</td>
<td>93</td>
</tr>
<tr>
<td>Other liabilities</td>
<td>1.874</td>
<td>1.567</td>
</tr>
</tbody>
</table>
| Liabilities directly related to assets held for sale and discontinued operations | 13 | -
| **total current liabilities** | **13.835** | **8.973** |
| % of total liabilities    | 26%  | 18%  |

| total liabilities and shareholders' equity | 52.511 | 51.042 |

\textsuperscript{30} Data from the scientific company annual report 2009, figures in 1,000,000 Euros.
### Condensed balance sheet

<table>
<thead>
<tr>
<th></th>
<th>2008</th>
<th>2009</th>
<th></th>
<th>2008</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Net non current assets</strong></td>
<td></td>
<td></td>
<td><strong>Shareholders equity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Goodwill</td>
<td>8.647</td>
<td>8.704</td>
<td>Capital stock of Holding</td>
<td>1.957</td>
<td>2.117</td>
</tr>
<tr>
<td>Other intangible assets</td>
<td>13.951</td>
<td>12.842</td>
<td>Capital reserves of Holding</td>
<td>4.028</td>
<td>6.167</td>
</tr>
<tr>
<td>Property, plant and equipment</td>
<td>9.492</td>
<td>9.409</td>
<td>Other reserves</td>
<td>10.278</td>
<td>10.613</td>
</tr>
<tr>
<td>Investments in associates</td>
<td>450</td>
<td>395</td>
<td>Equity attributable to non-controlling interest</td>
<td>77</td>
<td>54</td>
</tr>
<tr>
<td>Other financial assets</td>
<td>1.197</td>
<td>1.200</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other receivables</td>
<td>458</td>
<td>549</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deferred taxes</td>
<td>1.156</td>
<td>950</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other liabilities</td>
<td>-432</td>
<td>-415</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deferred taxes</td>
<td>-3.592</td>
<td>-3.210</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total net non-current assets</strong></td>
<td><strong>31.327</strong></td>
<td><strong>30.424</strong></td>
<td><strong>Total shareholders equity</strong></td>
<td><strong>15.340</strong></td>
<td><strong>18.951</strong></td>
</tr>
<tr>
<td>% of total net assets</td>
<td>75%</td>
<td>75%</td>
<td>% of total net capital</td>
<td>39%</td>
<td>47%</td>
</tr>
</tbody>
</table>

### Operating Working Capital

<table>
<thead>
<tr>
<th></th>
<th>2008</th>
<th>2009</th>
<th></th>
<th></th>
<th></th>
<th></th>
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<tbody>
<tr>
<td><strong>Operating Working Capital</strong></td>
<td></td>
<td></td>
<td><strong>Net debt</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trade accounts receivable</td>
<td>5.953</td>
<td>6.106</td>
<td>Other provisions</td>
<td>1.351</td>
<td>1.516</td>
<td></td>
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<tr>
<td>Other financial assets</td>
<td>634</td>
<td>567</td>
<td>Financial liabilities</td>
<td>10.614</td>
<td>11.460</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other receivables</td>
<td>1.284</td>
<td>1.357</td>
<td>Other provisions</td>
<td>3.163</td>
<td>3.089</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Claims for income tax refunds</td>
<td>506</td>
<td>347</td>
<td>Financial liabilities</td>
<td>6.256</td>
<td>1.489</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Trade accounts payable</strong></td>
<td><strong>-2.464</strong></td>
<td><strong>-2.735</strong></td>
<td><strong>Cash and cash equivalents</strong></td>
<td><strong>-2.094</strong></td>
<td><strong>-2.725</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Income tax liabilities</strong></td>
<td><strong>-63</strong></td>
<td><strong>-93</strong></td>
<td>Assets held for sale and discontinued operations</td>
<td><strong>-8</strong></td>
<td><strong>0</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Other liabilities</td>
<td>-1.874</td>
<td>-1.567</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Liabilities directly related to assets held for sale and discontinued operations</td>
<td>-13</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total operating working capital</strong></td>
<td><strong>10.542</strong></td>
<td><strong>9.873</strong></td>
<td><strong>Total net debt</strong></td>
<td><strong>25.629</strong></td>
<td><strong>21.346</strong></td>
<td>% of total net capital</td>
<td>61%</td>
<td>53%</td>
</tr>
<tr>
<td>% of total net assets</td>
<td>25%</td>
<td>25%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Net assets</strong></td>
<td>41.969</td>
<td>40.297</td>
<td><strong>Net capital</strong></td>
<td>41.969</td>
<td>40.297</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix 4 – selected companies involved in RF

**SCF users**

1. Airliquide  
2. Alcatel Lucent  
3. Alstom  
4. Big Lots  
5. Carrefour  
6. Cemex  
7. Eads  
8. Henkel  
9. Holcim  
10. Honda  
11. J Sainsbury,  
12. Kingfisher,  
13. Kohl’s,  
14. Lilly  
15. Lowe’s,  
16. Marks & Spencer,  
17. Metro  
18. Michelin  
19. Nestle  
20. Nestlé,  
21. Recit Benkckiser  
22. Saint gobain  
23. Sainsbury’s,  
24. Seat  
25. Siemens  
26. Sodexho  
27. Syngenta,  
28. Tesco,  
29. ThyssenKrupp  
30. Unilever  
31. Volkswagen  
32. Volvo  
33. Wal-Mart

**SCF providers**

**Banks**

1. Banco Santander  
2. Citybank  
3. Deutsche Bank  
4. HSBC  
5. Standard Chartered  
6. UniCredit  
7. SEB  
8. RBS  
10. ING – KBC  
11. JP Morgan Chase - Wachovia

**Non bank solutions**

On boarding suppliers
- ARIBA

Online access to finance providers
- Primerevenue  
- ORBIAN  
- Demica

Others
- [www.ezdglobal.com](http://www.ezdglobal.com)  
- [www.corporatelinx.com](http://www.corporatelinx.com)  
- The Receivables Exchange  
- UPS Capital
## Appendix 5 – Interviewees

<table>
<thead>
<tr>
<th>Function</th>
<th>Subject</th>
<th>Communication*</th>
<th>Important topics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Payment department manager and assistant manager</td>
<td>Payables processing</td>
<td>Interview</td>
<td>Invoice confirmation time</td>
</tr>
<tr>
<td>HTM, procurement managers &amp; SCF coordinators</td>
<td>HTM SCF case</td>
<td>3 Interviews, Multiple e-mails, phone calls &amp; exchange of files</td>
<td>Strategy, coordination, perception, model and results</td>
</tr>
<tr>
<td>GPC, API Sourcing President</td>
<td>Supplier integration and compensation</td>
<td>2 Interviews, Multiple e-mails, phone calls</td>
<td></td>
</tr>
<tr>
<td>GPC, API sourcer</td>
<td>Supply Chain finance</td>
<td>Two interviews</td>
<td>Multiple phone call, e-mail</td>
</tr>
<tr>
<td>GPC, Procurement payables performance</td>
<td>Various</td>
<td>Daily contact, exchange of files</td>
<td></td>
</tr>
<tr>
<td>GPC, Supplier Integration Policy coordinator</td>
<td>Supplier integration and Reverse factoring</td>
<td>+/- 10 interviews, Multiple e-mails, phone calls, and exchange of files</td>
<td>Compensation, focus, cases available, validation of models</td>
</tr>
<tr>
<td>GPC, Procurement performance coordinator, payables performance functionary, president of GSCM and university supervisor</td>
<td>Progress meetings</td>
<td>Monthly meeting</td>
<td>Focus, direction and planning</td>
</tr>
<tr>
<td>GPC, four SMCS case experts</td>
<td>4 SMCS cases</td>
<td>1 – 4 interviews each, Multiple e-mails, phone calls, and exchange of files</td>
<td>details, Compensation, validation of models</td>
</tr>
<tr>
<td>CEO</td>
<td>Culture, language and SCF</td>
<td>Short general conversation in informal setting</td>
<td></td>
</tr>
<tr>
<td>GPC Procurement president</td>
<td>Progress and SCF</td>
<td>+/- 5 interviews</td>
<td>results</td>
</tr>
<tr>
<td>GPC Procurement communication</td>
<td>SCF communication</td>
<td>1 Interview</td>
<td>Multiple e-mails, Communication</td>
</tr>
<tr>
<td>Role/Mandate Description</td>
<td>Contact Method</td>
<td>Main Activities</td>
<td>Notes</td>
</tr>
<tr>
<td>----------------------------------------------------------------------------------------</td>
<td>-------------------------------------</td>
<td>------------------------------------------------------</td>
<td>----------------------------------------------------------------------</td>
</tr>
<tr>
<td>PGC, GSCM accounting and reporting function</td>
<td>SCF and SI</td>
<td>Multiple interviews, emails, phone calls, and exchange of files</td>
<td>Scientific modeling and validation of models</td>
</tr>
<tr>
<td>Holding payables manager</td>
<td>SCF and SI</td>
<td>Multiple e-mails, phone calls, and exchange of files</td>
<td>Sourcers motivation, valuation, perception and results</td>
</tr>
<tr>
<td>Holding working capital manager and assistant</td>
<td>SCF and SI</td>
<td>Multiple e-mails, phone calls, and exchange of files</td>
<td>Sourcers motivation, valuation, perception and results</td>
</tr>
<tr>
<td>Holding treasurers</td>
<td>SCF</td>
<td>Multiple e-mails, phone calls, and exchange of files</td>
<td>SCF model, Valuation, perception and results</td>
</tr>
<tr>
<td>Financial market forecast employee</td>
<td>Economic development and rates</td>
<td></td>
<td>Euribor</td>
</tr>
<tr>
<td>Procurement accounting</td>
<td>SCF</td>
<td>Two conversations</td>
<td>Negotiation, SCF implementation costs</td>
</tr>
<tr>
<td>GPC packaging sourcer</td>
<td>Supplier integration and compensation</td>
<td>Multiple interviews, emails, phone calls</td>
<td></td>
</tr>
<tr>
<td>GPC contract manufacturing sourcer</td>
<td>Supplier integration and compensation</td>
<td>Multiple interviews, emails, phone calls</td>
<td></td>
</tr>
<tr>
<td>Former CEO Citibank, Currently at PrimeRevenue</td>
<td>SCF</td>
<td>Phone call, e-mail, exchange of files</td>
<td>Goals, negotiation preparation and SCF results</td>
</tr>
<tr>
<td>Holding representative for SCF implementation coordination</td>
<td>SCF, implementation</td>
<td>Multiple phone calls, emails, exchange of files</td>
<td></td>
</tr>
<tr>
<td>Nutrition, SCF implementation representative</td>
<td>SCF, implementation</td>
<td>Interview</td>
<td>Negotiation</td>
</tr>
</tbody>
</table>

*Phone calls are non-physical interviews varying from 5 minutes to multiple hours.

This list is an approximation, it need not be complete, but provides an indication.
Appendix 6 – SMI & Consignment impact

Impact on supplier

- Decreased inventory cost per unit
- Decreased freight and handling costs
- Decreased production cost per unit
- Less inventory in own warehouse
- Optimized transportation planning
- Optimized production scheduling
- Longer lead times with suppliers
- More inventory in supplier’s warehouse
- Shift of inventory ownership to supplier
- Sharing accurate forecasts

Impact on customer

- Decreased rental payments
- Decreased interest payments
- Decreased lost sales
- Decreased working capital requirements
- Decreased inventory or balance sheet

Increased sales
- Improved service level
- Increased inventory cost per unit
- Increased profit
- Compensation?
Appendix 7 – SMI & Consignment impact revised

Impact on supplier

Impact on customer

Decreased inventory on balance sheet
Optimized transportation planning
Decreased transportation cost per unit
Decreased inventory holding costs
Decreased interest payment
Decreased inventory handling cost per unit
Decreased production cost per unit
Decreased profit
Decreased working capital requirement
Decreased long term strategic partnership
Decreased order and administration costs
Decreased MRP and order efforts
Decreased lost sales
Decreased service level
Decreased profit
Decreased inventory holding cost per unit
Decreased inventory in suppliers own warehouse
Decreased inventories in supplier's warehouse
Decreased inventory in suppliers'
## Appendix 8 – Scientific versus conceptual model

### Impact on supplier

- Shift of inventory ownership to supplier
- Decreased inventory holding per unit
- Decreased transportation cost per unit
- Decreased production cost per unit
- Optimized transportation planning
- Optimized inventory holding costs
- Optimized capacity planning
- Decreased inventory in own warehouse
- Increased sales
- Increased MRP and order efforts
- Decreased MRP and order efforts
- Increased work in suppliers

### Impact on customer

- Shift of inventory ownership to supplier
- Decreased inventory holding per unit
- Decreased transportation cost per unit
- Decreased production cost per unit
- Optimized production scheduling
- Optimized capacity planning
- Increased service level
- Decreased lost sales
- Decreased production cost per unit
- Decreased inventory holding cost per unit
- Decreased inventory on balance sheet
- Decreased inventory holding costs
- Decreased working capital requirement
- Decreased interest payment
- Decreased MRP and order efforts
- Increased sales
- Increased holding costs
- Decreased order lead times

### SMI impact

- Improved service level
- Decreased lost sales
- Decreased production cost per unit
- Decreased transportation cost per unit
- Decreased inventory holding cost per unit
- Decreased inventory on balance sheet
- Decreased working capital requirement
- Decreased interest payment
- Decreased MRP and order efforts
- Increased sales
- Increased holding costs
- Decreased order lead times

### Compensation

- Profit

### Mixed impact

- Increased sales
- Increased holding costs
- Decreased order lead times

### Excluded in quantitative model

- Decreased MRP and order efforts
- Decreased inventory holding costs
- Decreased working capital requirement
- Decreased interest payment
- Decreased transportation cost per unit
- Decreased inventory holding cost per unit
- Decreased inventory on balance sheet

### Included in quantitative model

- Improved service level
- Decreased lost sales
- Decreased production cost per unit
- Decreased transportation cost per unit
- Decreased inventory holding cost per unit
- Decreased inventory on balance sheet
- Decreased working capital requirement
- Decreased interest payment
- Decreased MRP and order efforts
- Increased sales
- Increased holding costs
- Decreased order lead times

### Partly included in quantitative model

- Improved service level
- Decreased lost sales
- Decreased production cost per unit
- Decreased transportation cost per unit
- Decreased inventory holding cost per unit
- Decreased inventory on balance sheet
- Decreased working capital requirement
- Decreased interest payment
- Decreased MRP and order efforts
- Increased sales
- Increased holding costs
- Decreased order lead times
### Appendix 9 – Savings calculation per agreement

<table>
<thead>
<tr>
<th></th>
<th>Supplier impact ((S^s_j))</th>
<th>Buyer impact ((S^b_j))</th>
</tr>
</thead>
</table>
| **RF term extension**<br>(\(j = \theta\)) | \[
\frac{V^a}{365}\left( w^s(t^a - t^b - t') - (r^s + r')(t^a - t^b - t') \right) \] (3.4)                                                                                                                                  | \[
\frac{V^a w^b(t^a - t^b)}{365} \] (3.5)                                                                                                           |
| **TF price decrease**<br>(\(j = \mu\))  | \[
V^a \left( \mu(T^s - 1) - \frac{(1 - \mu)(r^s + r') - w^s}{365}(t^a - t^b - t') \right) \] (3.12)                                                                                                        | \[
V^a \left( (1 - T^b) + \frac{w^b(y + \zeta - t^a)}{365} \right) \] (3.14)                                                                 |
| **SMI & consignment stock**<br>(\(j = \beta\)) | \[
\sqrt{2c^s_D h^s u(1 - m^s) - \frac{c^s_D}{q^s_{\beta}} - u^s(1 - m^s)} \left( h^s \left( q^s_{\beta} - \frac{k^s_{\beta} - 1}{2} q^b_{\beta} \right) - w^s \left( \frac{a + x}{2k^s_{\beta}} + ss + \frac{a}{365} \right) \right) \] \] (4.14) | \[
\frac{u^b}{z^a h^s - y^s} \left( \frac{q^s_{\beta}}{2k^s_{\beta}} + ss \right) + \frac{a + x}{365} \] (4.8)                                                                 |
| **SMI & consignment stock**<br>(\(j = \beta + p^*\)) | \[
S^s_{\beta} + (u^s_{\beta} - u^s_{\alpha}) D(1 - T^s) \] (A8.1)                                                                                                                                                           | \[
S^b_{\beta} - \left( (u^s_{\beta} - u^s_{\alpha}) D \left( \frac{w^b(y + \zeta - t^a)}{365} + (1 - T^b) \right) \right) \] (A8.2)                                                                 |
| **SMI & consignment stock**<br>(\(j = \beta + t^*\)) | \[
S^s_{\beta} + \frac{t^a V^a w^s}{365} \] (A8.3)                                                                                                                                                                     | \[
S^b_{\beta} - \frac{t^a V^a w^b}{365} \] (A8.4)                                                                                                     |
### Appendix 10 – Credit ratings compared

<table>
<thead>
<tr>
<th>Moody’s</th>
<th>S&amp;P</th>
<th>Fitch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long-term</td>
<td>Short-term</td>
<td>Long-term</td>
</tr>
<tr>
<td>Aaa</td>
<td>AAA</td>
<td>AAA</td>
</tr>
<tr>
<td>Aa1</td>
<td>A+</td>
<td>AA+</td>
</tr>
<tr>
<td>Aa2</td>
<td>AA</td>
<td>A</td>
</tr>
<tr>
<td>Aa3</td>
<td>AA-</td>
<td>A-</td>
</tr>
<tr>
<td>A1</td>
<td>A+</td>
<td>A-</td>
</tr>
<tr>
<td>A2</td>
<td>A</td>
<td>A-</td>
</tr>
<tr>
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</tr>
<tr>
<td>Baa1</td>
<td>BBB+</td>
<td>A-</td>
</tr>
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<td>BB+</td>
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<tr>
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<tr>
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<td>C</td>
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<td>C</td>
</tr>
<tr>
<td>C</td>
<td>D</td>
<td>/</td>
</tr>
</tbody>
</table>

Sources:
Appendix 11 – 2 and 12 month euribor

\[ y = 0.9218x + 0.0069 \]
\[ R^2 = 0.9922 \]

### Desired Information

- Invoice status – 88%
- Purchase order status – 81%
- Key financial metrics (e.g. Days Payable Outstanding, Days Sales Outstanding) – 81%
- Shipment status – 81%
- Payment terms/aging list – 69%
- Volumes of transactions processed – 69%
- International trade-related documentation status – 56%
- Invoice discount-related information – 50%
- Credit limit/utilization – 50%
- Financing status (e.g. if using 3rd-party financing) – 44%
- Credit rating of trading partners – 44%

Source: Aberdeen Group, March 2007

### Desired Features

- Cash flow forecasting – 69%
- Financial risk analysis/management tools (e.g. credit risk) – 69%
- Access to platform via mobile devices – 67%
- Tool to calculate cash flow impact of offering/accepting invoice discounts – 67%
- Access to 3rd-party financing from one financial institution – 63%
- Analytics tools (e.g. supplier/customer scorecards) – 63%
- Dynamic invoice discounting (supplier- or buyer-initiated) – 56%
- Access to 3rd-party financing from multiple financial institutions – 50%
- Transaction visibility (order/shipment/inventory status) – 50%
- Alerts/notifications – 50%
- Supports multiple languages – 50%
- Access to a network/community of pre-connected trading partners – 44%

Source: Aberdeen Group, March 2007

Trade finance incorporates highly specialized instruments to mitigate risk between trading partners. Traditional trade instruments such as letters of credit are document-heavy and require extensive manual processing, and cost-to-income ratios of 50 percent are typical in the trade finance business. Consequently, a small number of large banks (varying in scope from local to global) dominate trade services, leveraging scale to establish centralized processing operations. The following glossary of trade finance terms provides an overview of traditional transactional and newer working capital solutions.

**Documentary collections (D/C)**
The supplier entrusts collection of payment to the remitting (supplier’s) bank, which sends documents and instructions for payment to the collecting (buyer’s) bank. The buyer pays the face amount either upon acceptance of documentation or at a specified future date to the collecting bank, which transfers funds to the remitting bank.

**Letter of credit (L/C)**
The buyer’s (issuing) bank makes payment to the supplier’s bank, with the supplier presenting documents confirming the shipment of goods within a given time frame. L/Cs reduce the risk of nondelivery for the buyer and guarantee payment to the supplier upon shipment.

**Letter of guarantee (L/G)**
Promise by the bank on behalf of a buyer to compensate a supplier for any detriment suffered on the basis of the non-fulfillment of obligations. L/Gs protect the buyer against the commercial risks of non-fulfillment of the supplier’s obligations and reduce non-payment risk for the supplier.

**Open account**
A standard arrangement with no third-party or guarantees involved. The seller presents an invoice to the buyer for goods delivered. Suppliers are increasingly obtaining credit insurance to mitigate the non-payment risk.

**Factoring**
The supplier sells its short-term accounts receivables to the factor (a bank or specialized trade finance company) for cash at a discount on the face value. Factoring allows the supplier to offer open account terms and reduce days sale outstanding.

**Forfaiting**
The supplier sells a large, medium-term receivable at a discount to the forfaiter “without recourse.” The supplier ships goods to the buyer and delivers documents to the forfaiter, who assumes the risk of non-payment and handles collection. In distinction from factoring, forfaiting contracts are made on a transaction basis with suppliers (usually exporters) that sell capital goods, commodities or large projects with medium-term credit needs ranging from 180 days up to 7 years.

**Export financing**
In pre-shipment export finance the bank provides a loan to the supplier (exporter) to finance the processing of goods to be delivered to the buyer (importer) on the basis of a confirmed purchase order.
and/or L/C. In post-shipment export finance the bank provides a loan to the supplier against their export receivables for the period between shipment of goods and receipt of payment from the buyer.

**Credit insurance (CI)**
CI protects an exporter of products or services against the risk of non-payment. CI generally covers commercial risks such as buyer insolvency, bankruptcy or protracted defaults, and certain political risks, as well as currency inconvertibility, expropriation, and changes in import or export regulations.

**Supply chain finance (SCF)**
SCF programs generally refer to bank-sponsored buyer-centric initiatives using open accounts and providing liquidity to suppliers through reverse factoring.

**Trade-receivables-backed financing**
The supplier transfers accounts receivable assets, usually on a revolving basis, to a special purpose vehicle, which issues notes sold to investors through secondary distribution. This form of structured finance can be beneficial to non-investment-grade medium-size suppliers, as the securitized assets are rated according to the creditworthiness of the buyers, providing the supplier with liquidity at a lower cost of funds.

**Commodity inventory financing**
A form of structured finance in which the pledge of a commodity is used to improve credit terms. Funding techniques include preexport finance and inventory finance, and
## Appendix 14 – SCF roles per department

<table>
<thead>
<tr>
<th>DEPARTMENT</th>
<th>ROLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Executive Board</td>
<td>Wherever possible a programme should be sponsored by a member of the executive board with the CEO or Managing Director supporting</td>
</tr>
<tr>
<td>Procurement</td>
<td>Vital that procurement understands the programme as they own the supplier relationship Procurement will lead the negotiation and placement of contracts with suppliers</td>
</tr>
<tr>
<td>Legal</td>
<td>The correct contract structure is critical to ensuring the right implementation for the buyer (financial treatment)</td>
</tr>
<tr>
<td>Financing / Treasury</td>
<td>Sourcing funding (internal/external) and liaison with banks and internal stakeholders, including setting expectation for returns from the programme</td>
</tr>
<tr>
<td>IT</td>
<td>ERP interfaces to platform provider and where appropriate funding banks</td>
</tr>
<tr>
<td>Accounting</td>
<td>Determine accounting treatment to ensure business needs are met with regard to consolidation as debt or trade creditor</td>
</tr>
<tr>
<td>Transaction processing</td>
<td>Management and ownership of the invoice approval and payment process (efficiency is a key success factor)</td>
</tr>
</tbody>
</table>

Source: Siddall, 2010
Appendix 14 – Excel spreadsheet used
By copying and pasting in Excel one obtains the Excel sheet as used for the sensitivity analysis.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>b</td>
<td>0,3</td>
</tr>
<tr>
<td>Ts</td>
<td>0,3</td>
</tr>
<tr>
<td>wb</td>
<td>0,08</td>
</tr>
<tr>
<td>ws</td>
<td>0,1</td>
</tr>
<tr>
<td>re</td>
<td>0,005</td>
</tr>
<tr>
<td>rf</td>
<td>0,015</td>
</tr>
<tr>
<td>year</td>
<td>365</td>
</tr>
<tr>
<td>tα</td>
<td>45</td>
</tr>
<tr>
<td>tθ</td>
<td>B8</td>
</tr>
<tr>
<td>tb</td>
<td>B2</td>
</tr>
<tr>
<td>tf</td>
<td>0,5</td>
</tr>
<tr>
<td>μ(tθ)</td>
<td>((B5+B6)/(B9-B8)/(1-B2)*B7-(B5+B6)/(B8-B10-B11)))</td>
</tr>
<tr>
<td>tθ(μ)</td>
<td>(((1-B12)<em>(B5+B6)</em>(B8-B10-B11)-B12*(B2-1)*B7)/(B5+B6)+B10+B11)</td>
</tr>
<tr>
<td>γ</td>
<td>150</td>
</tr>
<tr>
<td>ζ</td>
<td>45</td>
</tr>
<tr>
<td>Vα</td>
<td>B19*B20</td>
</tr>
<tr>
<td>SS</td>
<td>300</td>
</tr>
<tr>
<td>D</td>
<td>100</td>
</tr>
<tr>
<td>Variable</td>
<td>Formula</td>
</tr>
<tr>
<td>----------</td>
<td>---------</td>
</tr>
<tr>
<td>$u_\alpha$</td>
<td>2680</td>
</tr>
<tr>
<td>$a$</td>
<td>60</td>
</tr>
<tr>
<td>$x$</td>
<td>0</td>
</tr>
<tr>
<td>std</td>
<td></td>
</tr>
<tr>
<td>CV</td>
<td></td>
</tr>
<tr>
<td>SS</td>
<td></td>
</tr>
<tr>
<td>$z_{b\alpha}$</td>
<td>$= B_{18} + B_{19}/6$</td>
</tr>
<tr>
<td>$y_{b\alpha}$</td>
<td>$= 0.055$</td>
</tr>
<tr>
<td>$c_{b\beta}$</td>
<td>$= 100$</td>
</tr>
<tr>
<td>$h_{b\alpha}$</td>
<td>$= B_{28} + B_{3}$</td>
</tr>
<tr>
<td>$q_{b\beta}$</td>
<td>$= \sqrt{B_{29}B_{19}/(B_{37}B_{20}(1-B_{35}))}$</td>
</tr>
<tr>
<td>$c_{s\beta}$</td>
<td>$= 100$</td>
</tr>
<tr>
<td>$c_{s\alpha}$</td>
<td>$= B_{33}$</td>
</tr>
<tr>
<td>$m_s$</td>
<td>$= 0.25$</td>
</tr>
<tr>
<td>$y_s$</td>
<td>$= 0.055$</td>
</tr>
<tr>
<td>$h_{s\beta}$</td>
<td>$= B_{36} + B_{4}$</td>
</tr>
<tr>
<td>$q_{s\beta}$</td>
<td>$= \sqrt{(2B_{33}B_{19}/(B_{37}B_{20}(1-B_{35})))}$</td>
</tr>
<tr>
<td>$k_{\beta}$</td>
<td>$= \text{MAX} \left( \text{ROUND} \left( \sqrt{2B_{33}/B_{29}}; 0 \right); 1 \right)$</td>
</tr>
<tr>
<td>$B_{smi}$</td>
<td>$= (B_{20}(B_{27}B_{30}) + ((B_{21}/2+B_{22})B_{16}B_{3})/B_{7} - B_{28}2500B_{18})/1000$</td>
</tr>
<tr>
<td>$S_{smi}$</td>
<td>$= (\sqrt{2B_{19}B_{37}B_{20}(1-B_{35})} - B_{33}B_{19}/B_{38} - B_{20}(1-B_{35})(B_{37}B_{38}B_{31}/2 + B_{4}B_{38}/2 + B_{39}B_{18} + (B_{22}B_{21}/2)B_{19}/B_{7})))/1000$</td>
</tr>
<tr>
<td>Formula</td>
<td>Description</td>
</tr>
<tr>
<td>---------</td>
<td>-------------</td>
</tr>
<tr>
<td>Supply Chain</td>
<td>( B41 + B42 )</td>
</tr>
<tr>
<td>Supplier profit Chain</td>
<td>( B19 \times B20 \times B35 / 1000 + B42 )</td>
</tr>
<tr>
<td>BsmiRF</td>
<td>( B41 )</td>
</tr>
<tr>
<td>SsmiRF</td>
<td>( B42 + ((B16 / B7) \times (B4 \times (B8 - B10 - B11) - (B6 \times B5) \times (B13 - B10 - B11))) / 1000 )</td>
</tr>
<tr>
<td>Supply Chain</td>
<td>( B45 + B46 )</td>
</tr>
<tr>
<td>euribor</td>
<td>0,921843463465395 \times B5 + 0,00690524779175823</td>
</tr>
<tr>
<td>Compensation</td>
<td>0,05</td>
</tr>
<tr>
<td>new price</td>
<td>( B20 \times (1 + B18 / B19 \times (B49 + B50)) )</td>
</tr>
<tr>
<td>B smi p</td>
<td>( B41 - ((B51 - B20) \times (B19 \times B3 \times (B14 + B15 - B8) / B7 + B19 \times (1 - B1)) / 1000) )</td>
</tr>
<tr>
<td>s smi p</td>
<td>( B42 + ((B51 - B20) \times B19 \times (1 - B2)) / 1000 )</td>
</tr>
<tr>
<td>Supply Chain</td>
<td>( B52 + B53 )</td>
</tr>
<tr>
<td>b smi t</td>
<td>( (B20 \times (B27 \times B30) + ((B21 / 2 + B22 - B8) \times B16 \times B3) / B7 - B28 \times 2500 \times B18) / 1000 )</td>
</tr>
<tr>
<td>s smi t</td>
<td>( \sqrt{(2 \times B19 \times B37 \times B20 \times (1 - B35) - B33 \times B19 / B38 - B20 \times (1 - B35) \times (B37 \times (B38 - B31 \times (B39 - 1) / 2) + B4 \times (B38 / (2 \times B39) + B18 + (- B8 + B21 / 2) \times B19 / B7)) / 1000} )</td>
</tr>
<tr>
<td>Supply Chain</td>
<td>( B56 + B57 )</td>
</tr>
<tr>
<td></td>
<td>( B19 \times B20 \times B35 / 1000 + B57 )</td>
</tr>
</tbody>
</table>