Pre-shipment FSCM
opportunities for banks

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Pre-shipment FSCM: Opportunities for Banks

Master thesis project

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Management Summary

Problem statement

In the last decade Financial Supply Chain Management (FSCM) has gained a lot of attention in both practice and research. ING is aware of this trend and wants to investigate which opportunities there are in the FSCM domain. Currently, ING is already offering their own automated reverse factoring solution, which they refer to as Supply Chain Finance (SCF). This solution enables ING to serve post-shipment spectrum of FSCM. However, ING is currently not offering any pre-shipment solutions. Therefore, this research project aims to look for opportunities in the pre-shipment FSCM domain.

Risk profile of pre-shipment FSCM

In order to investigate opportunities for ING in the pre-shipment domain we considered the risk profile of pre-shipment FSCM. We started our risk analysis by identifying the different phases in a global trade process. Subsequently, we allocated relevant risk drivers to each individual phase based on prominent Supply Chain Risk Management literature. This resulted in the risk framework that is displayed in Table 1.

Supply Chain Phase	**Risk drivers**
Inbound supply line 	Geographical location
	Availability of raw materials
	Quality of raw materials
	Price of raw materials
Supplier operations 	Geographical location
	Supplier bankruptcy
	Breakdowns of operations
	Operating performance
	Process variations
	Operating capacity
	Moral hazard
	Goal conflict
	Technological uncertainty
	Product complexity
	Frequency of design changes
Inland transportation 	Geographical location
	Transportation mode
	Logistic service provider bankruptcy
Export customs 	Geographical location
Port of export 	Geographical location
	Handling of goods

Main transport 	Geographical location
	Transportation mode
	Logistic service provider bankruptcy
Port of export 	Geographical location
	Handling of goods
Import customs 	Geographical location
Inland transportation 	Geographical location
	Transportation mode
	Logistic service provider bankruptcy
Buyer operations 	Default risk

Table 1: Risk framework

In prominent Supply Chain Risk Management literature a risk is described as the probability of a hazardous event occurring and the harm the event causes. Therefore, to fully capture the overall risk exposure of pre-shipment FSCM, for each individual risk driver its probability of occurrence and its severity have to be determined. Additionally, if these are known, ING is able to set an interest rate based on their risk exposure. However, the main challenge ING faces regarding risk in the pre-shipment FSCM domain is that ING is currently only able to address the "Default risk" risk driver. Thus, ING is currently only able to make reliable estimates for 1 of the 31 risk drivers we identified.

Pre-shipment FSCM solutions

In this research project we identified two types of pre-shipment FSCM solutions: Purchase Order Finance (POF) based solutions and tolling based solutions. Under the POF solution a supplier receives a loan from a financial institution based on the Purchase Order (PO) of the buyer. Thus, essentially the PO serves as collateral to the financial institution, since it indicates that the supplier is able to sell its products after he finishes his operations.

When tolling is used, the buying firm has ownership over the goods throughout the whole trade process. Under a tolling agreement the supplier still performs its production operations, but it has never ownership over the goods. Thus, the buyer is essentially hiring the machines and resources of the supplier to perform an operation on the respective goods. Meanwhile, a financial institution can take part in the tolling agreement by providing working capital to the supply chain members.

After identifying these pre-shipment FSCM solution types, we analyzed which solution offers the highest potential for ING. Based on the mechanics of both solutions, we found that POF is for ING more convenient to offer as tolling. In order to initialize the POF scheme only a PO from the buyer is required. Meanwhile, in order to offer tolling the buyer is required to orchestrate a significant portion of the supply chain and is even required to extend its operations to other countries.

From a risk perspective tolling seems more promising from ING's perspective. Under the tolling agreement the buyer has ownership over the goods throughout the whole trade process. Therefore, the creditworthiness of the supplier is less relevant. Meanwhile, under the POF scheme both the supplier and buyer hold responsibility for a portion of the trade process. Since the buyer is assumed to have a higher creditworthiness under the POF scheme, POF's risk exposure is expected to be higher.

However, by using the Buyer-backed Purchase Order Finance (BPOF) solution instead of regular POF risk of the bank can be mitigated. Under the BPOF scheme the buyer offers a guarantee to the bank to cover a portion of their losses. For the rest the mechanics of BPOF and POF are essentially the same. As mentioned before, ING is currently only able to make reliable estimates for 1 of the 31 risk drivers we identified (the default risk of the buyer). Meanwhile, by using the BPOF scheme with the buyer offering a full guarantee to the bank, ING is only exposed to the default risk of the buyer.

Concluding, by looking at the mechanics of the different solutions and by looking at their risk exposure, we found that the BPOF has the best fit with ING's capabilities.

Use case analysis

In order to further explore opportunities in the pre-shipment FSCM domain, we analyzed the behavior of the BPOF scheme in a use case. Since ING is currently only able to make reliable estimates of the default risk of the buyer, we assumed that the buyer will provide a full guarantee to the ING in the BPOF scheme. Subsequently, we calculated the financial benefits of the supplier, the additional costs of the buyer, and the risk exposure of ING. Note that the costs of the buyer originate from the guarantee he offers to the bank. Moreover, we discussed the impact of several solutions extensions. The following solutions extensions are discussed:

- Asset based solution: this solution adds collateral to the FSCM scheme.
- Progressive payments: the loan is provided in terms.
- Cash in advance: in the initial situation the supplier requires the buyer to make a prepayment.

Table 2 gives an overview of our calculations for the different scenario's.

Scenario	**Supplier's benefits**	**Buyer's costs**	**ING's risk exposure**
Original solution	€2761,31	€555,50	€589,44
Asset based	€2761,31	€427,18	€419,24
Progressive payments	€591,78	€281,91	€329,40
Cash in advance	€1183,56	€62,35	€589,44

Table 2: Use case scenarios overview

Additionally, the use case offered several insights. First of all, the benefits of the supplier are higher than the costs of the buyer, so the BPOF scheme offers value on a supply chain level. Secondly, adding using the goods that are traded as collateral will always result in lower costs for the buyer and a lower risk exposure for ING. Thirdly, these can be further reduced by using progressive payments, but this goes at the costs of the supplier's benefits. Fourthly, for buyer's that have to provide pre-payments to their suppliers the BPOF is especially lucrative. Fifthly, only supply chains with exceptional high performance are eligible for the FSCM solution. For supply chains with a low performance the costs of the buyer are higher than the benefits of the supplier.

Conclusions

In our use case we showed that ING can already offer the BPOF solution to their customers, since it creates overall benefits on a supply chain level. Meanwhile, the greatest opportunities for ING in the pre-shipment domain lie in the extension of their risk assessment capabilities. ING's business model is based on taking risks and receiving interest rates for that. Therefore, if ING is capable for determining all 31 identified risk drivers, they can offer a significant more versatile product to their customers and they can earn interest for all the risk they take. Moreover, the less risk the buyer and supplier are exposed to, the more lucrative the FSCM solution becomes for them. Thus, ING taking on risk will also increase the willingness of their customers to take part in the FSCM solution.

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1. Introduction

The objective of this project is to explore opportunities for ING regarding pre-shipment Financial Supply Chain Management (FSCM) solutions. ING is currently only offering solutions in the post-shipment domain of FSCM, but ING has the ambition to offer financing products/services in all stages of the supply chain. Therefore, this research project is a stepping stone to fulfil this ambition. Note that the term Financial Supply Chain Management (FSCM) is used instead of the commonly used term Supply Chain Finance (SCF). Within ING the term Supply Chain Finance (SCF) refers in general to one specific solution, so in order to avoid confusion Financial Supply Chain Management (FSCM) will be used. The term FSCM is already used in literature (e.g. Wuttke et al.,2013b and Popa, 2013).

The first time the concept of FSCM is discussed in literature was by Stemmler in 2002 according to Iacono et al. (2015). Therefore, FSCM is a rather new research area. Moreover, the theory and practice of FSCM is still not mature (More and Basu, 2013). The financial crisis of 2007 and 2008 played a major role in the rise in popularity of FSCM solutions (Lekkakos & Serrano, 2016; Liebl et al., 2016; Song et al, 2018). In the economic environment after the crisis, companies have issues financing their operations and managing their working capital (Lekkakos & Serrano, 2016). Access to credit has the second place in the top 10 of business risks across the globe (Ernst & Young, 2010). Furthermore, due to competitive pressure and globalization supply chains become more complex and dynamic. Therefore, the need for the need for coordinating the financial supply chain rises (More and Basu, 2013).

PWC and the SCF community (2017) show in their study that post-shipment solutions like reverse factoring and dynamic discounting are well known by companies (71% of the respondents is well known of reverse factoring and 51% is well known of dynamic discounting). Meanwhile, pre-shipment financing is only well known by 18% of the respondents of the study. This can be a result of banks like ING not yet offering this kind of solutions. However, pre-shipment solutions become more crucial than post-shipment solution, especially for emerging markets (Demica, 2011). This suggests that pre-shipment solutions have the potential to become an increasing trend in the upcoming years. Therefore, it would be valuable for ING to know what opportunities pre-shipment FSCM can bring. This thesis helps ING in exploring these opportunities.

2. Research questions

In this section the research questions which will guide this project are initialized. For this thesis we make a distinction between a main research question and sub-questions. The main research question illustrates the research goal of this project on a high aggregation level. The sub-questions aim to answer different aspects of the main research question, so answering the sub-question must logically result in an answer for the main research question. The research questions for this project are formulated as follows:

Main question:

- What are the opportunities for ING regarding pre-shipment Financial Supply Chain Management (FSCM)?

Sub-questions:

1. Which pre-shipment FSCM solutions are known in literature and practice and what are their characteristics?
2. How does FSCM interact with Supply Chain Risk Management (SCRM)?
3. Which pre-shipment FSCM solution is most suitable for ING to implement?
4. How will the most suitable look like if implemented within ING?

2.1. Research question justification

In this subsection is discussed how each individual question contributes to the overall research goal of this project.

Main question:

The main question describes the research goal of this research project: identifying opportunities for ING in the pre-shipment FSCM domain.

Research question 1:

This research question helps to identify suitable solutions for ING in the pre-shipment FSCM domain. Before any opportunities can be discussed, we must know which solutions are out there. Moreover, this helps to create good understanding of the different solutions.

Research question 2:

This research question focusses on the risk management aspects of FSCM. In literature a research gap exists for the interaction between the FSCM domain and SCRM. Therefore, this question is introduced to fill this gap.

Furthermore, from ING's perspective SCRM is also relevant, since ING's business model is based on taking risks and earning interest over that. Therefore, understanding the risks aspects of pre-shipment FSCM is of great importance.

Research question 3:

This question helps to analyze which pre-shipment FSCM solution is most suitable for ING to offer to its customers. Based on this analysis we can give ING a recommendation which solution to focus on in the pre-shipment FSCM domain. Note that the analysis for this research question also considers the insights gained from the previous questions.

Research question 4:

This research question helps ING to understand the implications of a pre-shipment FSCM solution for all involved parties. The analysis for this research questions is performed by means of a use case. The use case shows the potential benefits and costs for all involved parties.

3. Literature review

In this part of the report we will look at the current state of research regarding pre-shipment FSCM. Recall that we use the term FSCM instead of Supply Chain Finance (SCF), since within ING SCF is considered one specific solution. Therefore, using the term FSCM will limit confusion.

The following specific aspects are discussed in this section:

- In section 3.1 is discussed how the FSCM domain can be categorized in different categories.
- In section 3.2 we discus different papers that specifically address pre-shipment FSCM.

3.1. FSCM domain categorization

As mentioned before, in this subsection the categorization of the FSCM domain is discussed. FSCM solutions can be classified in three different echelons: operational, tactical, and strategic (de Boer et al., 2015). This classification is also displayed in **Error! Reference source not found.**. The operational level consists of solutions regarding working capital finance, the tactical level consists of solutions regarding fixed asset financing, and the strategic level consists of solutions regarding equity related FSCM financing.

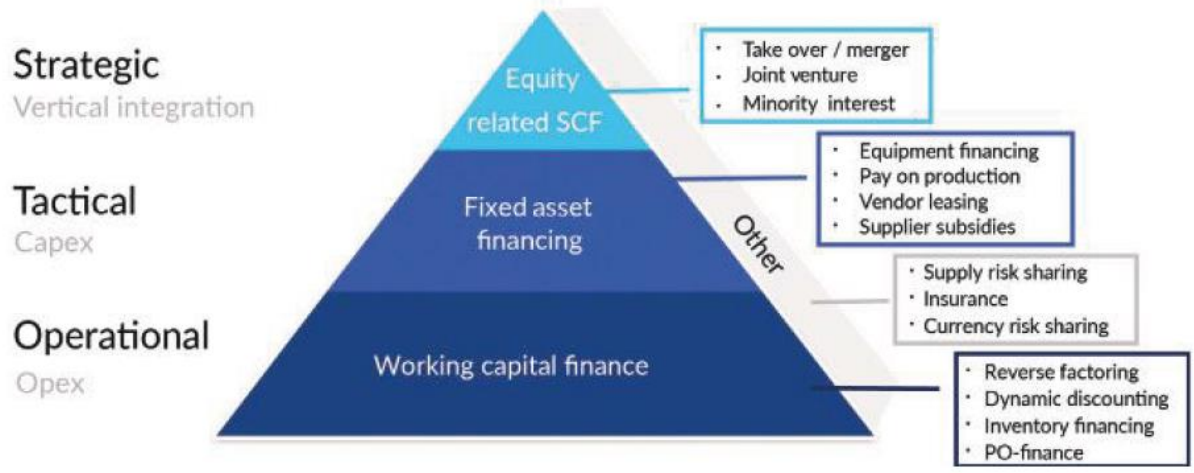

Figure 1: FSCM domain (source: de Boer et al., 2015)

Subsequently, the working capital finance domain can be further divided in three categories: pre-shipment, in-transit, and post-shipment. More and Basu (2013) were the first to divide the working capital echelon of FSCM into these three categories. In Figure 2 the categorization of the working capital finance echelon of FSCM is displayed. Moreover, it shows how these categories interact with the purchase to pay (P2P) process of the buyer.

- Pre-shipment solutions: Solutions that occur before the supplier ships the goods to the buyer.
- In-transit solutions: Solutions that occur during the shipment of the goods from the supplier's premises to the buyer's premises.
- Post-shipment solutions: Solutions that occur after the buyer has received the goods.

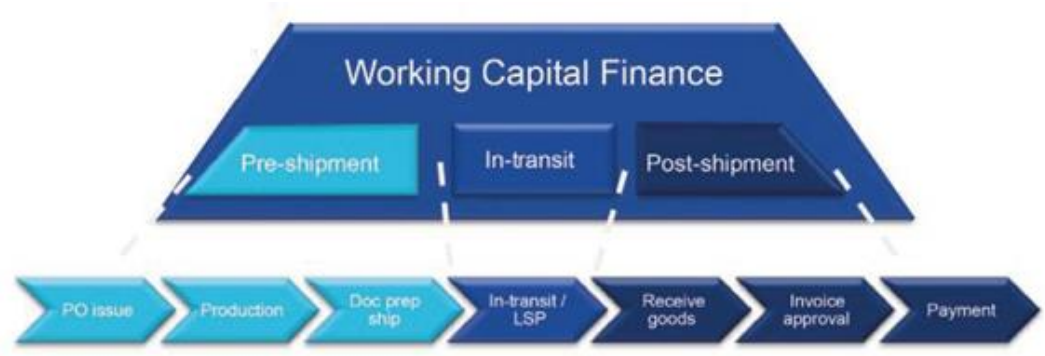

Figure 2: Working capital finance echelon categorization (Source: de Boer et al., 2015)

The goal of this thesis is to identify opportunities for banks in the pre-shipment domain of FSCM, so the focus lies on working capital finance solutions that occur before the supplier hands over goods to the Logistic Service Provider (LSP) for shipment.

3.2. Pre-shipment FSCM

FSCM solutions belong to pre-shipment if financing takes place before shipment of the goods from supplier to buyer. Because pre-shipment financing takes place before shipment, additional risks for banks occur. In general, FSCM theory focusses on the credit rating of the focal firm in the supply chain. Nevertheless, in pre-shipment financing the ability for the supplier to fulfill the order has to be considered. Operational risks for the supplier can cause a loss for the bank (Wu et al., 2014). However, de Boer (2015) acknowledges the benefits this particular FSCM category can bring. On average 4% of the price of finished goods comes from financing, so by using pre-shipment financing this percentage can be reduced. Wuttke et al. (2013b) argue that while the cash flow risk of the buyer increases in pre-shipment financing in comparison with post-shipment, the supply chain disruption risk decreases. In the end, the decrease of supply chain disruptions will overcompensate the cash flow risk for the buyer.

In practice pre-shipment solutions like purchase order financing are present, but post-shipment solutions like reverse factoring or trade credit are offered on a more regular and structured base. However, pre-shipment financing solutions are gaining increased interest (Lange et al., 2012). Lange et al. (2012) even argue that pre-shipment financing is more crucial for emerging markets than post-shipment financing.

3.2.1. Pre-shipment models

In this subsection we discuss different models we found in literature. Even though pre-shipment FSCM solutions only recently gained the attention of researchers (de Boer et al., 2015), several authors already investigated the domain by modelling these solutions.

Model of Lange et al. (2012):

The article of Lange et al. (2012) models POF by means of a Stackelberg game. In this game the buyer is the leader and the supplier the follower. They assumed a capital constrained supplier and a buyer with relatively more access to capital. In the model of Lange et al. (2012) POF enables the buyer to make a commitment for buying a minimum number of products which result in the supplier having

additional access to capital. Therefore, the both the financial benefits of the buyer and supplier are considered in the model. Additionally, the interest rate set by the bank is constant, so Lange et al. (2012) choose to model the risk exposure of the bank by setting a debt limit for the supplier. Note that the support the supplier receives from the buyer by POF results in an increase of the debt limit. However, this offers limit insights in the value POF offers to the bank. Moreover, Lange et al. (2012) also assumed that the buyer and supplier never default on the loan, while this is an important risk indicator for ING. Operational risk of the supply chain is only accounted for by a variable demand of the final market. Therefore, Lange et al. (2012) do not consider risks in the trade process between the buyer and supplier at all. Instead the focus of the model is on working capital implications.

Model of Wu et al. (2014):

The article of Wu et al. (2014) describes the BPOF solution by a stochastic programming problem. In their model the objective function is the profit function of the buyer. This profit is based on the buyer's purchase costs of products, the buyer's compensation to the bank under the guarantee agreement, buying and selling goods on the spot market, and the revenue of realized demand. Additionally, the revenue of the bank is determined by the value of produced assets, the interest rate on the loan, and the buyer's compensation to the bank. Wu et al. (2014) assumed that the revue of the bank is equal to the risk-free interest rate plus an interest rate that accounts for the probability of the supplier producing all requested goods. However, in practice the default risk of debtors is also relevant for ING. In case a borrower defaults ING tries to recover losses by addressing the current account of responsible parties or by claiming potential collateral. Wu et al. (2014) chose to not include this into the model by assuming no defaults take place. Furthermore, in the model of Wu et al. (2014) the risk in the trade process between the buyer and the supplier is only accounted for by one random variable. This variable is described as the supplier's overall risk in the fulfillment of the order. This variable in itself gives practitioners limit insights in the risks of their supply chain, so a model for analyzing the risk exposure for the trade process seems relevant.

Model of van Bergen et al. (2016):

The article of van Bergen et al. (2016) models the tolling agreement from the perspective of a large brewer, which is in the FSCM the buyer. In the article of van Bergen et al. (2016) three scenarios for tolling are considered: the brewer taking ownership after goods are received at his premises, the brewer taking ownership after his first-tier supplier receives goods, or the brewer taking ownership over the goods before the second-tier supplier starts operations. For all these scenario's the optimal profits for the brewer, the first-tier supplier, and the second-tier supplier are determined. In the model several risk drivers are accounted for: the reliability of the operations of both suppliers, price fluctuations of the different states of the product, the conversion rate of raw materials into products, demand fluctuations, and the effect of weather on the harvest of the second-tier supplier. The model in the article of van Bergen (2016) is very specific for the considered brewer, so the ability to generalize this model to other supply chains is limited even though it includes several supply chain risks. Moreover, the model does not consider the role of the bank.

4. Pre-shipment FSCM solutions

In this section the most notable pre-shipment FSCM solutions are discussed, so it covers research question 1.

The following is discussed in this section:

- In section 4.1 we discuss the POF solution.
- In section 4.2 we discuss the tolling solution.

4.1. POF

In this subsection the characteristics of the POF solution are discussed. The solution is described based on its mechanics, requirements, benefits, and risk profile. Furthermore, in section 4.1.1 the Buyer Backed Purchase Order Financing (BPOF) solution is described. This solution has in general the same mechanics as regular POF, but it enables the buyer to compensate a portion of the expected losses of the bank.

POF Mechanics:

Under POF a Financial Institution (FI) provides financing to a supplier based on the PO of its buyer. Thus, under POF a FI is willing to accept the future accounts receivables of the supplier (accounts payable from the buyer's perspective) as collateral for the loan (Lange et al., 2012).

In general funds are provided before the supplier ships the requested goods to the buyer (de Boer et al., 2015). Subsequently, the buyer pays the FI for the goods instead of the supplier to pay back the loan. Note that financing is based on the PO, so the loan the FI provides is in proportion to sales price of the goods. Moreover, since the buyer has pledged a PO and the buyer is paying back the loan, the creditworthiness of the buyer becomes more relevant instead of the creditworthiness of the supplier. Therefore, POF enables suppliers to acquire finance based on the credit ratings of their high creditworthy buyers (de Boer et al., 2015).

The basic process of POF can be described with the following steps and is displayed in Figure 3 (Based on Reindorp et al., 2018; and de Boer et al., 2015):

1. Buyer places purchasing order (PO) by supplier.
2. Supplier requests POF by the FI.
3. FI evaluates POF request and provides needed funds. The FI can choose to either fully advance all funds or a percentage of the order value.
4. After goods are produced, supplier sends goods to buyer.
5. Buyer pays FI for the goods on settlement date.
6. If funds were not fully advanced in step 3 or the loan does not fully cover the value of the transaction between the buyer and supplier, the FI pays the remaining proceeds to the supplier.

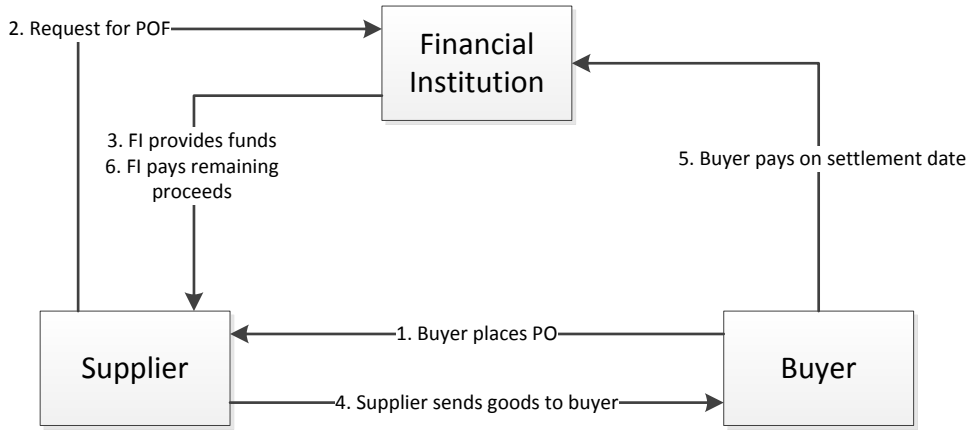

Figure 3: POF mechanics

POF requirements:

The mechanics of POF enable a supplier to acquire finance based on the credit rating of the buyer. From this the most important requirement for POF can be deduced. The supplier is only able to improve its financing facilities if the buyer has a higher creditworthiness as the supplier. Furthermore, since the PO is the initiator of this scheme, the PO must be issued before the FI can provide any funds.

POF Benefits:

The POF scheme offers the supplier to acquire finance based on the creditworthiness of the buyer. Thus, the supplier is able to acquire finance at a lower rate, but it also opens an additional source of finance which was previously unavailable. Lange et al. (2012) argue that many suppliers lack financing sources as consequence of the economic crisis of 2007, so the new financing source POF offers can be of great benefit.

Furthermore, the working capital position of the supplier is significantly improved. Instead of receiving payment at a predefined payment term, the supplier receives payment almost instantly. Thus, the accounts payables on the balance sheet of the supplier becomes close to zero for this specific order.

The main benefit for the buyer is that of a stronger supply chain. Since POF provides a new financing source to the supplier and its working capital position is improved, the probability of the supplier going out of business is reduced.

POF Risks:

The article of van Bergen et al. (2014) distinguishes two types of risk that are associated with POF:

- Default risk
- Performance risk

Default risk is the risk of a borrower not paying back the loan on settlement date. FIs are also experiencing this risk by regular loans. The performance risk describes the risk of operations jeopardizing the successful delivering of goods described in the PO. Performance risk is relevant for POF due to its pre-shipment nature.

4.1.1. BPOF

As described above, under regular POF the FI provides a loan to a supplier based on a PO. Since the buyer is responsible for paying back the loan to the FI, the FI focusses more on the credit rating of the buyer instead of only on the supplier. However, there is still some risk associated with the supplier, because the supplier is exposed to a variety of operational risks. This will ultimately cause a lost to the FI that is responsible for providing the loan.

The BPOF solution aims to solve these problems to a certain extend. Under BPOF the buyer offers a guarantee to the FI to cover a portion of its expected loss. The article of Wu et al. (2014) argue that the difference between POF and BPOF is the same as the difference between factoring and reverse factoring. In Figure 4 an overview is given of the difference between these financial solutions.

	Collateral or Subject	Initiator	Type
Factoring	A/R	Supplier	Post-shipment
RF	A/R	Buyer	Post-shipment
POF	PO	Supplier	Pre-shipment
BPOF	PO & Guarantee	Buyer	Pre-shipment

Figure 4: Solution comparison (source: Wu et al., 2014)

BPOF mechanics:

Because the guarantee is added to the scheme, the mechanics of BPOF slightly differ from POF. The BPOF scheme can be described with the steps below and is displayed in Figure 5 (based on Wu et al., 2014).

1. Buyer places purchasing order (PO) by supplier.
2. Buyer pledges a guarantee for covering potential losses of the bank (Note that the buyer can either partly cover the losses of the bank or cover all losses).
3. Supplier requests POF by the FI.
4. FI evaluates POF request and provides needed funds. The FI can choose to either fully advance all funds or a percentage of the order value.
5. After goods are produced, supplier sends goods to buyer.
6. Buyer pays FI for the goods on settlement date.
7. Buyer compensates potential losses of the bank if there are any based on the guarantee of step 2.
8. If funds were not fully advanced in step 3 or the loan does not fully cover the value of the transaction between the buyer and supplier, the FI pays the remaining proceeds to the supplier.

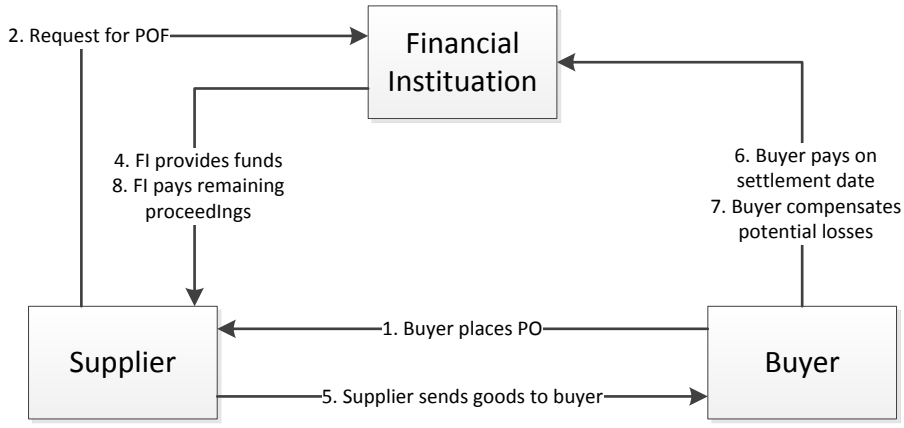

Figure 5: BPOF mechanics

BPOF requirements:

The BPOF solution has basically the same requirements as POF. The buyer must have a higher creditworthiness than the supplier and a PO must be issued, since this is the initiator of the solution. Moreover, the FI provides funds based on the value of the PO.

BPOF benefits:

For the benefits of BPOF holds the same as for its requirements, they are essentially the same as the benefits of POF. The supplier obtains an additional supply line, which can provide financing at a reduced rate since the creditworthiness of the buyer becomes prominent. However, because the buyer compensates a portion of the risk exposure of the bank under the BPOF scheme, the bank will be inclined to reduce the interest rate for the loan. Therefore, the supplier can benefit from an even cheaper loan in comparison to regular POF. Furthermore, the supplier's working capital position is significantly improved, because the days in account receivables are severely reduced.

The main benefit of buyer is again the stronger supply chain. Since the financial position of the supplier is improved the buyer is less likely to experience any problems caused by the financial position of its supplier.

BPOF risks:

The risks for BPOF can also be described with the following two types of risk (van Bergen et al., 2014):

- Default risk
- Performance risk

The main difference between BPOF and POF is the way these risks are allocated to the different supply chain partners. Due to the guarantee the buyer offers to the bank, the buyer takes on a larger portion of the overall risk compared to POF. Thus, basically the supply chain is exposed to the same amount of risk, but because the buyer bears responsibility to a bigger portion of these risks, the bank will in the end experience a lower risk exposure. Note that this only holds if the requirement of

the buyer having a higher creditworthiness than the supplier is honored. Moreover, since the buyer is required to take additional risk in the chain, this suggests that the BPOF solution might not be that lucrative for buyers in comparison with POF.

4.2. Tolling

In this subsection the Tolling solution is discussed. As was previously done for POF and BPOF, the mechanics, requirements, benefits, and risks of this solution are discussed.

Tolling mechanics:

In a Tolling agreement one party (toller) provides another party (project company) raw materials to perform operations on. The toller keeps ownership over the raw materials and/or products during the whole process, so the project company is in essence only providing a service to the toller. In fact, the toller pays the project company for the usage of their machines and/or services. The fee the toller has to pay is called a toll.

Under the tolling agreement the buyer has ownership over the goods during the operations of the supplier. Subsequently, the buyer is responsible for procuring raw materials needed for the supplier's operations by a second-tier supplier. Therefore, under tolling the buyer deals with both its first-tier supplier and its second-tier supplier, while in a situation without tolling the buyer only has to deal with its first-tier supplier (van Bergen et al., 2016).

The supplier needs significantly less working capital under the tolling agreement, because procurement of raw materials is not needed anymore. Thus, the supplier requires only working capital for performing its operations. Subsequently, since the buyer is responsible for acquiring raw materials it can finance inventories against its own credit rating.

Tolling requirements:

The tolling agreement requires the buyer to extends its traditional procurement activities, since the buyer has to deal with both its first-tier supplier and its second-tier supplier under tolling. Therefore, the buyer must possess the capabilities to coordinate this whole process.

Furthermore, as holds for POF and BPOF, financing benefits can only be acquired if the buyer has a better credit rating as the supplier. If this is not the case, the supplier can acquire financing at a lower rate on its own, so the using the Tolling solution would not make any sense.

Tolling benefits:

By using the Tolling agreement suppliers need less working capital, since the buyer is responsible for the procurement of raw materials. Moreover, the buyer can acquire finance for goods against its own credit rating, since it has ownership over the goods during the whole process. Therefore, the financing costs in the supply chain decrease.

Tolling risks:

Since the tolling agreement also takes place in the pre-shipment domain, the tolling agreement is also exposed to the following risks:

- Default risk
- Performance risk

By using Tolling the buyer has ownership over the goods through the whole process. Therefore, if ING provides a loan, the buyer is fully responsible for paying back the loan. Meanwhile, by using POF or BPOF the supplier is also responsible for a portion of the overall risk profile. Therefore, since the buyer is required to be the supply chain member with the highest credit worthiness, the Tolling agreement has a lower risk exposure as POF and BPOF from ING's perspective.

5. Pre-shipment FSCM risk

In this section the interaction between pre-shipment FSCM and Supply Chain Risk Management (SCRM) is investigated, so this section is focused on providing an answer for research question 2. Earlier, is discussed that pre-shipment FSCM solutions are exposed to two types of risk:

- Default risk
- Performance risk

However, the distinction between these two types of risk in itself does not provide many insights. Therefore, in order to discover opportunities for ING in the pre-shipment FSCM domain, we will analyze the risk aspects more extensively in this section.

The following is discussed in this section:

- In section 5.1 we identify different supply chain phases in the trade process between a buyer and a supplier. This enables us to allocate risk drivers to specific phases later in the analysis.
- In section 5.2 we discuss the different risk drivers that can be found in the trade process and in which phases they occur.
- In section 5.3 we analyze how the different risk drivers contribute to the overall risk exposure of the supply chain.
- Lastly, in section 5.4 the implications risk has for ING is discussed and the overall conclusion of this section is given.

5.1. Supply chain phases

In this section the different phases in the supply chain between a buyer and its first-tier supplier are identified. To identify the different supply chain phases, we looked from both a practical perspective as from a theoretical perspective.

In practice buyers and suppliers usually use Incoterms to communicate the moment responsibilities transfer from the supplier to the buyer in the trade process. Therefore, we argue that by looking at Incoterms we can identify the different phases companies acknowledge in their supply chain. In section 5.1.1 Incoterms are further discussed.

To identify supply chain phases from a more theoretical perspective we use the article of Hausman et al. (2010). In this article a trade process of a global supply chain is described in 106 individual steps. Based on these steps, different phases in the trade process are identified. In section 5.1.2 the identification process based on the article of Hausman et al. (2010) is discussed.

This subsection is concluded by providing an overview of the supply chain phases we identified in section 5.1.3.

5.1.1. Incoterms

The Incoterms are an international acknowledged set of rules that are used in global trade of goods to indicate the responsibilities of the buyer and the supplier. In general Incoterms describe the: tasks, costs, and risks of both parties during the process. The Incoterms are revised every ten years, so the most recent version is the Incoterms 2010. The party that is providing the Incoterms is the International Chamber of Commerce (ICC) (Ramberg, 2011). In the Incoterms 2010 11 different rules are distinguished and are displayed in Figure 6.

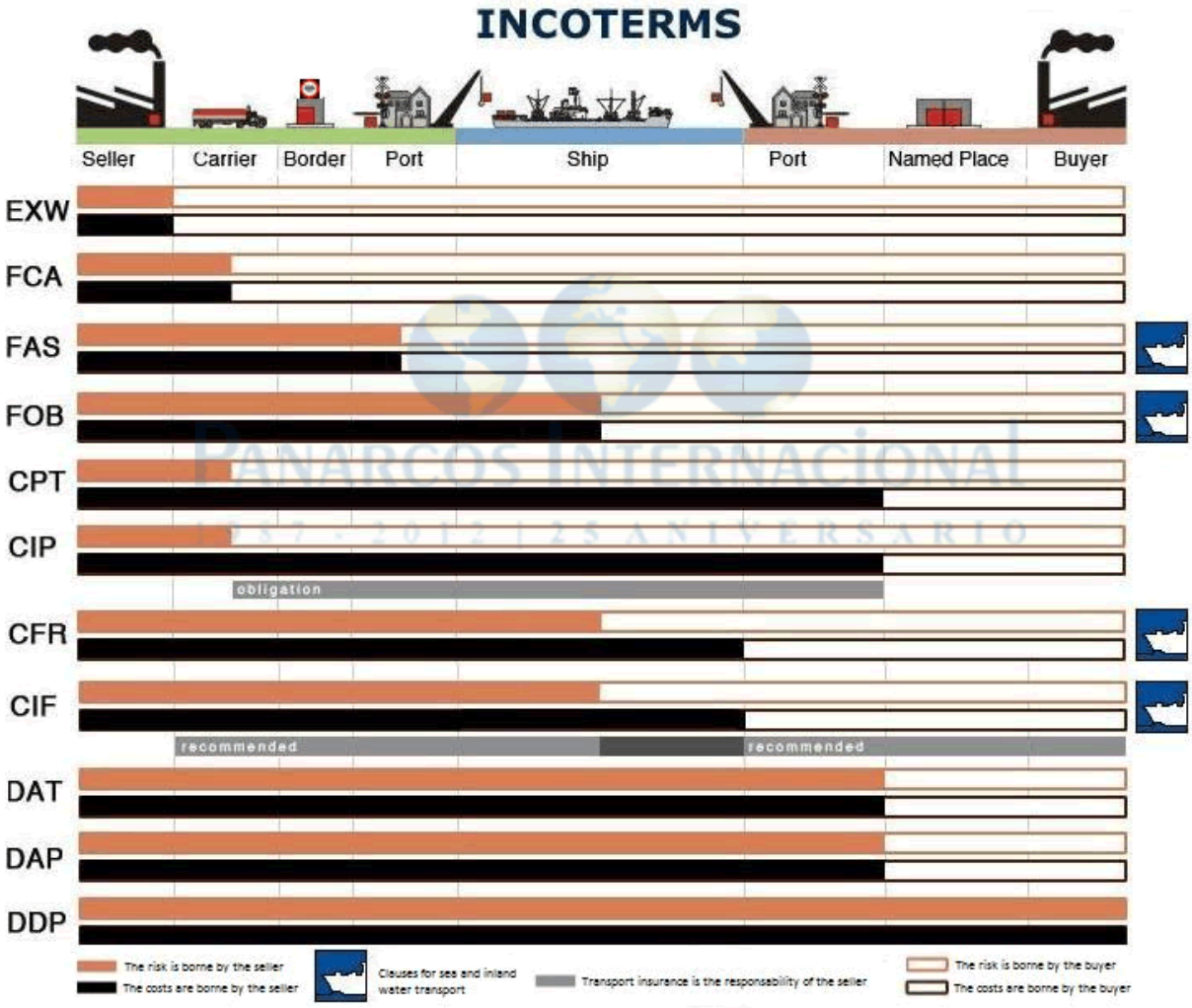

Figure 6: Incoterms (source: Panarcos, 2018)

On the left side of Figure 6 the 11 different Incoterms are displayed. Note that only the abbreviates of the rules are displayed. The full names and the practical implications of the rules are as follows:

- EXW = Ex works: The supplier is only obligated to produce the goods and place them at disposal of the buyer. All activities regarding transportation are at the cost and risk of the buyer.
- FCA = Free carrier: The supplier is obligated to deliver the goods (cleared for export), to a specific named place nominated by the buyer. The supplier bears all cost and risk up until successful delivery at that location. Note that this nominated place is located before export.
- FAS = Free alongside ship: Under FAS the supplier bears all cost and risk up until the moment the goods are places alongside the vessel at the port of export. The supplier is also obligated to clear the goods for export. This rule is only applicable for transportation by ship.
- FOB = Free on board: The supplier's responsibility for cost and risk are transferred to the buyer after goods are successfully loaded on the ship at the port of export. Clearing goods for export also belongs to the responsibility of the supplier. This rule is only applicable for transportation by ship.
- CPT = Carriage paid to: The supplier has to deliver the goods to a carrier or another entity determined by the buyer. If delivered successfully, risks shift from the supplier to the buyer.

However, the supplier is responsible for the transportation contract and has to pay the cost of transporting the goods to the place of destination.

- CIP = Carriage and insurance paid to: CIP is in essence the same as CPT, but the supplier has the additional obligation to conclude an insurance contract to mitigate the risks for damaged and/or lost goods for the buyer during carriage.
- CFR = Cost and freight: Under cost and freight the supplier is responsible for the risks up until the moment the goods are successfully loaded on the ship at the port of export. In comparison to FOB the supplier also has to pay the cost and make agreements for transportation to the port of import. This rule is only applicable for transportation by ship.
- CIF = Cost insurance and freight: CIF is in essence the same as CFR, but the supplier has the additional obligation to procure marine insurance against the buyer's risk of loss and/or damage of goods during carriage.
- DAT = Delivered at terminal: The supplier is obligated to deliver goods at a specified terminal at the location of destination. Both the responsibility and costs shift from the supplier to the buyer after the goods are successful unloaded at the terminal.
- DAP = Delivered at place: The supplier is obligated to deliver goods after carriage to a specific named location by the buyer. The risks and costs shift to the buyer if goods are ready for unloading at the buyer's premises. Under DAP the buyer is responsible for import clearance.
- DDP = Delivered duty paid: Under DDP the supplier has maximum obligation in the process. The supplier has to deliver the goods to a specified place by the buyer, but the supplier also carries the risks regarding import formalities.

As can be seen from Figure 6, the Incoterms clearly indicate whether the supplier or buyer is responsible for the costs and risks of a certain phase in the trade process. In general, the party that is carrying the risk is also responsible for acquiring insurance for transportation. However, in the Incoterms CIP and CIF the supplier is obligated to acquire insurance up until the point he carries the costs. Most Incoterms can be used for all transportation commodities (air, water, and land), however the rules FAS, FOB, CFR, and CIF are specifically for water transport. This is also displayed on the right side of Figure 6. Based on the Incoterms the different supply chain risks identified earlier can be allocated to the both the buyer and supplier.

While the Incoterms give great insight on the responsibility of both supply chain members, it fails to capture the whole scope of pre-shipment FSCM. Incoterms are used to indicate responsibility during the transportation process of goods, so after goods are produced by the supplier (Chung & Lee, 2013). Therefore, Incoterms do not consider the production process and the inbound supply line of the supplier. Moreover, Incoterms are in itself not legally binding. They are introduced to enable parties all over the world to communicate the tasks, costs and risks associated with the transportation and delivery of goods not to indicate ownership of goods. The binding factor in global trade finance is the sales contract between the supplier and buyer. This document indicates which party has entitlement over the goods and who carries risk in the supply chain. However, Incoterms can be used in such contract to communicate the transfer of ownership and/or risk.

5.1.2. Supply chain phases of Hausman et al. (2010)

In the article of Hausman et al. (2010) an extensive flowchart of a global trade process between a supplier in China and a buyer in the US is given. The flowchart can be found in Appendix A. For their model Hausman et al. (2010) assumed the incoterm Free at Carrier (FCA), a trade process in the

apparel industry, and the transportation mode was by ship. In total they distinguished 106 different steps in the process model. Based on the steps of Hausman et al. (2010) different phases in the global trade process are identified. The identified phases and the corresponding process steps are displayed in Table 3. Note that Hausman et al. (2010) describe step 47 "Inspection of goods" as an optional part in the global trade process.

ID	Phase	Steps in framework of Hausman et al. (2010)
1	Partner screening and PO acknowledgement	1 - 19
2	Pre-shipment trade finance request of exporter	21 - 23
3	LC terms	24 - 32
4	Sales order (SO) creation, final screening by exporter of ability to fulfil order	33 - 39
5	Production of order	40 - 42
6	Inland transport preparations	43 - 46
7	Inspection of goods (quality)	47
8	Document preparation for inland transport	49 - 51
9	Inland transportation of goods to port (including loading of containers), Importer receives Advance Ship Notice	52 - 53
10	Customs and inspection bureau information related activities	48, 54 – 58, 61, 67
11	Export customs inspection	61
12	Document preparation for shipment	59, 60, 62 - 66
13	Goods are loaded on ship	68 – 69
14	Bill of Lading is created and distributed to stakeholders.	71, 77
15	LC approval	70, 72 - 76
16	Physical shipment of goods by ship	78 - 79
17	Import documentation handling	80 – 83, 85 - 86
18	Import customs inspection	84
19	Transporting goods from port to final destination and unpacking of containers	87 - 89
20	Post shipment document handling	90 – 95
21	Payment to exporter	98 - 99
22	Payment processing	100 – 105
23	Post shipment trade finance request	96 - 97
24	Settling of provided trade finance (both pre-shipment and post-shipment)	106

Table 3: Phases in global trade process (based on: Hausman et al., 2010)

In a supply chain three different kind of flows can be distinguished: physical, information, and financial (Fairchild, 2005; Gupta and Dutta, 2011). These categories of flows can be allocated to the different phases identified in Table 3. The different phases we identified can be allocated to these three types of flows as follows:

- Physical flow: 5, 7, 9, 11, 13, 16, 18, and 19 (green in Table 3).
- Information flow: 1, 3, 4, 6, 8, 10, 12, 14, 15, 17, 20, and 22 (blue in Table 3).
- Financial flow: 2, 21, 23 and 24 (red in Table 3).

Note that phases 3 and 15 are associated with L/C, so these phases are only applicable if the trade process makes use of an L/C.

5.1.3. Supply chain phases overview

By looking both at Incoterms and the article of Hausman et al. (2010), a lot of comparisons can be identified for the physical flow of goods. In essence the physical flow starts with the supplier producing the goods. After goods are produced they have to be delivered to the main carrier. Subsequently, the main carrier will transport the goods to the country of destination. Lastly, the goods are transported to the final destination specified by the buyer. Therefore, in general the goods are two times transported by means of inland transportation and one time by Mondial transportation. During transportation the goods are also subdue to export and import customs. As mentioned before, the Incoterm rules indicate which party is responsible for clearance at customs. From the article of Hausman et al. (2010) the significance of customs in the trade process can also be deduced, as several steps are related to it. By taking this into account, the general physical flow of goods in the trade process between a supplier and a buyer can be described by the phases illustrated in Figure 7.

Note that while Incoterms do not consider the operations of the supply chain members, the article of Hausman et al (2010) considers a production phase at the supplier in the global trade process. Subsequently, in the study of Lange et al. (2012) the operations of the buyer are also considered for analyzing the mechanics of the pre-shipment FSCM solution purchase order financing (POF). Therefore, the operations of the buyer are also considered in this master thesis. Furthermore, the supplier has its own inbound supply line to acquire raw materials. Therefore, this phase is also added to our overview displayed in Figure 7.

Moreover, at the bottom of Figure 7 the moment of occurrence of pre-shipment, in-transit, and post-shipment FSCM solutions is displayed. As mentioned before, pre-shipment FSCM solutions occur before the goods are transported from the supplier's premises. Subsequently, in-transit solution can occur from that moment up until the moment the buyer receives the goods and post-shipment solutions occur after the buyer has received the goods.

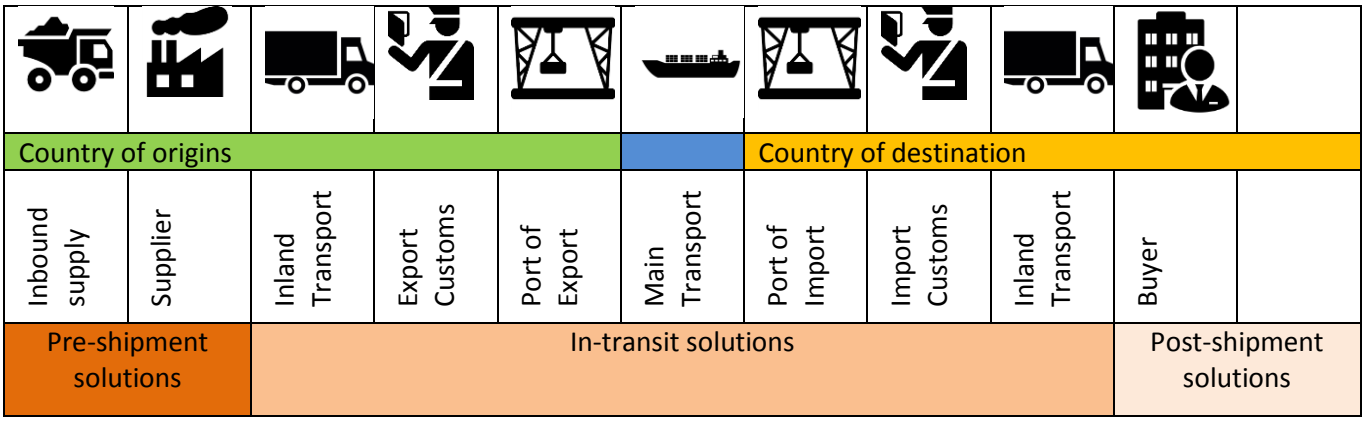

Figure 7: Supply Chain Phases

5.2. Risk drivers in the trade process

In this section the different risk drivers that play a role in the trade process are discussed. We will discuss for all the different supply chain phases we identified in section 5.1 which risk drivers are relevant for that specific phase. In the end this will result in a framework that shows which risk drivers are relevant for pre-shipment FSCM.

The identification and allocation of risk drivers is based on prominent SCRM literature. The most notable articles that are used for constructing the risk framework are from Manuj & Mentzer (2008)

and Chopra & Sodhi (2014). Additionally, the different risk drivers we found based on literature are validated by interviews with field experts. This results in a framework that is both based on prominent SCRM literature and relevant in practice.

Subsequently, after we identified the different risk drivers we constructed a framework that allocates risk drivers to the different supply chain phases. The framework is displayed in Table 4. In total 31 risk drivers are identified, which are distributed over the different supply chain phases we introduced earlier. In Appendix B a description of each individual risk driver is given and there is more extensively discussed which risk drivers are relevant for which supply chain phase.

Based on this framework ING can see which risk drivers are relevant for them if they offer financing to a supply chain. For example, if ING decides to finance an order that just finished the supplier's operation phase, all risk drivers after that phase are relevant for the loan.

Supply Chain Phase	**Risk drivers**
Inbound supply line 	Geographical location
	Availability of raw materials
	Quality of raw materials
	Price of raw materials
Supplier operations 	Geographical location
	Supplier bankruptcy
	Breakdowns of operations
	Operating performance
	Process variations
	Operating capacity
	Moral hazard
	Goal conflict
	Technological uncertainty
	Product complexity
	Frequency of design changes
Inland transportation 	Geographical location
	Transportation mode
	Logistic service provider bankruptcy
Export customs 	Geographical location
Port of export 	Geographical location
	Handling of goods
Main transport 	Geographical location
	Transportation mode
	Logistic service provider bankruptcy
Port of export 	Geographical location
	Handling of goods

Import customs 	Geographical location
Inland transportation 	Geographical location
	Transportation mode
	Logistic service provider bankruptcy
Buyer operations 	Default risk

Table 4: Risk driver framework

5.3. Risk analysis

In the previous subsection we identified a risk framework that enables ING to determine which risks are relevant in the trade process between a buyer and its first-tier supplier. In this section we discuss how these 31 risk drivers contribute to the overall risk exposure of the supply chain.

First in subsection 5.3.1 we discuss how risk is analyzed in literature. After that we discuss how ING is currently assessing risk in section 5.3.2. Lastly, we present a quantitative approach for determining the overall risk exposure based on our risk framework in section 5.3.3.

5.3.1. Risk in literature

According to Norrman and Jansson (2004) a risk is a combination of the probability of a hazardous event occurring and the harm the event causes. Therefore, a risk can be described by the following equation:

$$Risk = probability\ (of\ the\ event) * severity\ (of\ the\ event)$$

This suggest that for all the different risk drivers ING should determine their probability of occurrence and their severity. For example, to determine the risk score for the risk driver 'Breakdown of operations' ING must determine the probability a breakdown occurs and what the expected impact is of the breakdown.

5.3.2. ING risk assessment

ING determines risk at a slightly different way as literature suggests. Instead of calculating risk exposure by the probability and severity variable ING uses three variables: Probability Default (PD), Exposure At Default (EAD), Loss Given Default (LGD). This results in the following equation for risk exposure:

$$Risk\ exposure = PD * EAD * LGD$$

In the remainder of this subsection the three variables are further discussed and the subsection concludes with a discussion about the similarities with the risk formula found in literature.

PD

The PD can be defined as the probability a borrower will default on its payment obligations. This measure is based on a timespan of one year. ING uses credit risk rating grades to assess its client's ability to meet their financial obligations in full and on time. ING distinguished 22 different risk ratings that all have their own PD. Clients with a rating of 1 have to the lowest PD and clients with rating grade 22 are perceived to have the highest PD. In general, the PD does not consider covers or collateral, because these are covered in the LGD (the PD is an overall indicator of the creditworthiness of the client and the LGD is specific for a certain credit activity). ING splits the rating grades in the following categories:

- Investment grade (Risk rating 1-10)
- Non-investment grade (Risk rating 11-17)
- Substandard grade (Risk rating 18-19)
- Non-Performing Loan grade (Risk rating 20-22).

The investment grade category consists of companies with solid earnings and margins, a comfortable balance sheet, and stable long-term prospects. Many companies at the high end of this category are market leaders, so they experience low susceptibility of adverse market conditions. Moreover, companies in this category have easy access to public financial markets, so under most circumstances they are able to raise significant amounts of funds any time they want.

Non-investment grade companies have usually less or limited access to public markets in comparison with the investment grade category and are often not market leaders. Therefore, they are more susceptible to an unfavorable business environment or adverse economic conditions. However, companies in this category meet their financial obligations, but their financial flexibility becomes worse for less favorable risk ratings.

The substandard grade category consists of companies that show clear signals of pending problems, but these companies are still going concern and perform under its obligations to ING. ING expects that these companies are in need for additional liquidity and ING doubts whether all loan repayment terms will be honored.

The non-performing loan grade companies are companies that are not able to meet the obligations set by ING. Both companies that are already in the liquidating process and companies before this stage belong to this category. The company in question is considered bankrupt if the liquidation process cannot cover full exposure.

To gain better insight in the rating process of ING the corporate rating model will be discussed. Companies are eligible for the corporate rating model if they are a corporate legal entity with a consolidated annual sales bigger as 100 million, regardless of whether they are publicly traded. The corporate rating model is also used for corporate legal entities that do not fulfill this requirement if no alternative rating model is available. The rating model consists out of the following aspects:

- Financial model: This sub-model generates a score based on financial risk drivers of a company. The input factors for the financial sub model consist of 7 financial factors, the Domestic Macro Risk (DMR) rating, and industry risk. The 7 financial factors that are used are: net worth, total assets, net income after taxes, working capital, EBITDA, sales, and total interest bearing debt. The DMR rating measures the probability of disruptions in the normal functioning and payment ability of borrowers for the country of residence of the corporate.

The industry risk is a predefined measure within ING. ING defined 13 industry sector groups that all have their own score of riskiness.

- Qualitative model: This sub-model determines a score based on five qualitative risk drivers: market position, product diversification, quality of management, time between statement and publication date, and access to liquidity.
- Standalone rating: this rating is calculated as the rounded sum of the financial model and the qualitative model.
- Influenced rating: this rating is applicable for companies that have a parent company and for companies that are government owned. The standalone rating of these corporates is adjusted based on the rating of the parent company if applicable or based on the sovereign rating of the country of residence in case of a government owned company. The impact of the adjustment is based on the influence the parent or government has on the corporate. Note that if a corporate is neither influenced by a parent company or a government, the standalone rating is used.
- Final rating: ING assumes that the final rating of a corporate cannot be better as the sovereign rating of the country of residence. Therefore, the sovereign rating is set as a cap for the standalone rating and the influenced rating, depending on which of the two is relevant for the corporate in question.

EAD

The exposure at default (EAD) is the total value a bank is exposed if the underlying credit activity defaults. According to Tong et al. (2016) for fixed exposures an estimate for the EAD can simply be taken from the on-balance amount. Determining the EAD becomes significantly more complicated in case of credit cards and overdraft portfolios. In these instances, the current account of the customer cannot provide a reliable estimate of the EAD, because the credit line is constantly revolving. ING also addresses this phenomenon. For the calculation of the EAD ING uses two instances: the exposure at observation and the expected additional drawings until default occurs. However, the loans used in FSCM solutions are of a fixed exposure nature, as customers are not able to make additional drawings. This suggests that the EAD can be estimated as the on-balance value of the loan.

LGD

The loss given default (LGD) represent the expected economic losses in case of default occurs and is expressed as a percentage of the EAD. ING uses the following formula for determining the LGD:

$$LGD = \frac{EAD - (CV * RR + Unsecured\ Amount * RRu) * DF)}{EAD} * (1 - CureRate) + Costs$$

In which:

$LGD = Loss\ Given\ Default$

$EAD = Exposure\ at\ Default$

$CV = Collateral\ Value$

$RR = Recovery\ Value$

$RRu = Recovery\ Value\ of\ Unsecured\ Amount$

$DF = Discount\ Factor$

$CureRate = Probability\ that\ a\ defaulted\ Borrower\ will\ return\ to\ the\ perfroming\ book$

$Costs = The\ costs\ associated\ with\ the\ workout\ process\ of\ the\ default$

The formula calculates the amount of economic losses by calculating the difference between the amount of money that is at risk in case of default EAD and the amount of money that can be recovered in case of default. ING can cover losses by underlying collateral CV and by making a claim on the unsecured amount of the loan. However, during foreclosure a percentage of the cover value will be economically lost. Therefore, the recovery rates RR and RRu are used to address the percentage of cover that can be retrieved. Besides the losses that occur due to the inability of recovering the full amount of the EAD, ING will also experience losses related to the workout process. This is described with the $Costs$ variable in the formula above. These costs can vary from legal costs to travel expenses of people working in the Credit Restructuring Unit. The discount factor DF illustrates the time value of money, so by using DF ING can determine the value of the LGD today instead of at the moment of default. As mentioned above, the $CureRate$ represents the probability of the defaulted borrower returning to the performing book. In case this happens, the borrower is able to repay any outstanding debt to ING and is no longer at default, so in case the borrower is cured there is no loss.

Risk measure implications

As mentioned before, risk in literature is commonly addressed with two variables: probability of occurrence and its severity. Meanwhile, ING uses three variables: PD, EAD, and LGD. However, in essence ING's risk assessment is quite similar as the risk equation found in literature. The PD variable of ING is basically the probability the hazardous event occurs, so this has major similarities with the probability variable found in literature. Furthermore, the EAD and LGD variables together indicate the financial losses expects to suffer, so these two variables together are quite similar to the severity variable found in literature. This suggests that ING's method for risk assessment is in line with literature.

However, note that the PD variable of ING is exclusively for determining the probability a debtor defaults on its repayment obligations. This measure is not useful for determining operation related risks. Subsequently, this suggests that ING is currently only able to determine default risk in the pre-shipment FSCM domain. Note that default risk is only 1 of the 31 identified risk drivers. By interviewing a risk expert of ING, we found that this is indeed the case. Therefore, from a risk perspective one of the major opportunities for ING in the pre-shipment domain is to extend its capabilities so all risk drivers can be accounted for.

5.3.3. Quantitative approach to risk framework

In this research project we formulated a quantitative model that could theoretically calculate the overall risk exposure of ING based on the probability of occurrence and severity of the 31 identified

risk drivers. However, since we found that ING currently only has the tools to determine the probability of default risk and not for the remaining 30 risk drivers, the quantitative model loses relevance. Therefore, instead of extensively discussing the model, only the underlying mechanics are discussed in this subsection.

Figure 8 shows which variables play a role in determining the overall risk exposure and corresponding interest rate. The relationships of the different variables are displayed with either a plus or a minus sign. This indicates whether increasing the variable from which the arrow originates will increase or decrease the variable the arrow is going to. Thus, the figure gives a visual representation of the relationship between these variables.

In our model we use the risk equation we found in literature to determine the risk score of an individual risk driver:

$$Risk\ score\ =\ probability\ (of\ risk\ driver\ occuring)\ *\ severity\ (of\ the\ risk\ driver)$$

Subsequently, we argue that the severity of a risk driver is difference between the loan principal minus the value of underlying collateral. Thus, severity can be expressed with the following equation:

$$Severity\ =\ Loan\ principal\ -\ Value\ of\ underlying\ collateral$$

Taking collateral into account for determining the severity of a risk is in line with the article of Hofmann (2009). In his article Hofmann (2009) states that in global trade finance the severity of a risk is mainly influenced by collateral. Moreover, collateral is also an important variable for ING for determining the LGD in a risk assessment.

The expected total risk exposure variable in Figure 8 represents the risk score of all the 31 individual risk drivers together. Subsequently, the total risk exposure determines the interest rate of the loan. However, for determining the interest rate we must also consider the ability of the borrower to pay back the loan. The probability that a high creditworthy borrower pays back the loan is much higher than the probability a low creditworthy party pays back.

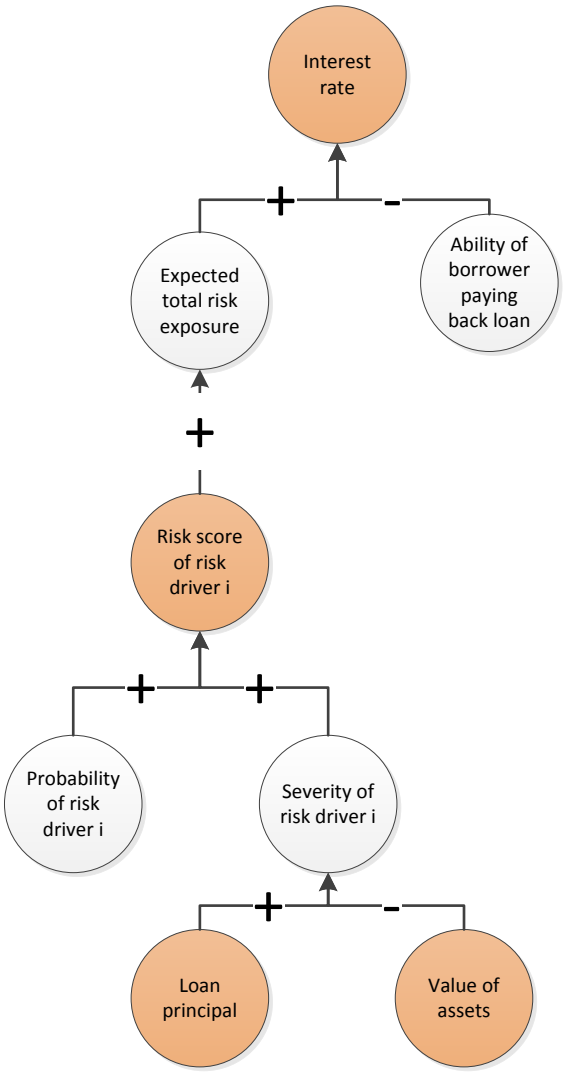

Figure 8: Risk exposure model overview

Model implications

Based on the model ING can obtain some insight:

- First of all, since increasing the loan principal will also increase the severity of a risk driver, ING can choose to lower the loan principal in case the risks is perceived as too high.
- Furthermore, the relationships in Figure 8 show that supply chains where collateral has a high value are preferred. A high collateral value will lower the perceived severity of our risk drivers. Therefore, ING can try to target only supply chains where collateral has high value in order to mitigate their risk exposure.
- Our model also shows that the probability of risk drivers occurring will increase the overall risk exposure of the trade process. Therefore, ING has to target supply chains where risks only rarely occur. Klapper (2006) even argues that pre-shipment FSCM is only eligible for supply chains with good operating performance and stable position.
- Lastly, ING should consider the ability of the borrower to pay back the loan. Providing a loan to very high creditworthy company is not risky for ING, because the company can pay back the loan independent of the riskiness of their trade process.

5.4. Risk conclusions

In this section we investigated the role of risk in pre-shipment FSCM. We identified 31 different risk drivers that are relevant for pre-shipment FSCM solutions. Moreover, we allocated the 31 risk drivers to different phases in the global trade process between a buyer and its first-tier supplier. The 31 risk drivers together form a framework ING can use to determine which risk drivers they have to consider to fully capture the risk profile of a supply chain's trade process.

Furthermore, based on our risk framework we constructed a model to determine ING's risk exposure. The model gives ING insight in which variables ultimately determine the riskiness of loan in the pre-shipment domain.

Lastly, we found that ING is currently only addressing default risk. In our risk framework this is only 1 of the 31 risk drivers. Thus, ING does currently not have the capabilities to make reliable estimates of the risk drivers that are relevant in the pre-shipment domain. Therefore, extending ING's risk assessment capabilities, so other risk drivers can also be accounted for, offer a great opportunity for ING from a risk perspective.

6. FSCM solutions analysis

In this section we analyze which FSCM solution is most suitable for ING to offer to customers in the near future, so this section is focused on providing an answer for research question 3. In section 3 we discussed that the most notable pre-shipment FSCM solutions we found are POF and Tolling. Additionally, we discussed the BPOF solution, but we consider this a special form of POF. Therefore, this section is focused on determining whether POF or Tolling is most suitable for ING.

The following is discussed in this section:

- In section 6.1 we analyze the POF solution.
- In section 6.2 we analyze the Tolling solution.
- In section 6.3 conclusions are given based on the risk framework we introduced in section 5 of this document.
- In section 6.4 conclusions are made for which FSCM solution is most suitable for ING based on this research project. Note that this research project is mainly focused on the risk aspects of pre-shipment FSCM. Therefore, the overall conclusions are made from a risk perspective. If for example a marketing or legal perspective is taken one might argue that other FSCM solutions are more suitable for ING.

6.1. POF analysis

The mechanics of POF are already discussed in section 3 of this report. However, in this section we will provide a more extensive analysis to determine the suitability of POF for ING. Moreover, we will consider the risk framework we constructed in section 5.2 of this research project, to better understand the risk drivers that are relevant for POF.

In section 6.1.1 we analyze the POF solution based on the risk framework we introduced in section 5. Additionally, in section 6.1.2 we discuss the role of production strategies of the supplier. In section 6.1.3 we analyze the loss at default for POF and in section 6.1.4 we briefly discuss what changes in case BPOF is used instead of regular POF.

6.1.1. POF risk framework analysis

The initializing event for offering POF is the buyer issuing a PO to its supplier (de Boer et al., 2015). Therefore, POF is usually issued at the following moments in the trade process:

1. Before the moment of ordering raw materials (Before “inbound supply line” phase)
2. During the process of obtaining raw materials (During “inbound supply line” phase)
3. After receiving raw materials, but before production (Between phases: “inbound supply line” and “supplier operations”)
4. During production (During “supplier operations” phase)
5. After production (Between phases “supplier operations” and “inland transport”)

Based on the moment of issuance the framework can give insights in the different potential risks the FSCM solution is exposed to. Because POF can be offered even before the supplier has received raw materials from its upstream supply line, all risk drivers in our framework are potentially relevant for analyzing POF.

However, the mechanics of POF will result into the mitigation of the 'goal conflict' risk driver. POF is mainly focused on providing working capital at the beginning of the trade process. A supplier is able to receive funds at the creditworthiness of the buyer. Subsequently, the buyer fulfills the order by making payment to the bank that provides the funds to the supplier (de Boer et al., 2015). Thus, POF significantly improves the Cash Conversion Cycle (CCC) of the supplier, while the CCC of the buyer remains untouched. Since the supplier and buyer are collaborating to optimize working capital in their supply chain, the risk driver "goal conflict" seems irrelevant under POF. Without POF supply chain members can try to improve their own CCC at the costs of their partners, however POF enables them to improve their CCC without harming the Days Payables Outstanding (DPO) and Days Sales Outstanding (DSO) of their partners. Because the mechanics of POF only mitigate the 'goal conflict' risk driver, still 30 of the 31 risk drivers of our framework are relevant for POF.

6.1.2. Production strategy

The moment of receiving the PO becomes an important indicator, since it determines which risk drivers have to be considered in determining the overall risk exposure of POF. If a supplier receives a PO after he is finished producing the goods, the risk drivers in the "inbound supply line" and "supplier operations" phases are not relevant. This suggests that the production strategy of the supplier is related to the overall risk exposure of POF. The article of Olhager (2003) distinguishes four strategies based on the Order Penetration Points (OPP):

- Make-to-Stock (MTS)
- Assemble-to-Order (ATO)
- Make-to-Order (MTO)
- Engineer-to-Order (ETO)

The OPP is the last point in the production process inventory is held and where product specifications get frozen (Sharman, 1984). In Figure 9 can be seen how the OPP differs between the identified production strategies. For example, for the MTS strategy inventory is held after the full production process is finished, so the supplier only has to ship the goods upon receiving an order.

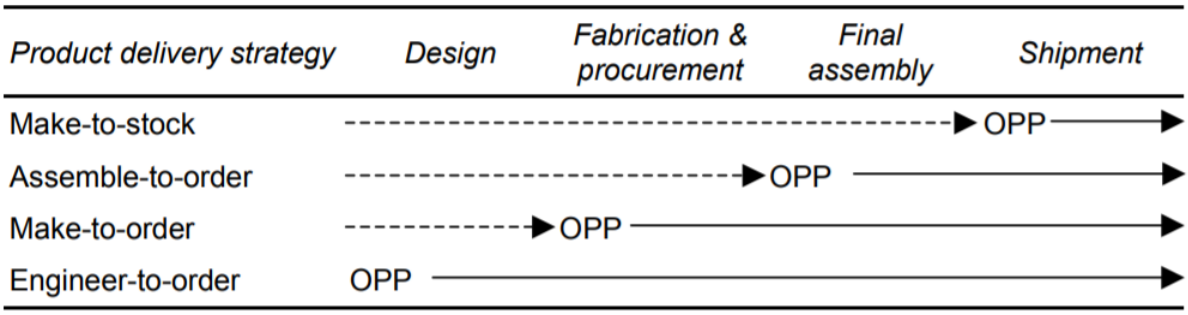

Figure 9: OPP under different production strategies

Translating this to the domain of FSCM, the OPP can be seen as the moment of the supplier receiving the PO. Therefore, the moment of receiving the PO has some major implications for the risk exposure of POF. Under MTS orders are received after the production of the goods is finished. In the risk framework introduced earlier, this suggests that the supplier receives the PO after the "supplier operations" phase. Thus, a supply chain with a supplier using the MTS production strategy is not exposed to risk drivers associated with the first two phases. Additionally, for a supply chain with a supplier using MTO or ETO these are potential risk drivers. Concluding, the production strategy of

the supplier and subsequently the moment in the production process the supplier receives the PO is an important determinant of the overall risk exposure of POF.

6.1.3. Loss at default

POF offers a big opportunity for optimizing working capital, but it is still not offered by ING. One of the main issues for banks is recovering outstanding loans in case of default. In general, POF is used in case of a high creditworthy buyer and a supplier having a hard time obtaining funds.

The losses that occur in case of default can be explained by the LGD. According to ING's equation for the LGD given in section 5.3.2 a loan can be fully unsecured or it can be backed by collateral. For both parts ING determines a certain recovery rate that indicates how much of the loan ING is able to recover in case of default. Therefore, for ING the value of collateral and the ability of the responsible supply chain member paying back the loan from its current account are important determinates for the overall risk exposure. Thus, ING experiences least risk in case of collateral that is easy to recover and in case of a supply chain member that has no problem covering the unsecured part of the loan. In general, POF assumes a high creditworthy buyer and a supplier having a hard time obtaining funds, so to reduce risk ING would prefer the buyer to be responsible for the unsecured part of the loan.

In a supply chain that is using POF the buyer is responsible for paying back the loan to the bank. Hence, the ability of the buyer to fulfill payment is crucial from the bank's perspective (Lange et al., 2012). However, default is not considered here. Under POF the buyer pledges to purchase a certain minimum amount of products stated in the PO, but in case of default products not always fulfill requirements stated in the PO. In such situations POF does not obligate the buyer to make payment to the banks, since the supplier was not able to meet requirements. Therefore, the main question regarding POF that is still not answered in literature to my best knowledge is: Who is responsible for paying back the loan to the bank in case of default?

In current global trade practices, the Incoterms are commonly used to indicate the responsibilities of the buyer and supplier. In the context of POF Incoterms can also be considered to communicate the responsibility of supply chain members for paying back the loan. However, note that Incoterms only describe the transportation part of the trade process, so there is no Incoterm that states the buyer is responsible for the production process of the supplier, but theoretically a buyer could take this responsibility under POF. Thus, although the Incoterms do not consider all relevant phases in the trade process, they show possible distributions of responsibility in the supply chain. Like mentioned before, the bank will experience the least risk if the supply chain member with the highest creditworthiness takes on full responsibility for paying back the loan, so in case of POF the Incoterm that results in the lowest risk exposure is EXW.

6.1.4. Buyer-backed purchase order finance (BPOF)

BPOF is extensively discussed in the article of Wu et al. (2014). Under this arrangement a buyer offers a guarantee to the bank besides regular POF in order to relief the bank's risk regarding pre-shipment financing. The buyer reliefs the bank of a portion of its losses in case the supplier is not able to fully produce the amount of requested units stated in the PO. The model of Wu et al. (2014) describes the loss of the bank as the difference between the loan plus interest rate minus the wholesale value of produced units. This suggests that they assume that without the guarantee (so in a normal POF) a buyer only has to pay the wholesale value of produced units. Therefore, the risk

regarding unreliable production of the supplier are allocated to the bank in their model. Note that this risk is accounted for by the interest rate on the loan. Moreover, in case the supplier is not able to fulfill the order, the supplier does not suffer any consequences in the model. Previously is discussed that ING also considers the current account of the firm in determining the LGD, so in practice the supplier does experience consequences for not fulfilling operations according to the PO. The formula for the LGD described in section 5.3.2 indicates that the bank expects a certain recovery rate for the unsecured amount of the loan. Therefore, to fully capture the expected loss for the bank under BPOF this rate must also be considered.

The main question for POF is who is going to pay back the loan in case of default. BPOF can help to give some insights in this matter, since the guarantee offered by the buyer clearly indicates to which extend the buyer will take responsibility for potential losses for the bank. However, note that for the part of the loan that is not covered by the guarantee, the question remains for who is responsible for covering losses for the bank. Furthermore, the mechanics of BPOF offer no additional risk mitigation. It serves as a means to transfer risk from the bank to the buyer, which could be necessary if the supplier has a hard time obtaining funds (Wu et al., 2014). Therefore, from the perspective of the framework no risk drivers can be eliminated by using BPOF.

6.2. Tolling agreement

In section 3 of this document we already discussed the basic characteristics of Tolling. We discussed that the buyer has ownership over the goods during the whole trade process under a tolling agreement. Therefore, he also bears the responsibility for paying back the bank loan during the whole process. The supplier is only providing a service to the buyer by performing operations on the product, so the supplier has never ownership over the goods. Therefore, from a bank's perspective financing a tolling agreement seems not that risky in comparison to POF, because the high creditworthy buyer is responsible for the whole process. Translating this to the framework introduced in section 5.2, the buyer is potentially exposed to all the risk drivers in the framework. Van Bergen et al. (2016) investigated in their study how tolling could help improve the supply chain of a large brewer. They showed that for their business case the brewer's profit increases by using the tolling agreement. Therefore, based on this study the tolling agreement can also be beneficial for the buyer even though he takes on all the risks in the trade process.

The tolling agreement also helps in mitigating some of the risk drivers identified in the framework. Moral hazards will be mitigated, because the supplier will not receive the loan itself. The supplier is only responsible for performing operations on the goods, so the supplier is for example not able to provide misleading information about assets or to use the loan for risky ventures. The risk driver "goal conflict" is also less relevant, because the supplier needs significantly less working capital for its operations under the tolling agreement. Nevertheless, the buyer has to pay the supplier for performed operations, so payment terms still exist. Therefore, conflicts regarding the working capital goals of supplier and buyer could still occur under a tolling agreement. The risks drivers in the inbound supply line phase depend on the moment the bank provides the loan to the buyer. If the materials are already in possession of the buyer, these risk drivers are not relevant anymore. However, if the buyer still has to obtain raw materials form the provider, these risk drivers have to be considered in the overall risk assessment of the loan. Considering the risk mitigating mechanics of the tolling agreement and the risk framework introduced in section 5.2, we conclude that the moral hazard risk driver and goal conflict are mitigated by tolling.

Therefore, for the tolling agreement is exposed to one risk driver less than POF according to our framework. Nevertheless, still 29 of the 31 risk drivers have to be considered if tolling is used. However, under the tolling agreement the buyer is responsible for paying back the loan, so the supply chain risks must be analyzed considering the ability of the buyer paying it back. Thus, in case the supplier has very unreliable operations, but the buyer has a very high creditworthiness, the probability the buyer does not pay back the loan to the bank is still small. Therefore, from ING's perspective the creditworthiness of the supplier is only of minor concern.

6.3. Risk framework conclusions

Based on the analysis of both POF and the tolling agreement can be concluded that both solutions are exposed to almost all of the risk drivers in the framework. POF is mainly focused on solving the goal conflict in the supply chain. Both the supplier and the buyer are able to improve their CCC without harming the CCC of their partner. Additionally, only financing raw materials has the ability to reduce the impact of risk drivers in the inbound supply line phase and moral hazards will be mitigated. Furthermore, the mechanics of BPOF are discussed. This solution enables the supply chain to move risk from the bank to the buyer. While this in itself will not mitigate any specific risk drivers mentioned in the framework, it can serve as a valuable tool to transfer losses of the bank to the buyer.

Under the tolling agreement the buyer takes ownership over the goods at the start of the identified supply chain phases. The supplier is only responsible for performing the required operations and does not have any additional obligations. Therefore, the risk driver moral hazards loses relevance and also the risk driver goal conflict is less relevant under the tolling agreement.

Concluding, the discussed FSCM solutions are only able to mitigate a small proportion of the risk drivers of the framework. In total 31 risk drivers were identified, so many risk drivers remain for the identified pre-shipment FSCM solutions. Note that the time of providing the loan and the production strategy of the supplier also influence the overall risk exposure. However, the solutions enable the supply chain to transfer risk from a low creditworthy supplier to a high creditworthy buyer. Therefore, solely based on the risk framework no hard conclusion can be drawn for which FSCM solution offers most opportunities for banks.

6.4. Comparing POF and Tolling

The POF solution enables supply chains to acquire cheaper finance based on a PO of the buyer in that chain. The PO represents a future promise of a cash flow for the supplier, so if the supplier succeeds in completing the order (performance risk) and the buyer does not default (credit risk) the cash flow is completed. One of the main problems for POF at the moment is that a PO does not provide any entitlement for the borrower in case of default. Subsequently, legally POF is considered an unsecured loan to the supplier. For banks this has major implications on the loss given default (LGD) of providing POF. In case the supplier defaults on the loan and subsequently goes bankrupt a curator tries to compensate all relevant debtors. In the process secured loans hold priority before unsecured loans. For post shipment solutions like reverse factoring the invoice serves as entitlement and therefore, the loan is secured. However, since a PO gives no entitlement whatsoever, a loan under POF has a larger LGD as a loan under for example reverse factoring.

Under tolling this issue is less relevant, because the bank does not require to send a blanc cheque to the supplier. In a supply chain that uses tolling the buyer takes over the supply chain by procuring raw materials itself. The supplier is only required to perform its operations on the product, but never has ownership over the goods. In case of defaults the buyer remains owner over the products and the LGD will be significantly lower. Thus, from a legal perspective tolling seems most in line with the risk appetite of banks.

However, the main issue with tolling is that it requires the buyer to take over a significant part of the supply chain. Even if tolling is only used for the first-tier supplier, the buyer needs orchestrate the whole supply chain from second-tier suppliers up until the products arrive at its own premises. This requires the buyer to have extensive knowledge of its supply chain and he must be able to make arrangements with second-tier suppliers for obtaining raw materials. In general, coordinating such a large operation is only reserved for large corporates. However, the department of ING this research project is performed for is focused on offering finance products to large SMEs. In most situations these companies are not familiar with second-tier suppliers in their supply chain and do not have the operational capabilities available to orchestrate their whole supply chain. Therefore, for large SMEs offering tolling is not realistic. On the other hand, large corporates, who are able to use tolling for their supply chain, do not need a bank as service provider. These companies can introduce their own FSCM programs, without relying on standardized products in the market. Meanwhile, large SMEs do not have the required capital to introduce a FSCM program on their own. They require a bank or another service provider to provide a FSCM program.

Concluding, for ING offering POF offers more risk as tolling due to the higher LGD. However, POF mechanics allow it to be offered much more convenient than Tolling. For POF only a PO is needed to provide finance. For tolling the buyer is required coordinate the whole supply chain starting from its second-tier supplier. Moreover, the BPOF extension of POF enables ING to transfer a portion of its risk exposure to the buyer. Therefore, the difference in the expected LGD can be reduced drastically. Therefore, we argue that the POF solution is most suitable for ING to offer in the near future.

7. Use Case

In this section of the report we consider a use case, which gives more insight in how a pre-shipment FSCM solution will look like, if implemented by ING. Therefore, the goal of this section is to provide an answer for research question 4. The use case in this section is fictive, but is based on common characteristics of an ING customer. Moreover, the FSCM solution that is provided in the use case is POF, since we concluded in section 6.4 that this is the most suitable pre-shipment FSCM for ING to offer.

The following is discussed in this section:

- In section 7.1 we start by arguing which is a suitable supply chain for ING to offer pre-shipment financing to.
- In section 7.2 we describe the characteristics of our fictive use case.
- In section 7.3 introduce the FSCM solution to the use case.
- In section 7.4 we describe several solution extensions that can be used to reduce ING's risk exposure.
- Lastly, in section 7.5 we provide a sensitivity analysis of the use case.

7.1. ING supply chain choice

In order to construct a use case for ING we must first determine what will be a suitable supply chain for ING to offer FSCM solutions to. Therefore, in this subsection we will discuss which supply chain characteristics are most beneficial from ING's perspective.

Reliable supplier operations

First of all, the supply chain must have reliable operations (Klapper, 2006). As mentioned before, if the supplier is not able to provide the goods according the PO the buyer might not accept the goods. In this case payment for the goods does not take place. However, in the POF scheme the loan of ING is payed off by this payment. Therefore, essentially a default on the loan takes place and in general a default will result in costs for ING. Concluding, ING must only target supply chains that have reliable operations.

Type of goods

In case ING uses the goods that are traded in the between the buyer and supplier as collateral, the type of goods also plays an important role. Hofmann (2009) described that the value of collateral depends on the kind of goods that are produced (i.e. work in progress items need additional processing steps, so are not suitable for sale, but commodities can directly be sold on the stock market). From the lender's perspective the marketability of the goods is most important. Major commodities can be traded on the stock market, which indicates a high marketability (i.e. goods can easily be sold at competitive prices, as prices are based on the stock value). However, specialized goods have a much lower marketability. In case of default the lender has a hard time finding markets for these goods. Therefore, these goods are significantly less valuable as collateral for lenders.

Furthermore, for some goods the value decreases rapidly over time. For example, perishables like fruit can only be stored for limited time. Therefore, if these are not sold in time its collateral value

becomes zero. Concluding, ING should target supply chains for which the marketability of goods is high. Thus, ING should target supply chains with relatively simplistic non-perishable goods.

Claimability of collateral

An additional issue regarding collateral is the ability to claim it. According to Cao and Zhang (2012) it is hard to claim inventories that are used as collateral in global trade finance. In current trade finance processes the lender is not always aware of the exact location of the goods. Moreover, even if the location is known the lender cannot always claim them due to regulations. Concluding, ING should focus on supply chains that can provide them sufficient information of the whereabouts of goods and the trade process must be located in countries for which regulations do not deny ING from claiming collateral.

Order size

Another important criterion for POF to be beneficial is that orders are from significant size. Setting up FSCM programs takes time and money. Therefore, the transactions that result from the program must be of sufficient size to compensate the investments that are made. Therefore, the orders that are financed in the program must be of sufficient size. Otherwise the program is not able to compensate set up costs.

7.1.1. Use case supply chain

Based on the characteristics described above we chose to consider a supply chain operating in the fashion industry for our use case. We consider a supplier located in China that is producing jeans and a buyer that is located in the Netherlands that is importing and selling these jeans in its own shops.

In this industry it is very rare that suppliers do not meet the product descriptions stated in the PO, so the trade process is very reliable. Furthermore, jeans are quite simplistic non-perishable products. Moreover, to our best knowledge do China's regulations not limit foreign institutions from claiming collateral. Additionally, in the fashion industry companies only have a limited amount of suppliers and orders are large. Therefore, based on our characteristics this supply chain seems suitable.

Furthermore, in the current customer base of ING are already several companies that are operating in the fashion industry. Therefore, ING has already significant knowledge about these kind of supply chains.

7.2. Supply chain description

In this section a description of the supply chain for our use case is given. In this section we will discuss the following aspects of the supply chain:

- In section 7.2.1 a description of the buyer is given.
- In section 7.2.2 a description of the supplier is given.
- In section 7.2.3 we discuss ING's relationship to the supply chain.
- In section 7.2.4 the current trade process of the supply chain is discussed.
- In section 7.2.5 we discuss information asymmetry that is manifested in the supply chain.

7.2.1. Buyer description

For this use case we consider a buying firm which we address to as BUYER. BUYER is a retailer participating in the fashion industry, is located in the Netherlands and is selling jeans to consumers in their own shops. The jeans BUYER sells in their shops are produced in China.

The operations of BUYER consist of importing the jeans and subsequently selling them to end customers. BUYER does not perform any operations on the jeans itself. The jeans are important from China as finished goods, so the full production is performed there. Because BUYER is selling the jeans to the end customer, BUYER can be considered the most downstream member of the supply chain. While BUYER is not performing any operations on the jeans, BUYER is responsible for the design process. This design process occurs before a PO is sent to suppliers, so it is not considered part of the trade process itself.

In the fashion industry four seasons can be distinguished. These seasons are defined by their own trends and characteristics, so for every season new clothes are designed to cope with the latest fashion. This means that BUYER has to design and procure new jeans four times a year. Therefore, BUYER only places a few orders a year of high volume. Moreover, because suppliers need access to the designs of BUYER for production, a good relationship between the two is required. This results in BUYER having only 5 suppliers who are responsible for a large amount of the total procurement amount of BUYER. In general BUYER is considered the strongest party in its supply chain and has therefore a higher credit rating as its suppliers.

7.2.2. Supplier description

For this use case the supplier of BUYER that we consider is SUPPLIER. SUPPLIER is located in the province Jiangsu in China and is responsible for producing jeans for BUYER. Jiangsu borders with Shanghai city in the south-east and has good communications and convenient transportation linkages with other regions of China. Moreover, Jiangsu is the top textiles industry base in China. The main operations of SUPPLIER are basically the production of the jeans. The production process of SUPPLIER consists of the full transformation of cotton to jeans, so after the operations of SUPPLIER no additional processing steps are needed.

The raw materials SUPPLIER needs are cotton (95%), and copper or zinc for buttons, rivets, and zippers. SUPPLIER procures all required raw materials in China. SUPPLIER is procuring raw materials independent of BUYER, so BUYER is in general not familiar with its second-tier suppliers. Nevertheless, the jeans have to meet the quality standards of BUYER, so the quality of raw materials must be accordingly.

The second tier suppliers where the supplier procures raw materials are in general small cotton farmers, who are also located in the Jiangsu area. These parties have very limited working capital themselves and have very limited tools to attract financing themselves. Therefore, supplier pays the second tier suppliers on the spot and payment terms are in general non-existent.

As mentioned before, the fashion industry is sub due to different fashion season’s, so supplier receives only a limited amount of orders of high volume. Furthermore, we discussed that SUPPLIER and BUYER have a good relationship. This is needed, since SUPPLIER obtains the designs of BUYER for production. Because SUPPLIER has to produce based on latest designs, the production strategy of

SUPPLIER is Make-to-order. Therefore, the moment SUPPLIER receives the PO still all operations have to be completed.

Furthermore, SUPPLIER has a significant lower credit rating as BUYER.

7.2.3. ING's relationship to the supply chain

In this use case ING is the bank of BUYER. ING has a quite good indication of the creditworthiness of BUYER. Meanwhile, SUPPLIER is an unknown party for ING, so ING has no idea of the creditworthiness of SUPPLIER. Determining a credit score for a company is an extensive procedure. The credit score comes to existence based on the collaboration of ING with its customers, so if ING has a longer relationship with a customer it has more information available for determining this credit score. Therefore, ING is not capable of just giving a credit score to the supplier. This requires an extensive process. ING will start to just provide a small L/C to a new customer and if the transaction went well trust is built. Based on this trust ING can provide higher loans or more risky products.

ING has also limited knowledge on the supply chain as a whole, because ING is not familiar with the different aspects of the chain. This limits ING making reliable estimations of the different risks involved in the supply chain. The buyer and supplier on the other hand are quite capable of making reliable estimations of these risks. Therefore, ING only offers pre-shipment FSCM if the buyer guarantees repayment whatever happens. In this situation, only the ability of BUYER paying back the loan is relevant for ING. The default risk of the buyer paying back the loan is known by ING and their business enables them to make these calculations. Currently, ING does not have the tools to make reliable estimates of the remaining risks in the trade process. Therefore, for ING offering pre-shipment FSCM seems only reasonable if the buyer is hold responsible for paying back the loan.

7.2.4. Current trade process

The current trade process between BUYER and SUPPLIER follows the phases introduced earlier. In Figure 10 the trade process and the corresponding duration of each phase is displayed.

	PO		Invoice			BOL					Pay
	Country of origins						Country of destination				
	Inbound supply	Supplier	Inland Transport	Export Customs	Port of Export	Main Transport	Port of Import	Import Customs	Inland Transport	Buyer	
Duration (days)	30	30	2	1	1	30	1	1	1	1	2

Figure 10: Trade process durations

BUYER and SUPPLIER use the Incoterm FOB for their trade process. This means that SUPPLIER bears responsibility (both risk and costs) up until the moment the goods are put on the ship at the port of export. After this moment responsibilities are transferred to BUYER.

The jeans are transported from SUPPLIER to BUYER in containers. The transportation mode used for main transport is ship. The goods are shipped from the port of Shanghai to the port of Rotterdam. In both the inland transportation phases the goods are transported by truck.

The current trade process is initialized by BUYER sending a PO to SUPPLIER. Upon receiving the PO, SUPPLIER orders raw materials (cotton, zinc and/or copper) from the second-tier supplier. The time between receiving the PO and receiving raw materials takes on average 30 days. After SUPPLIER has receives raw materials its operation phase starts. SUPPLIER takes about 30 days to fully produce all required products. Subsequently, SUPPLIER hands over the goods to the Logistic Service Provider LSP. LSP transports the produced jeans in containers to the port of Shanghai. This first inland-transportation phase takes 2 days. Next, the goods remain 2 days at port of Shanghai before they are shipped to the Netherlands. In these 2 days the customs process and the container handling process take place.

In the current trade process the moment between the port of export phase and the main transport phase is crucial. At this moment the Bill of Lading (BOL) is composed. The BOL enables SUPPLIER to transfer ownership of the goods to BUYER, so in case something goes wrong BUYER can use the goods as collateral. Therefore, the BUYER feels comfortable taking on responsibility from that moment on.

The transportation of the jeans from the port of Shanghai to the port of Rotterdam takes about 30 days. Upon arrival at the port of Rotterdam, the goods have to be moved from the ship, go through customs, and are made available for the inland transportation phase. The process at the port of Rotterdam takes about 2 days. Subsequently, it takes the LSP 1 day to transport the jeans to the premises of BUYER. After that the buyer will confirm if all goods meet the requirements stated in the PO and BUYER approves the invoice of SUPPLIER. At this moment the trade process is concluded. However, it takes BUYER an additional 2 days before he makes payment to SUPPLIER. In these two days he checks whether the received goods fulfill the requirements stated in the PO and the transaction is processed within COPMANY NAME's administration. Concluding, there are 100 days between the issuance of the PO and payment for the goods.

Orders

BUYER orders 4 times a year new jeans by SUPPLIER, based on the 4 fashion seasons. BUYER purchases the jeans by SUPPLIER for a price of €30 and sells them for €100. The jeans have specific designs for that season, so in general designs change between seasons. Note that the production process does not change based on these new designs. The yearly revenue of BUYER is €20 million, so on average every season generates €5 million. The value of the goods under the PO contribute only 30% to the total sales value of the jeans, so every season the value of the goods is €1.5 million. Furthermore, BUYER uses a limited sourcing strategy, so BUYER has only a few suppliers that contribute to a large amount of the total procurement of BUYER. Currently, BUYER orders jeans by 5 different suppliers. Therefore, the average PO value BUYER sends to its suppliers is €300.000 (this corresponds to 10.000 jeans). Note that there is assumed that all products BUYER wants to order by a single supplier for a specific season are compressed in one PO.

7.2.5. Information asymmetry

During the trade process there is significant information asymmetry between involved parties. In general, the validity of other information is based on trust. For example, after all operations are completed, SUPPLIER can inform BUYER that all products meet quality standards. However, BUYER cannot be sure whether this information is reliable. In practice the first time BUYER can check the validity of this information is when the jeans are at their own premises.

Meanwhile, SUPPLIER has significant information available regarding their own operations. It has data over the time of completion of the goods, their quality, and the amount of goods that are produced. Moreover, SUPPLIER is also aware of the success of the inbound supply line phase. At the end of the supplier operations phase, SUPPLIER hands over the produced jeans over to the LSP. Thus, from the inland transportation phase onward the LSP possesses the information regarding the status of the trade process. However, in the current trade process of BUYER and SUPPLIER this is still limited. The only information the LSP provides are departure times and the estimate times of arrival (ETA).

While there is significant information asymmetry in the supply chain, BUYER is in general confident with information SUPPLIER offers. Both companies are highly dependent on each other, because they are responsible for a large amount of each other's revenue. Therefore, BUYER and SUPPLIER are constantly working on maintaining a good relationship. However, for the bank this does not offer any securities. Just BUYER assuring that SUPPLIER is a reliable party does not suffice for the bank. However, the good relationship between the buyer and supplier offers an incentive for BUYER to take on supply chain risks SUPPLIER is responsible for.

7.3. Use case: FSCM solution

In this section of the report we introduce the FSCM solution POF to the supply chain we described in section 7.2. In section 0 we made an extensive analysis whether POF or tolling is more suitable for ING to offer to its customers. We concluded that POF has the highest potential based on the characteristics of both FSCM solutions.

In this section the following is discussed:

- In section 7.3.1 the basic steps of the FSCM solution are described based on its mechanics.
- In section 7.3.2 the supplier's implications of the FSCM solution are discussed.
- In section 7.3.3 the buyer's implications of the FSCM solution are discussed.
- Lastly, in section 7.3.4 ING's implications of the FSCM solution are discussed.

7.3.1. Solution implementation

The basic POF solution ING can offer to BUYER and SUPPLIER can be described according to Figure 11 and the following steps:

1. BUYER initiates a PO for €300.000 worth of jeans and sends it to SUPPLIER.
2. All involved parties make arrangements and agreements for the use of POF.
3. The bank provides €240.000 of funds to the SUPPLIER, so SUPPLIER can finance the PO.
4. After production is finished, SUPPLIER sends the goods and invoice to BUYER via regular channels.

5. The buyer makes payment (€300.000) for the goods to the bank at the settlement date of the invoice.
6. The bank claims the outstanding loan plus interest from the payment of BUYER and pays remaining proceeds to SUPPLIER. Based on the credit rating of the buyer the interest rate is 2%. For this FSCM there is assumed that funds are provided after 30 days. Note that the duration of the trade process is 100 days, so the bank charges in total $1{,}02 * ((100 - 30)/365) \approx 1{,}004$ is 0,4% is €1.200.

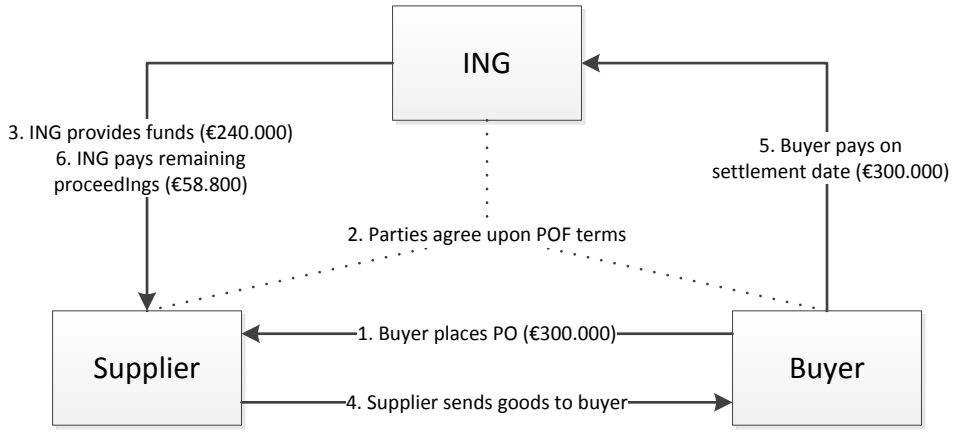

Figure 11: Use case: BPOF solution

This solution describes a generic POF scheme that is also found in literature (e.g. de Boer et al. 2015). ING provides an unsecured loan to SUPPLIER for which BUYER has to provide refunds in case of default. The loan ING gives to the supplier does not cover the PO for 100% to mitigate the risk of moral hazards. In general ING would offer a maximum of 80% of the total value for comparable finance products. Thus, for this case ING offers a loan of €240.000. In section 7.2 is discussed that BUYER is an investment grade company. Trade finance experts of ING argue that ING would charge an interest rate of approximately 2% for investment grade companies.

7.3.2. Supplier's implications

The supplier's benefits for participating in the POF scheme are quite obvious. De Boer et al. (2015) even argue that a supplier will always benefit if buyers increase PO commitments, since it transfers a portion of the supplier's risk to the buyer. From an economic perspective the main benefits come from the reduced cost of financing, and the supplier's improved liquidity position.

Financing costs

In our use case the bank charges an interest rate of 2% for the POF solution. Note that this rate is based on the creditworthiness of BUYER. Meanwhile, the cost of capital of SUPPLIER is 8%, so SUPPLIER experiences a decrease of 6% for financing its operations. For the situation without POF the financing costs of SUPPLIER can be calculated with the following equation:

$$c = x * r * \frac{t}{365}$$

Where

$c = financing\ costs$

$x = required\ capital$

$r = interest\ rate\ for\ financing$

$t = payment\ term\ of\ the\ loan$

Recall that the bank will finance €240.000 in the proposed POF scheme. Therefore, for the initial situation the financing costs for the capital equivalent of the loan under POF can be calculated as follows:

$$c = 240000 * 0{,}08 * \frac{100}{365} = €5260{,}27$$

Thus, the costs of financing one PO for SUPPLIER are €5260,27 if POF is not used. However, if POF is used, the supplier can receive finance at an interest rate of 2%, so the financing costs are reduced by 6%. This results in the following financing costs under POF:

$$c = 240000 * 0{,}02 * \frac{100}{365} = €1315{,}07$$

Note that for this calculation is assumed that SUPPLIER receives the loan at the beginning of the trade process, so all supply chain phases have yet to be completed. In case the loan is offered at a later stage in the trade process the equation changes slightly. Moreover, since the second tier suppliers of this supply chain consists of small cotton farmers in China, the supplier has neglectable payment terms towards these parties. Thus, the supplier has to acquire finance against its own cost of capital up until the point the loan is offered and after that the interest rate of POF is used. Therefore, the equation of the financing costs can be calculated with the following equation:

$$c = x * r_s * \frac{n}{365} + x * r_{POF} * \frac{t-n}{365}$$

Where

$n = Moment\ in\ time\ the\ supplier\ requires\ POF$

$r_s = Cost\ of\ capital\ of\ the\ supplier$

$r_{POF} = Interest\ rate\ under\ POF$

Suppose that for our use case the supplier receives POF after the inbound supply line phase is completed $n = 30$. The financing costs for the supplier become:

$$c = 240000 * 0{,}08 * \frac{30}{365} + 240000 * 0{,}02 * \frac{100-30}{365} = €2498{,}63$$

Thus, by using the POF scheme the financing costs of a loan of €240.000 are equal to €2498,63, while without using POF these costs are equal to €5260,27.

Liquidity position

Based on these calculations the reduced financing costs of the supplier are visible. However, Bonzani et al. (2018) argue that the most evident benefit of POF is caused by the improved liquidity position. The supplier obtains a new financing channel that allows him to accept orders that would otherwise be impossible to pursue. To illustrate the improved liquidity position, we look at the orders BUYER issues to SUPPLIER over a period of 5 years. Recall that BUYER on issues 4 PO's a year to SUPPLIER

(based on the 4 seasons in the fashion industry) with an expected value of €300.000. Table 5 gives an overview of all the POs over these 5 years. The first column displays the ID number of the POs, column two illustrates the date a specific PO is issued, the third column illustrates the date of payment if no POF is used (recall that for our use case the PO is payed after 100 days), the fourth column displays the PO value, and the fifth column displays the date the supplier receives funds if POF is used. For this use case the PO value is normal distributed with a mean of €300.000 and a standard deviation of 50.000. Furthermore, under the POF agreement the funds are provided to SUPPLIER after 30 days, so after the inbound supply line phase is completed.

PO number	PO date	Initial payment date	Amount	POF initialization
200001	1-1-2019	11-4-2019	€ 218.457,26	31-1-2019
200002	1-4-2019	10-7-2019	€ 231.723,98	1-5-2019
200003	1-7-2019	9-10-2019	€ 261.585,86	31-7-2019
200004	1-10-2019	9-1-2020	€ 294.696,27	31-10-2019
200005	1-1-2020	10-4-2020	€ 334.019,32	31-1-2020
200006	1-4-2020	10-7-2020	€ 300.097,25	1-5-2020
200007	1-7-2020	9-10-2020	€ 400.530,81	31-7-2020
200008	1-10-2020	9-1-2021	€ 227.343,16	31-10-2020
200009	1-1-2021	11-4-2021	€ 273.544,30	31-1-2021
200010	1-4-2021	10-7-2021	€ 381.887,02	1-5-2021
200011	1-7-2021	9-10-2021	€ 338.624,33	31-7-2021
200012	1-10-2021	9-1-2022	€ 221.132,29	31-10-2021
200013	1-1-2022	11-4-2022	€ 278.452,83	31-1-2022
200014	1-4-2022	10-7-2022	€ 335.851,25	1-5-2022
200015	1-7-2022	9-10-2022	€ 259.573,74	31-7-2022
200016	1-10-2022	9-1-2023	€ 298.705,35	31-10-2022
200017	1-1-2023	11-4-2023	€ 256.212,44	31-1-2023
200018	1-4-2023	10-7-2023	€ 309.182,50	1-5-2023
200019	1-7-2023	9-10-2023	€ 268.295,95	31-7-2023
200020	1-10-2023	9-1-2024	€ 285.509,10	31-10-2023

Table 5: PO issuances of BUYER over 5 years

Because, POF enables the SUPPLIER to acquire financing in a much earlier stage in the process his liquidity position improves significantly in comparison with the situation without any FSCM solution. For example, for PO 200001 SUPPLIER receives funds at 31-01-2019 instead of 11-04-2019. In Figure 12 is displayed how SUPPLIER's liquidity improved by using POF. The bars in Figure 12 show the additional working capital SUPPLIER has access to for that period in time. Therefore, Figure 12 shows the benefits POF offers SUPPLIER from a liquidity perspective.

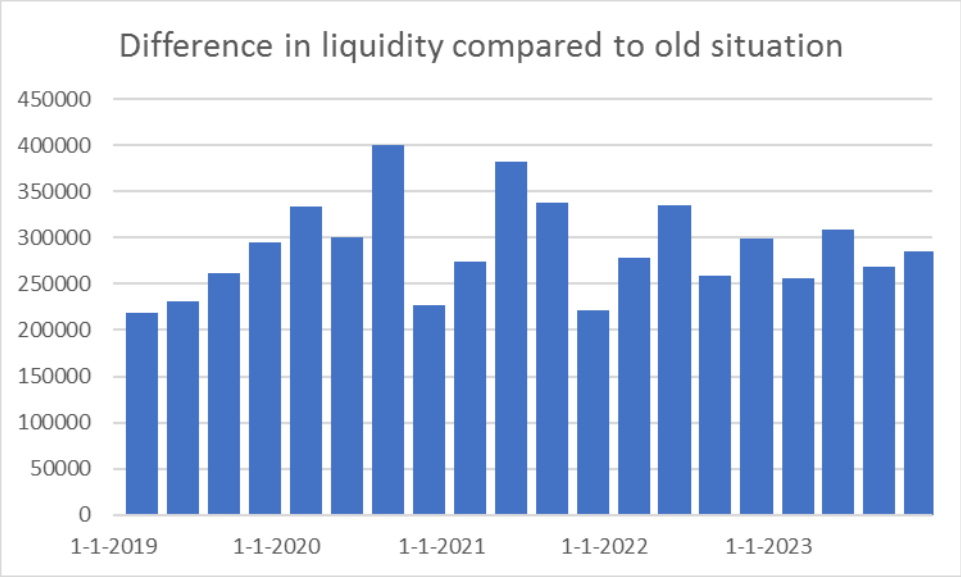

Figure 12: Liquidity difference of FSCM solution

Risk transfer

Besides the economic benefits, SUPPLIER also experiences benefits from a risk perspective. Recall that in the initial situation BUYER and SUPPLIER participate in an open account trade process. Therefore, the supplier is exposed to the default risk of the buyer. In case the buyer goes bankrupt during the production process, the supplier is not able to sell the produced goods. Thus, SUPPLIER is only able to retrieve a fraction of the initial PO value or in some cases all invested money is lost.

Meanwhile, in case POF is introduced to the supply chain the supplier receives a large sum of the PO up front, so in case the buyer defaults only a small portion of the PO value is at risk. In the business case of BUYER and SUPPLIER the PO value is €300.000 and the loan the bank provides to SUPPLIER is €240.000, so only €60.000 of the total PO value experiences credit risk of the buyer. Thus, from the supplier's perspective the POF scheme can be seen as a form of cash in advance. Because ING is the one who is providing the loan to SUPPLIER, the credit risk of BUYER is transferred from SUPPLIER to ING. Note that BUYER is a customer of ING and ING already has a good indication of its credit risk.

7.3.3. Buyer's implications

In this section we will look more in-depth to the implications the FSCM solution has for BUYER. In section 7.2.5 is discussed that ING is not familiar with SUPPLIER. Thus, ING is not able to make reliable estimates of the creditworthiness of SUPPLIER. Note that conducting a creditworthiness audit is a complex process that cannot be performed on the spot, so claiming that ING could just determine the creditworthiness of SUPPLIER is not valid.

Furthermore, in section 5 we investigated ING's capabilities of determining all relevant risk drivers in the trade process. There was concluded that ING is currently only able to determine 1 of the 31 identified risk drivers (the default risk of the buyer). Therefore, because ING is not able to estimate the overall risk exposure of pre-shipment financing, ING does not want to bear the risks.

Concluding, if ING wants to offer the POF solution, it requires the buyer to cover all their potential losses originating from performance risk. Therefore, our FSCM solution must operate according to

the BPOF solution of Wu et al. (2014) with a full guarantee of the buyer (recall that section 4.1.1 discusses the main characteristics of BPOF).

In the article of Wu et al. (2014) the cost function of the bank can be calculated with the following equation:

$$(1 + r_f)m = E_\zeta[\min\{w\zeta y_1, (1 + r)m\} + z]$$

Where:

$r_f = Risk\ free\ interest\ rate$

$m = Loan\ principal$

$w = Wholesale\ price\ of\ goods$

$y_1 = Amount\ of\ units\ in\ the\ purchase\ order\ (PO)$

$\zeta = Risk\ of\ the\ supplier\ not\ fulfilling\ the\ order\ (\zeta y_1\ is\ the\ amount\ of\ units\ produced)$

$r = Loan\ interest\ rate$

$z = The\ portion\ of\ the\ of\ the\ loss\ of\ the\ bank\ recovered\ by\ the\ buyer's\ compensation$

Additionally, z can be described with the following equation:

$$z = x[(1 + r)m - \min\{w\zeta y_1, (1 + r)m\}]$$

Where:

$x = Guarantee\ offered\ by\ the\ buyer\ to\ cover\ losses\ of\ the\ bank$

Since we assume a that the buyer will offer a full guarantee to the bank ($x = 1$), the cost function of the bank can be described as follows:

$$(1 + r_f)m = E_\zeta[\min\{w\zeta y_1, (1 + r)m\} + (1 + r)m - \min\{w\zeta y_1, (1 + r)m\}]$$

$$(1 + r_f)m = (1 + r)m$$

$$r = r_f$$

Concluding, according to the model of Wu et al. (2014) the bank does not experience any risk. However, note that Wu et al. (2014) assumed that the buyer will never default. Nevertheless, this shows that ING is only exposed to the default risk of the buyer in case the buyer offers a full guarantee in the BPOF scheme. Therefore, from ING's perspective this FSCM solution offers the same amount of risk as a regular unsecured loan.

Meanwhile, ING requiring the buyer to offer full coverage for losses has also major implications on the buyer's profit function. By offering the guarantee the buyer will experience additional costs in comparison with a situation without a FSCM solution. In the model of Wu et al. (2014) these costs are expressed by z, which is the difference between the loan plus interest and the value of the goods the supplier successfully produced. Note that in case the supplier is able to produce all requested goods successfully these costs are equal to 0 and if the supplier was not able to produce anything at all these costs are the full loan principal plus interest rate. Thus, the additional costs the buyer experiences due to the BPOF scheme are determined by the performance of the supplier.

Solution costs

Based on the article of Wu et al. (2014) the costs of the buyer can be determined for our business case. The costs are calculated with the following equation (Note that this is based on the model of Wu et al. (2014)):

$$\text{Buyer BPOF costs} = \max(Loan + interest - Performance * PO\ value, 0)$$

Recall that for our business case the loan is equal to €240.000, the interest rate is 2%, and the PO value is €300.000. Note that the performance variable of the article of Wu et al. (2014) is a stochastic variable, so in order to calculate the costs for the buyer the probability function of the performance variable must be considered. However, for this business case a discrete probability function is assumed. The distribution of the performance variable and the corresponding costs are displayed in Table 6. At the bottom of Table 6 the expected performance of SUPPLIER, the expected costs for BUYER, and the standard deviation of the costs are displayed. Note that trade finance experts of ING are interviewed to determine realistic values for the probabilities of Table 6. Below a description is given for the different columns in the table:

- The first column in Table 6 displays the expected performance of the supply chain. Thus, this represents the portion of the order that is successfully fulfilled. For example, the 0,3 in the first column indicates that 30% of the order is successfully fulfilled.
- The second column of table 6 indicates the probability a certain performance occurs. For example, the performance of 0,3 corresponds with a probability of 0,0002. This indicates that there is a probability of 0,0002 that 30% of the order is successfully fulfilled.
- The third column represents the cumulative distribution of the probability function. Note that the cumulative distribution increases to 1.
- The fourth column displays the costs the buyer experiences for a certain performance. For example, if 30% of the order is successfully fulfilled the costs of the buyer are equal to €150.920,55.

Performance			
X	**f(x)**	**F(x)**	**Buyer BPOF costs (€)**
0	0,0016	0,0016	240920,55
0,1	0,0002	0,0018	210920,55
0,2	0,0002	0,002	180920,55
0,3	0,0002	0,0022	150920,55
0,4	0,0002	0,0024	120920,55
0,5	0,0002	0,0026	90920,55
0,6	0,0002	0,0028	60920,55
0,7	0,0002	0,003	30920,55
0,8	0,0008	0,0038	920,55
0,9	0,0012	0,005	0,00
1	0,995	1	0,00

Expected performance	0,9973
Expected costs	€555,50
Std costs	10866,04
Break even discount	0,185%

Table 6: Expected costs based on supplier performance

Based on the performance variable probability distribution the expected costs for the buyer are €555,50 with a standard deviation of 10.866,04. The corresponding expected performance of the supplier is 0,9973, so we expect the supplier to produce 99,73% of all the goods that are ordered in the PO.

Based on the mechanics of BPOF the buyer has to cover losses for the bank and the supplier will experience reduced financing costs and an improved liquidity position. Thus, in general the FSCM solution is beneficial for the supplier, but will generate costs for the buyer. However, in order to make the FSCM solution lucrative for the buyer the supplier can offer a discount rate on the PO to compensate the losses for the buyer. For this business case BUYER requires a discount of 0,185% on the PO of €300.000 to cover expected losses. Recall that the supplier is able to reduce its financing costs by €2.761,64 and the expected costs of the buyer are only €550,50, so both parties are able to benefit from the FSCM solution.

While the expected costs of the buyer and the reduced financing rate of the supplier suggest that both parties can benefit from POF, the financing solution is still risky from the buyer's perspective. This riskiness is also expressed by the relatively high standard deviation of expected costs. In general, the supplier is able to deliver all required goods successfully and the buyer will not experience any costs (f(1)=0,995). However, there is also a small probability that the supplier is not able to deliver anything at all or only a very small portion of the PO. For these cases the expected costs of the buyer are substantial in comparison with the expected costs (e.g. in case the supplier does not deliver anything costs are €240.920,55). Since the buyer also has to cover losses for the bank in such a scenario, the working capital position of the buyer is severely harmed. It is even possible that the buyer is not capable of providing the required funds. Therefore, even though the expected costs of POF are satisfactory for the considered supply chain, the buyer can perceive the solution as too risky.

7.3.4. ING's implications

Interviews with experts of ING indicated that at this moment ING is only willing to provide pre-shipment financing if the buyer covers potential losses for ING. We discussed that if the buyer agrees to these terms the bank experiences the same risk exposure for the FSCM solution as for a regular loan to the buyer. Therefore, ING can use their current risk measures to analyze the solution, since only the credit risk of the buyer is relevant. Recall that ING currently measures risk by looking at the PD, LGD, and EAD. ING determines the PD based on the creditworthiness of BUYER. The EAD is equal to the loan principal outstanding, which is for this business case €240.000. In a POF scheme the PO serves as collateral to the borrower for providing the loan (Lange et al., 2012; Wu et al., 2014; de Boer et al., 2015). The PO itself has no value, but is a future promise for a cash flow. Therefore, the loan ING provides to the supplier in the POF scheme is of an unsecured nature. Note that this implies potential losses are solely covered by the current account of the buyer.

In general, unsecured loans are not preferred by ING, since they have a low priority in case a debtor goes bankrupt. During the bankruptcy process secured loans are compensated prior to unsecured loans. Therefore, the LGD for unsecured loans is higher than the LGD of secured loans. Thus, due to the unsecured nature of the loan in this use case, we assume a LGD of 80%.

The BUYER is considered an investment grade company, so it will have a low PD score. For this use case we assume the PD score of the BUYER to be equal to 0,3070%. Recall that this corresponds to the probability the BUYER does not pay back the loan to ING.

Recall that ING calculates its risk exposure by multiplying the PD, LGD, and EAD. Therefore, ING's risk exposure for the BPOF solution with full guarantee of the supply chain of BUYER and SUPPLIER is equal to:

$$Exposed\ risk = PD * EAD * LGD = 0{,}003070 * 240000 * 0{,}8 = €589{,}44$$

This corresponds to approximately 0,25% of the total value of the loan. Therefore, can be argued that offering POF with the buyer covering potential losses results in a very small risk exposure for ING.

7.4. Use case: solution extensions

Up until this point the business case is narrowed down to a specific setting between the companies BUYER and SUPPLIER. However, in this section we will discuss how the FSCM solution behaves under slightly different circumstances. The additional scenarios that will be discussed are:

- Asset based financing solution in section 7.4.1.
- Providing the loan progressively in section 7.4.2.
- Initial situation requires the buyer to provide cash in advance in section 7.4.3.
- Tolling agreement in section 7.4.4.
- Different supply chains in section 7.4.5.
- Lastly, we wrap up this section by providing an overview of the different solution extensions we discuss in section 7.4.6.

7.4.1. Asset based solution

In the current case description, the loan that is provided to SUPPLIER is unsecured, so there are no assets used as collateral. In literature this is also a common practice (e.g. Lange et al., 2012; Wu et

al., 2014). Meanwhile, banks also have the option to provide a secured loan. Trade finance experts of ING state that this has major implication of the LGD of ING. The LGD of an unsecured loan is expected to be around 80% while the LGD of secured loans is only expected to be approximately 30%. This indicates that secured loans experience significant less risk than unsecured loans.

Considering secured loans in the pre-shipment FSCM domain implies that the bank can use the goods, which the supplier produces according to the PO, to serve as collateral. For this use case the value of raw materials for one pair of jeans is equal to €15, the value of work-in-progress is €1, and the value of finished goods for the borrowers is equal to €25. This is also displayed in Table 7. Furthermore, SUPPLIER produces 10.000 jeans and sells them for €30 each to BUYER (note that this corresponds with the PO value of €300.000). Note that the sales price is higher than the collateral value of finished goods. The difference between the two values represents SUPPLIER's profit margin.

Collateral form	Value per unit
Raw material	€15
Work-in-progress	€1
Finished good	€25

Table 7: Jeans collateral value

The difference between the asset based solution and the POF scheme described earlier is that the assets the supplier procures and transforms are used as collateral. From ING's perspective, considering an asset based POF solution transforms the loan from unsecured to secured, which results in a lower LGD.

Subsequently, the value of collateral becomes an important indicator of the risk and benefits of involved parties. In case something goes wrong this value is used to cover the losses of the bank. Note that ING will hold the buyer responsible for covering their losses caused by the performance of the supplier, so ultimately the collateral value also determines the compensation costs of the buyer. However, determining the value of collateral offers two main challenges to ING at this moment:

- In case a hazardous event occurs the value of collateral can also be harmed.
- In case the supplier goes bankrupt ING not always capable of seizing collateral.

One of the main issues regarding determining the value of collateral during the trade process is its relationship with hazardous events. For example, if a truck has an accident during transport, the goods that the truck is transporting could be damaged. This suggests that the value of collateral is correlated with the risk exposure of the chain.

The value of collateral is also at risk in case the supplier experiences bankruptcy. In case of bankruptcy all assets of the supplier will be used to compensate the supplier's creditors. During a significant portion of the trade process the supplier has ownership over the goods, so these are also used to payback outstanding debt. Even though the loan is secured, in most cases a portion of collateral value is lost due to the bankruptcy. This can for example be caused by regulations of a specific country or the supplier has also pledged the assets as collateral to another creditor.

Asset based solution implications

Recall that in our business case the buyer is held responsible to cover potential losses of ING resulting from the performance risk of the supply chain. We calculated the associated cost for the buyer by considering the model of Wu et al. (2014). In this model potential losses are determined by

calculating the difference between the loan plus interest and the portion of the PO that is successfully delivered to the buyer. Therefore, there is assumed that the portion of the PO that is not delivered successfully has no value. However, for an asset based solution this is not the case. The bank is able to compensate a portion of its losses by the collateral value of the assets. Therefore, we can modify the cost function of the buyer, originating from the article of Wu et al. (2014) into the following equation:

$$\text{Buyer BPOF costs} = \max(Loan + interest - Performance * PO\ value\ - (1 - Performance) * Collateral\ value, 0)$$

The value of collateral will be modelled by considering the expected value of the assets, a variable that described the correlation between the performance of the chain and the value of the assets, and a variable that describes the claimability of collateral. Below we further discuss why these variables are relevant for determining the collateral value. Considering these additional variables results in the following equation for the buyer costs of compensating ING's losses:

$$\text{Buyer BPOF costs} = \max(Loan + interest - Performance * PO\ value\ - (1 - Performance) * Asset\ value * (1 - Correlation) * Claimability, 0)$$

To determine the average asset value of the goods in the supply chain of BUYER and SUPPLIER we have to take a closer look to the trade process. The first 30 days the process is in the inbound supply line phase. During this phase the supplier does not have possession over any assets, so there is no collateral yet. The next 30 days are allocated to the supplier's operation phase. For the business case of BUYER and SUPPLIER, during this phase goods are on average considered raw materials for 5 days, work-in-progress for 20 days, and finished goods for 5 days. The remaining 40 days of the trade process goods remain finished goods. Furthermore, to determine the average value of the assets we must consider the moment the loan will be initiated. Under raw material finance ING will provide financing based on the raw materials of the production process, so it can only be initiated after the supplier owns the raw materials. Therefore, we assume that financing is provided after the inbound supply line phase. Subsequently, the average asset value is calculated based on the following equation:

$$Asset\ value = \frac{d_{rm} * v_{rm} + d_{wip} * v_{wip} + d_{fg} * v_{fg}}{T} * q$$

Where:

$d_i = duration\ in\ days\ the\ assets\ are\ in\ state\ i\ (rm = raw\ materials, wip = work\ in\ progress, fg = finished\ goods)$

$v_i = Value\ of\ assets\ in\ state\ i\ (rm = raw\ materials, wip = work\ in\ progress, fg = finished\ goods)$

$T = The\ amount\ of\ time\ the\ loan\ is\ outstanding\ in\ days$

$q = The\ amount\ of\ assets\ the\ supplier\ has\ to\ produce\ according\ to\ the\ PO$

Filling in the equation gives the following average asset value:

$$Asset\ value = \frac{5*15+20*1+45*25}{70} * 10000 = €174.285,71$$

Before the collateral value of the goods can be determined, also the correlation and claimability variables have to be known. For this business case we assume a correlation between the

performance and the value of assets of 50% and the assets have a claimability of 60%, so the value of non-delivered goods decreases with 50% due to the hazardous events that have occurred, and the bank is only able to claim these goods as collateral 60% of the time. Based on these values the expected costs and the break-even discount for the buyer in the asset based scheme are calculated. The input parameters are displayed in Table 8 and the results of the calculations are displayed in Table 9.

Variable	**Value**
Loan	€240000
Interest rate	0,02
PO value	€300000
Loan duration	70 days
Average Asset value	€174.285,71
Correlation	0,5
Claimability	0,6

Table 8: Input variables cost calculation asset based solution

Performance			
X	**f(x)**	**F(x)**	**Buyer Asset based costs (€)**
0	0,0016	0,0016	188634,83
0,1	0,0002	0,0018	163863,41
0,2	0,0002	0,002	139091,98
0,3	0,0002	0,0022	114320,55
0,4	0,0002	0,0024	89549,12
0,5	0,0002	0,0026	64777,69
0,6	0,0002	0,0028	40006,26
0,7	0,0002	0,003	15234,83
0,8	0,0008	0,0038	0,00
0,9	0,0012	0,005	0,00
1	0,995	1	0,00
Expected performance	0,99728		
Expected costs	€427,18		
Std costs	8450,65		
Break even discount	0,142%		

Table 9: Cost calculations asset based solution

The cost calculation in Table 9 support the intuitive claim that using the assets that are produced in the trade process as collateral reduces the costs the buyer has to make to cover losses for the bank. The expected costs for the buyer are €427,18 with a standard deviation of 8.451,62. In the use case where no collateral was used the expected costs were €550,50 with a standard deviation of 10.866,04, so using collateral is indeed beneficial for the buyer. However, the standard deviation of the buyer's cost function is still substantial. Therefore, the buyer will experience periods were a huge amount of working capital is required to compensate costs. As mentioned before, this could have catastrophic consequences if the buyer does not possess required funds.

Using the produced goods as collateral also results in a decrease of the risk exposure of the bank. In the situation described in the use case the loan was unsecured. For such a loan ING estimates the

LGD to be approximately 80%. However, in this scenario a portion of the loan is covered by collateral. Adding collateral resulted in a decrease of expected costs of 23,10%, so we can argue that for this scenario the LGD of ING decreases to 56,90%. This results in the following risk exposure for ING:

$$Exposed\ risk = PD * EAD * LGD = 0{,}003070 * 240000 * 0{,}569 = €419{,}24$$

Thus, the risk exposure of the bank is decreased by 28,86%. Considering that banks calculate interest rates based on a risk-free rate plus a rate that accounts for their risk exposure (Wu et al., 2014), there can be argued that ultimately ING will decrease the interest rate it charges for the FSCM solution. This again will result in lower financing costs for the supplier.

7.4.2. Progressive payments

Additionally, the ING can choose to offer funds in a progressive way. In the quantitative model in section 5.3.3 we showed that the severity of a risk is determined by the difference between outstanding funds and the underlying value of collateral. Thus, by adjusting the outstanding loan in proportion to the collateral value ING can control their overall risk exposure.

To analyze the implications of progressive payments the same characteristics as for the asset based solution are assumed. Financing is initiated after 30 days in the trade process of 100 days, so the loan will be outstanding for 70 days. In the progressive payment scheme ING will not transfer the full loan at this stage. A portion of the loan will be transferred to the supplier after he has completed the 'supplier operations' phase.

During the supplier's operations phase, which lasts for 30 days, a pair of jeans is considered raw materials for 5 days, work-in-progress for 20 days, and finished good for 5 days, since the production process of the jeans is partly sequential. Therefore, the average value of collateral during this phase is:

$$Asset\ value_{term\ 1} = \frac{5*15+20*1+5*25}{30} * 10000 = €73.333{,}33$$

The remaining 40 days in the trade process are allocated to transporting the finished goods from the premises of SUPPLIER to the premises of BUYER, so during this period the goods are considered finished goods. This result in the following equation:

$$Asset\ value_{term\ 2} = \frac{40*25}{40} * 10000 = €250.000$$

Note that the bank and the buyer can only determine whether this is indeed the case by adding an inspection in the trade process after the supplier's operation phase. After the inspection validated that the goods have indeed a collateral value of €250.000, ING can transfer the remaining portion of the loan to SUPPLIER, so the loan is transferred in two terms.

By using progressive payments, the loss function of the bank changes slightly from the asset based solution equation. The original equation, which describes the loss for the bank the buyer has to compensate, of the article of Wu et al. (2014) can be modified into the following equation for the progressive payment scheme:

Buyer BPOF costs =

$$\max\left(\frac{x}{T}\left(Loan_{term1} + interest - Performance * PO\ value\ - (1 - Performance)\right.\right.$$
$$\left.* Asset\ value_{term1} * (1 - Correlation) * Claimability\right)$$
$$+ \frac{T - x}{T}\left(Loan_{term2} + interest - Performance * PO\ value\ - (1 - Performance)\right.$$
$$\left.\left.* Asset\ value_{term2} * (1 - Correlation) * Claimability\right), 0\right)$$

Where:

$x = The\ time\ the\ bank\ provides\ remaining\ funds\ to\ the\ supplier.$

$T = The\ amount\ of\ time\ the\ loan\ is\ outstanding.$

For the use case of BUYER and SUPPLIER $x = 30$, since after 30 days the supplier's operation phase is completed and the value of collateral has increased. The loan is outstanding for 70 days, so $T = 70$. Furthermore, for this progressive payment extension is assumed that the ING provides half of the loan principal at the beginning of the 70 days and the remaining half at time x. Meanwhile, in order to be able to compare the different extensions the remaining variables follow the ceteris paribus principle. In Table 10 an overview is given of all the values of the different variables and Table 11 gives a representation of the compensation costs of the buyer.

Variable	**Value**
Loan term1	€120000
Loan term2	€240000
Interest rate	0,02
PO value	€300000
Loan duration	70 days
Start term2	After 30 days
Asset value term 1	€73.333,33
Asset value term 2	€250.000
Correlation	0,5
Claimability	0,6

Table 10: Input variables cost calculation progressive payment solution

Performance			
X	**f(x)**	**F(x)**	**Buyer Asset based costs (€)**
0	0,0016	0,0016	137009,002
0,1	0,0002	0,0018	112237,5734
0,2	0,0002	0,002	87466,14481
0,3	0,0002	0,0022	62694,71624
0,4	0,0002	0,0024	37923,28767
0,5	0,0002	0,0026	13151,8591
0,6	0,0002	0,0028	0
0,7	0,0002	0,003	0
0,8	0,0008	0,0038	0
0,9	0,0012	0,005	0
1	0,995	1	0

Expected performance	0,99728
Expected costs	€281,91
Std costs	5931,91365
Break even discount	0,094%

Table 11: Cost calculation progressive payment solution

Based on cost calculations can be concluded that providing the loan in a progressive way even further reduces the loss of the bank, which the buyer has to compensate. The expected costs for the progressive payment extension are €281,91 with a standard deviation of 5.931,91. As a result of the lower expected costs the break-even discount the buyer requires to compensate these costs also decreased to 0,094%. However, even by using progressive payments the standard deviation remains high, so in case the performance of the supplier is low the buyer's working capital position is severely harmed.

The benefits of the supplier also differ from the situation sketched in the use case and the asset based solution. While the liquidity benefits stayed the same for these scenarios, the supplier's liquidity benefits will be slightly less by using progressive payments. In this scheme the supplier receives a portion of the loan at a later stage. Thus, the costs reduction of the buyer is at the expense of the supplier's benefits. To illustrate this difference the liquidity benefits of the BPOF solution in the use case and the liquidity benefits of progressive payments are compared in Figure 13. In Table 12 the PO's of BUYER over the upcoming 5 years are displayed with the respective days of payment, which are used to illustrate the liquidity difference. As can be seen in Figure 13 SUPPLIER's liquidity position is better in the BPOF scheme described in the use case.

Initial situation				**Case BPOF**	**Progressive payments**			
PO number	**PO date**	**Initial payment date**	**Amount**	**POF payment**	**Term 1**	**Amount 1**	**Term 2**	**Amount 2**
200001	1-1-2019	11-4-2019	€ 267.158,98	31-1-2019	31-1-2019	€ 133.579,49	2-3-2019	€ 133.579,49
200002	1-4-2019	10-7-2019	€ 304.708,06	1-5-2019	1-5-2019	€ 152.354,03	31-5-2019	€ 152.354,03
200003	1-7-2019	9-10-2019	€ 272.030,73	31-7-2019	31-7-2019	€ 136.015,36	30-8-2019	€ 136.015,36
200004	1-10-2019	9-1-2020	€ 254.615,75	31-10-2019	31-10-2019	€ 127.307,87	30-11-2019	€ 127.307,87
200005	1-1-2020	10-4-2020	€ 278.589,69	31-1-2020	31-1-2020	€ 139.294,85	1-3-2020	€ 139.294,85

200006	1-4-2020	10-7-2020	€ 217.684,89	1-5-2020	1-5-2020	€ 108.842,44	31-5-2020	€ 108.842,44
200007	1-7-2020	9-10-2020	€ 282.876,81	31-7-2020	31-7-2020	€ 141.438,41	30-8-2020	€ 141.438,41
200008	1-10-2020	9-1-2021	€ 351.467,71	31-10-2020	31-10-2020	€ 175.733,85	30-11-2020	€ 175.733,85
200009	1-1-2021	11-4-2021	€ 300.420,54	31-1-2021	31-1-2021	€ 150.210,27	2-3-2021	€ 150.210,27
200010	1-4-2021	10-7-2021	€ 245.951,41	1-5-2021	1-5-2021	€ 122.975,70	31-5-2021	€ 122.975,70
200011	1-7-2021	9-10-2021	€ 346.741,05	31-7-2021	31-7-2021	€ 173.370,52	30-8-2021	€ 173.370,52
200012	1-10-2021	9-1-2022	€ 264.013,73	31-10-2021	31-10-2021	€ 132.006,86	30-11-2021	€ 132.006,86
200013	1-1-2022	11-4-2022	€ 392.358,72	31-1-2022	31-1-2022	€ 196.179,36	2-3-2022	€ 196.179,36
200014	1-4-2022	10-7-2022	€ 285.920,69	1-5-2022	1-5-2022	€ 142.960,34	31-5-2022	€ 142.960,34
200015	1-7-2022	9-10-2022	€ 353.629,46	31-7-2022	31-7-2022	€ 176.814,73	30-8-2022	€ 176.814,73
200016	1-10-2022	9-1-2023	€ 253.557,17	31-10-2022	31-10-2022	€ 126.778,58	30-11-2022	€ 126.778,58
200017	1-1-2023	11-4-2023	€ 272.247,72	31-1-2023	31-1-2023	€ 136.123,86	2-3-2023	€ 136.123,86
200018	1-4-2023	10-7-2023	€ 338.108,60	1-5-2023	1-5-2023	€ 169.054,30	31-5-2023	€ 169.054,30
200019	1-7-2023	9-10-2023	€ 348.020,80	31-7-2023	31-7-2023	€ 174.010,40	30-8-2023	€ 174.010,40
200020	1-10-2023	9-1-2024	€ 298.523,65	31-10-2023	31-10-2023	€ 149.261,82	30-11-2023	€ 149.261,82

Table 12: PO issuances of BUYER over 5 years with progressive payments

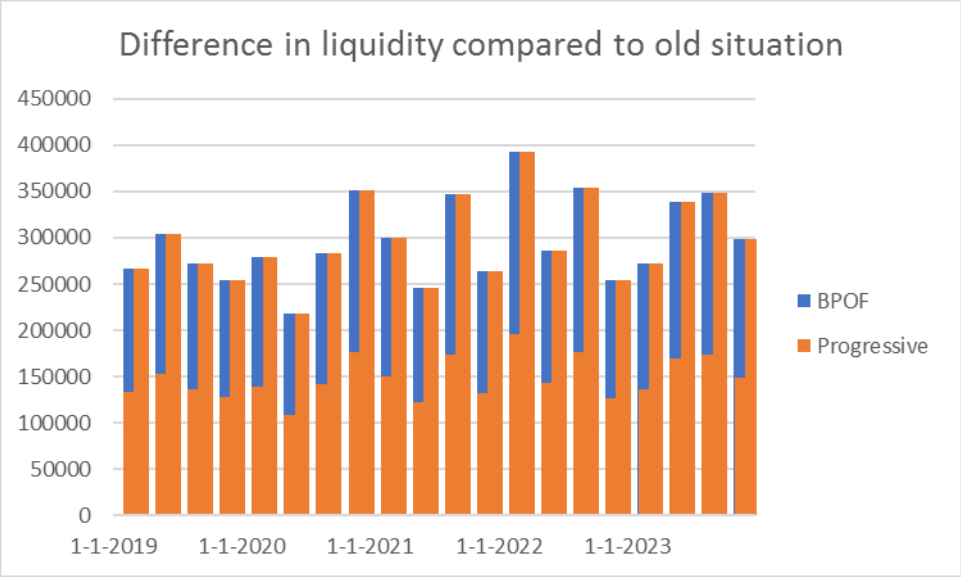

Figure 13: Liquidity benefits BPOF and Progressive payments

Additionally, the supplier has to attract the portion of the loan that he receives at a later time against its own creditworthiness. Therefore, the financing costs for the progressive payments solutions are slightly higher as for our initial scenario and the asset based solution. Recall that the whole trade process lasts for 100 days, the first term is at day 30, and the second term is at day 60. Moreover, the amount of money provided at the first term is €120.000 and €240.000, and the

supplier can attract financing at a rate of 8% and the buyer at a rate of 2%. This results in the following financing costs for the supplier:

$$c = 240000 * 0{,}08 * \frac{30}{365} + 120000 * 0{,}08 * \frac{30}{365} + 120000 * 0{,}02 * \frac{30}{365} + 240000 * 0{,}08 * \frac{40}{365}$$
$$= €4668{,}49$$

Recall, that without using a FSCM solution the financing costs of the supplier are equal to €5260,27, so by using progressive payments the supplier experiences a reduction of €591,78 in financing costs.

The asset based solution showed that including the produced assets as collateral in the FSCM solution results in a decrease of the LGD of the bank. Subsequently, using progressive payments can even further reduce the exposed risk of the bank. In the asset based solution the EAD is equal to €240.000, but using progressive payments the EAD is only €120.000 for the first 30 days the loan is outstanding. Therefore, the risk exposure of ING can be calculated as follows (note that the same LGD is taken as for the asset based situation):

$$Exposed\ risk = \frac{x}{T} * PD * EAD_{term1} * LGD + \frac{T-x}{T} * PD * EAD_{term2} * LGD$$

$$= \frac{30}{70} * 0{,}003070 * 120000 * 0{,}569 + \frac{70-30}{70} * 0{,}003070 * 240000 * 0{,}569 = €329{,}40$$

Based on these calculations can be concluded that using progressive payments result in an even lower risk exposure for the bank than using the assets as collateral. Furthermore, there can be argued that the ING will set a lower interest rate for the FSCM solution due to their lower risk exposure. Meanwhile, the liquidity benefits of the supplier are reduced, since a portion of the loan principal is received at a later moment.

7.4.3. Initial situation with cash in advance

One of the assumptions we made for constructing the business case between BUYER and SUPPLIER is that the initial trade process is an open account trade process where no trade finance solutions are used. This means that the whole process is based on trust and the supplier has very limited assurance whether the buyer will pay for the ordered goods. In order to decrease the risk of the buyer defaulting on the order, in several supply chains suppliers require the buyer to pay a portion of the PO in advance.

For this solution extension the supply chain of SUPPIER NAME and BUYER is considered with the additional constraint that BUYER must pay 30% of the PO value in advance to SUPPLIER in the initial situation. By using the BPOF solution BUYER is no longer required to provide this cash advancement, since this is included in the loan. Therefore, the costs for the buyer associated with providing cash in advance are no longer relevant.

In our BPOF solution the buyer is no longer burdened by providing 30% of the PO value in advance, since the supplier receives a loan from the bank. Therefore, the disappearance of the prepayment can be seen as a benefit of BPOF. Thus, the costs associated with the advancement can be reduced from the buyer's cost function. For this solution extension is assumed that the buyer acquires the cash advancement at the same interest rate ING charges for the loan, so at a rate of 2%. This results in the following equation for use case scenario:

$$\text{Buyer BPOF costs} = \max(Loan + interest - Performance * PO\ value, 0) - (Advancement\ rate * PO\ value + interest)$$

Note that we assumed there were no cash advancement in our initial use case. Therefore, the advancement rate variable is equal to 0 in the original use case. Subsequently, filling in 0 in the equation above results in our original cost function, which we derived from Wu et al. (2014).

Subsequently, the expected costs of the buyer can be determined in the same way as for the use case. The input variables are displayed in Table 13 and the results of the calculations are displayed in Table 14. Note that we use the same distribution of the performance variables as in our initial use case.

Variable	**Value**
Loan	€240000
Interest rate	0,02
PO value	€300000
Advancement rate	0,30 (30%)

Table 13: Input variables for cost calculations cash in advance

Performance			
X	**f(x)**	**F(x)**	**Buyer cash in advance costs (€)**
0	0,0016	0,0016	240427,3973
0,1	0,0002	0,0018	210427,3973
0,2	0,0002	0,002	180427,3973
0,3	0,0002	0,0022	150427,3973
0,4	0,0002	0,0024	120427,3973
0,5	0,0002	0,0026	90427,39726
0,6	0,0002	0,0028	60427,39726
0,7	0,0002	0,003	30427,39726
0,8	0,0008	0,0038	427,3972603
0,9	0,0012	0,005	-493,1506849
1	0,995	1	-493,1506849
Expected performance	0,99728		
Expected costs	€62,35		
Std costs	5931,91		
Break even discount	0,021%		

Table 14: Cost calculations cash in advance extension

Based on the cost calculations of Table 14 there can be concluded that in case BUYER is required to provide cash in advance, the expected costs are significantly reduced. The expected costs of the buyer are €62,35 with a standard deviation of 5931,91. Thus, in case cash in advance is required by the supplier, the expected costs for the buyer are even lower than in the scenario collateral is used. However, note that it is also possible to the produced assets as collateral for supply chains that use cash in advance, so a combination will result in even less costs for the buyer. Note that the costs of a low performing supplier are still very high, so buyers must still be aware of the catastrophic impact low performance can have on their working capital position.

From the supplier's perspective BPOF generates slightly less benefits in case he required the buyer to provide a portion of the PO value in advance. For the portion that is already advance he does not require to pay any interest, so his financing costs are already reduced by the advancement. Moreover, his liquidity position is also slightly improved by the advancement, so the liquidity

benefits are also slightly less for this scenario. To calculate the initial financing costs of the supplier the following equation is used:

$$c = (x - x * a) * r_s * \frac{t}{365}$$

Where:

$$a = The\ portion\ of\ the\ PO\ that\ is\ advanced\ to\ the\ supplier.$$

By using the equation above the financing costs of the supplier in its initial situation are (Note that $t = 100$, since by using cash in advance the buyer pays the supplier right after the PO is issued, while in our BPOF scheme financing is required after 30 days in the trade process):

$$c = (240000 - 240000 * 0{,}3) * 0{,}08 * \frac{100}{365} = €3682{,}19$$

As mentioned before, by using BPOF the financing costs of the supplier are equal to €2498,63, so the supplier still benefits from a reduction of €1183,56 in financing costs.

To illustrate the liquidity benefits again for the upcoming 5 years the liquidity benefits are illustrated. In Figure 14 the liquidity benefits of the use case scenario and the liquidity benefits in case the supply chain uses cash advancements are displayed. The input data used to construct Figure 14 is displayed in Table 15. As Figure 14 indicates, the liquidity benefits of the supplier are less in case of cash advancements. Moreover, since there was assumed that under BPOF funds are transferred after 30 days, during some periods the supplier's liquidity position is worse compared to its initial situation.

Initial situation with Cash in advance						**Use case**	
PO number	PO date	Advancement	Advance Date	Remaining	Payment date	Amount	POF initialization
200001	1-1-2019	€ 89.436,10	1-1-2019	€ 208.684,23	11-4-2019	€ 298.120,33	31-1-2019
200002	1-4-2019	€ 91.885,56	1-4-2019	€ 214.399,64	10-7-2019	€ 306.285,20	1-5-2019
200003	1-7-2019	€ 99.886,77	1-7-2019	€ 233.069,14	9-10-2019	€ 332.955,91	31-7-2019
200004	1-10-2019	€ 93.816,49	1-10-2019	€ 218.905,14	9-1-2020	€ 312.721,63	31-10-2019
200005	1-1-2020	€ 71.217,58	1-1-2020	€ 166.174,34	10-4-2020	€ 237.391,92	31-1-2020
200006	1-4-2020	€ 95.940,79	1-4-2020	€ 223.861,84	10-7-2020	€ 319.802,62	1-5-2020
200007	1-7-2020	€ 88.524,07	1-7-2020	€ 206.556,16	9-10-2020	€ 295.080,24	31-7-2020
200008	1-10-2020	€ 86.877,98	1-10-2020	€ 202.715,28	9-1-2021	€ 289.593,26	31-10-2020
200009	1-1-2021	€ 97.100,25	1-1-2021	€ 226.567,26	11-4-2021	€ 323.667,51	31-1-2021
200010	1-4-2021	€ 71.066,70	1-4-2021	€ 165.822,29	10-7-2021	€ 236.888,99	1-5-2021
200011	1-7-2021	€ 86.571,09	1-7-2021	€ 201.999,21	9-10-2021	€ 288.570,30	31-7-2021
200012	1-10-2021	€ 92.301,34	1-10-2021	€ 215.369,79	9-1-2022	€ 307.671,13	31-10-2021
200013	1-1-2022	€ 105.056,56	1-1-2022	€ 245.131,97	11-4-2022	€ 350.188,53	31-1-2022
200014	1-4-2022	€ 103.798,26	1-4-2022	€ 242.195,93	10-7-2022	€ 345.994,18	1-5-2022
200015	1-7-2022	€ 112.202,41	1-7-2022	€ 261.805,62	9-10-2022	€ 374.008,03	31-7-2022
200016	1-10-2022	€ 89.257,60	1-10-2022	€ 208.267,74	9-1-2023	€ 297.525,34	31-10-2022
200017	1-1-2023	€ 91.447,96	1-1-2023	€ 213.378,58	11-4-2023	€ 304.826,55	31-1-2023

200018	1-4-2023	€ 92.038,77	1-4-2023	€ 214.757,13	10-7-2023	€ 306.795,90	1-5-2023
200019	1-7-2023	€ 90.114,51	1-7-2023	€ 210.267,20	9-10-2023	€ 300.381,71	31-7-2023
200020	1-10-2023	€ 66.663,56	1-10-2023	€ 155.548,31	9-1-2024	€ 222.211,87	31-10-2023

Table 15: PO overview cash in advance solution

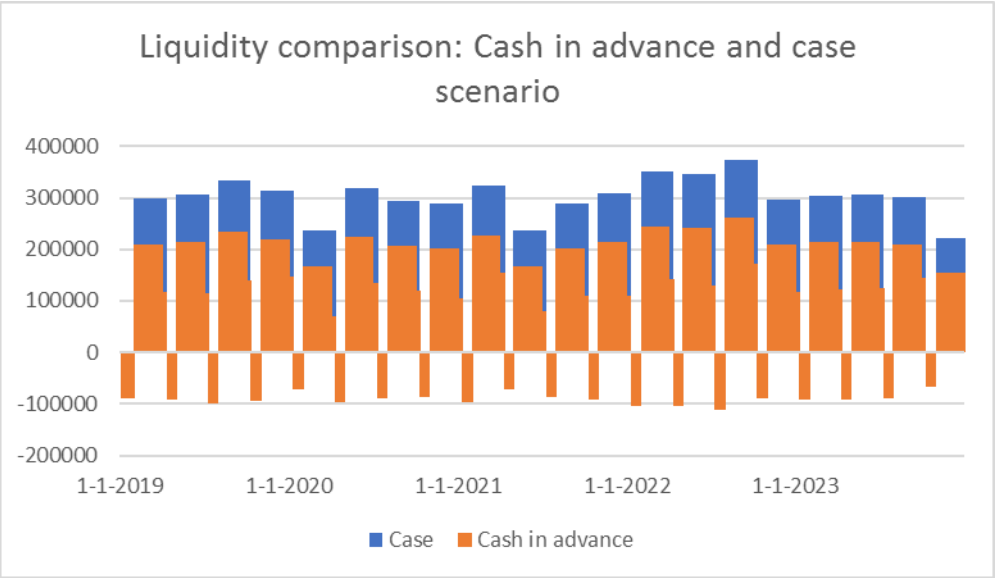

Figure 14: Liquidity benefits of business case compared with cash in advance extension

While the presence of cash advancements in the initial situation influences the costs and benefits of the supplier and the buyer, for ING not many changes. The risk exposure remains the same, since the PD, LGD, and EAD are the same compared to the case scenario. However, from a marketing perspective considering supply chains with cash advancement could be useful. Recall that ING is in general the bank of the buyer. Previously, the calculations showed that BPOF is more attractive for buyer's that have to provide a cash advancement to their supplier. Therefore, if ING wants to offer BPOF to their customers, looking for buying companies with such a supply chain could be interesting, because they benefit the most.

7.4.4. Tolling with buyer ownership

As discussed before, under the tolling agreement the buying company it the owner over the goods throughout the whole process. The supplier is only responsible to perform their operations on the goods for a fee, but has never possession over the goods. For the supply chain of BUYER and SUPPLIER this means that BUYER itself responsible for the procurement of the raw materials at the cotton farms in China and additionally has to organize the whole process of getting the goods at its own premises while quality, quantity and timing requirements are met. Since BUYER does not know its second tier supplier and is located in the Netherlands, taking over the supply chain seems beyond their capabilities. Nevertheless, in this section the implications of using the tolling agreement are discussed.

Suppose BUYER introduces tolling to the supply chain. To finance all required operations BUYER acquires a loan from the bank with a principal of €240.000. Note that this corresponds to the loan principal of the other discussed solution. However, the main difference is that the buyer receives the loan, since he orchestrates the supply chain. Therefore, from ING's perspective this is just a regular

loan. Involved parties can choose to use the assets that are produced in the process as collateral. Than the loan becomes secured instead of unsecured.

Thus, at first sight it looks like that for ING BPOF and financing under the tolling agreement is exactly the same. However, there is a subtle difference between the two if the loan is secured. Under the BPOF scheme both the buyer and the supplier have ownership over the goods, but with tolling the buyer has ownership over the goods throughout the whole process. If something goes wrong in the process ING covers their losses by claiming and selling collateral. However, claiming collateral from the unknown supplier in China is a lot harder than claiming collateral from the buyer, who is ING's customer. The proposed cost function of the buyer for the asset based solution shows that a higher claimability results in lower compensation costs for the buyer. Subsequently, the LGD of ING decreases due to the higher claimability. Therefore, increasing the duration the buyer has ownership over the goods is beneficial for both the buyer as for the bank.

Thus, while introducing tolling itself seems not that attractive due to the operational changes it requires, it results in a lower risk exposure for ING. This is mainly caused by the goods being on the balance sheet of the buyer. Therefore, a hybrid form of BPOF and tolling can be proposed that combines the benefits of both solutions. For this solution the buyer is not required to take over the operational aspects of the chain, so finance will be offered based on the mechanics of BPOF. However, this hybrid solution requires the buyer to have ownership over the goods while the loan is outstanding. This means that the supplier is still responsible for acquiring raw materials, but at the moment the supplier receives funds according to the BPOF scheme ownership over the goods is transferred to the buyer. Therefore, the assets become trade receivables on the balance sheet of the supplier and become inventory on the balance sheet of the buyer.

7.4.5. Different supply chains

Currently, the business case is only focused on the supply chain of BUYER and SUPPLIER and the production of jeans. However, the BPOF solution with all discussed extensions is not limited to only to the fashion industry. The mechanics of the FSCM solution does not limited its applicability to any specific supply chain.

In general, all the values of the variables that are used to determine the costs and benefits of the different supply chain members are supply chain specific (e.g. PO value, collateral value, buyer's PD, etc.). Therefore, the difference between supply chains can essentially be modeled by adjusting the values of these variables. For example, take a supply chain of a high tech company located in the Netherlands that orders a very specific laser lens from its supplier in China that is only applicable for this specific high tech firm. Because the laser lens is only applicable for this specific buyer, ING is not able to recover any collateral value in case the buyer defaults. For this example the costs of the buyer can still be calculated by earlier introduced equations, but the value of the finished good variable will be equal to 0.

Nevertheless, ING can make some considerations for deciding on suitable supply chains for a future BPOF program. Providing BPOF without using the produced assets as collateral is for ING in essence the same as offering an unsecured loan to the buyer. However, if the goods that are produced in the trade process are used as collateral ING's risk exposure decreases. Therefore, ING should look for supply chains in which the goods that will be traded have some value in case of defaults. In general, the higher the collateral value of the goods the more the risk exposure of ING decreases.

Meanwhile, the risk profile of the supply chain is not relevant, because the buyer covers all losses for the bank under the proposed FSCM solution. Therefore, ING is not limited to offering the BPOF solution to only supply chains with a low risk profile. The main decision criteria for ING providing the solution is the creditworthiness of the buyer and the value of collateral. Thus, even the riskiest supply chains are eligible for the BPOF solution.

7.4.6. Solution extension overview

In this subsection we give an overview of the different solution extensions we discussed. Additionally, we discuss how the cost function of the buyer differs for these different situations in comparison in respective to models we found in literature.

In our analysis we calculated the additional costs the buyer makes by participating in the BPOF scheme based on the model of Wu et al. (2014). Subsequently, we modified the buyer's cost function for the different extensions we discussed. In Table 16 an overview is given for the different solutions extensions and their respective cost function.

Situation	**Buyer's cost function**
Model of Wu et al. (2014)	$x * max(Loan + interest - Performance * PO\ value, 0)$
Use case scenario	$max(Loan + interest - Performance * PO\ value, 0)$
Asset based solution	$\max(Loan + interest - Performance * PO\ value - (1 - Performance) * Collateral\ value, 0)$
Progressive payments	$\max(\frac{n}{T}(Loan_{term1} + interest - Performance * PO\ value - (1 - Performance) * Collateral\ value_{term1}) + \frac{T-n}{T}(Loan_{term2} + interest - Performance * PO\ value - (1 - Performance) * Collateral\ value_{term2}), 0)$
Cash in advance	$\max(Loan + interest - Performance * PO\ value, 0) - (Advancement\ rate * PO\ value + interest)$

Table 16: Buyer's cost function comparison

In Table 16 the variable x indicates the portion of the losses of the bank the buyer will compensate, n indicates the duration after which the bank provides the second term under the progressive payments solution, and T indicates the total duration the overall loan is outstanding under the progressive payments solution.

Table 16 gives an overview of how we modified the existing cost function of the model of Wu et al. (2014) for different situations. Practitioners and researchers can use our new proposed cost functions to further analysis the BPOF scheme. However, note that for our use case we assumed that $x = 1$, so the buyer will fully compensate losses for the bank originating from performance risk. This was assumed, since it represents the current capabilities of ING in the pre-shipment FSCM domain.

Additionally, Table 17 shows a quantitative comparison of the different solutions we discussed. We found that introducing collateral will always result in lower costs for the buyer and a lower risk exposure for ING. Subsequently, progressive payments can be used to reduce the costs of the buyer, but this will also reduce the benefits of the supplier. Lastly, if the supplier requires the buyer to pay cash in advance in the initial situation, also both the benefits of the supplier and the costs of the buyer are lower than in the original situation. However, ING's risk exposure stays the same.

Scenario	Supplier's benefits	Buyer's costs	ING's risk exposure
Original solution	€2761,31	€555,50	€589,44
Asset based	€2761,31	€427,18	€419,24
Progressive payments	€591,78	€281,91	€329,40
Cash in advance	€1183,56	€62,35	€589,44

Table 17: Solution results

7.5. Use case: sensitivity analysis

In this section we provide a sensitivity analysis for our use case. The sensitivity analysis provides more insight in the behavior of the different variables we used in the use case.

7.5.1. Supply chain benefits

For constructing our use case we assumed that the supplier receives some financial benefits due to the FSCM solution and the buyer experiences some extra costs. Therefore, we can argue that the overall benefits of the overall supply chain can be determined by considering both instances. This results in the following equation:

$$BPOF\ supply\ chain\ benefits = Supplier's\ benefits - Buyer's\ costs$$

For the supplier's benefits we look especially to his financial benefits. De Boer et al. (2015) argue that by using pre-shipment FSCM solutions the creditworthiness of the buyer becomes more relevant to banks for providing a loan. Therefore, the supplier acquires financing at a reduced rate instead of based on its own cost of capital. Note that for example the article of Lange et al. (2012) also uses an interest rate for the POF scheme independent of the cost of capital of the supplier. For the buyer's cost function used the model of Wu et al. (2014). In their model Wu et al. (2014) describe the additional costs the buyer have to make under the BPOF scheme.

Subsequently, we calculated the supplier's financial benefits with the following equation:

$$S = x * r_s * \frac{t}{365} - x * r_s * \frac{n}{365} - x * r_{BPOF} * \frac{t-n}{365}$$

Where

$S = Supplier's\ benefits$

$x = Required\ capital\ (or\ Loan\ principal)$

$n = Moment\ in\ time\ the\ supplier\ receives\ POF$

$r_s = Cost\ of\ capital\ of\ the\ supplier\ (or\ supplier\ yield)$

$r_{BPOF} = Interest\ rate\ under\ BPOF\ (based\ on\ the\ capital\ market)$

$t = Payment\ term\ of\ the\ loan$

Additionally, we calculated the buyer's costs by the following equation:

$$B = \max(x * (1 + r_{BPOF}) - P * PO, 0)$$

Where

$B = Buyer's\ costs$

$x = Loan\ principal\ (corresponds\ to\ the\ x\ variable\ of\ the\ supplier's\ function)$

$r_{BPOF} = Interest\ rate\ under\ BPOF$

$P = Risk\ of\ the\ supplier\ not\ fulfilling\ the\ order\ (Performance\ of\ the\ supply\ chain)$

$PO = The\ value\ of\ the\ purchase\ order$

Therefore, by combining the supplier's benefit function and the buyer's cost function, and considering the time value of money in the buyer's cost function ($r_{BPOF} * \frac{t-n}{365}$), the equation for the overall supply /chain benefits can be described as follows:

$$SCB = x * r_s * \frac{t}{365} - x * r_s * \frac{n}{365} - x * r_{BPOF} * \frac{t-n}{365} - \max(x * \left(1 + r_{BPOF} * \frac{t-n}{365}\right) - P * PO, 0)$$

Where

$SCB = Supply\ chain\ benefits$

Rewriting the equation gives:

$$SCB = x * r_s * \frac{t-n}{365} - x * r_{BPOF} * \frac{t-n}{365} - \max(x * \left(1 + r_{BPOF} * \frac{t-n}{365}\right) - P * PO, 0)$$

Note that the supply chain benefits can be negative. This indicates that the cost for the buyer are higher than the financial benefits of the supplier. Furthermore, we assume a two-point distribution for the performance variable (P): either the buyer receives the entire order according the PO, or the buyer receives nothing at all. According to interviews with trade finance experts of ING, this is a pretty accurate representation of reality. Subsequently, the performance variable (P) indicates the probability the order is fully completed. Therefore, $1 - P$ represents the probability the buyer does not receive any goods. Meanwhile, the max statement of our supply chain benefits equation is equal to 0 in case the buyer receives the entire order. Additionally, the max statement is equal to $x * \left(1 + r_{BPOF} * \frac{t-n}{365}\right)$ in case the buyer receive no goods. Moreover, since the variables t and n together determine the time the loan is outstanding, we introduce a new variable d, which represents the duration of the loan ($d = t - n$). Thus, by assuming a two-point distribution for the performance variable and our new variable d, the supply chain benefits equation can be rewritten as follows:

$$SCB = x * r_s * \frac{d}{365} - x * r_{BPOF} * \frac{d}{365} - (1 - \mathrm{P}) * x * \left(1 + r_{BPOF} * \frac{d}{365}\right)$$

Subsequently, this equation can be rewritten as follows:

$$SCB = x * r_s * \frac{d}{365} - (2 - P) * x * r_{BPOF} * \frac{d}{365} - (1 - \mathrm{P}) * x$$

In this sensitivity analysis we used the above equation for supply chain benefits. In the remainder of this section we will analyze the influence of the different variables on the overall supply chain

benefits. Moreover, we consider the bank's perspective for interpreting our supply chain benefits equation.

7.5.2. Variable sensitivity

In this subsection we analyze the behavior of each individual variable of our supply chain benefits equation. This analysis is performed by plotting SCB against each variable over a certain range, while all other variables are set at a default value. In Table 18 is displayed which default values are used for our variables. Additionally, the last column of Table 18 displays the range over which we plotted each variable.

Variable	Default value	Range
x	240000	{0; 400000}
r_s	0,08	{0; 0,10}
r_{BPOF}	0,02	{0; 0,10}
d	70	{0; 200}
P	0,99	{0,8; 1}

Table 18: Variables' default value and range

7.5.2.1. Performance variable

Recall that the performance variable indicates the risk of the supplier not fulfilling the order. Furthermore, we assumed a two-distribution for this variable. Therefore, the value of the performance variable (P) indicates the probability the buyer receives all ordered goods and $(1 - \mathrm{P})$ indicates the probability the buyer does not receive any goods.

In Figure 15 the influence of the performance variable on the obtained supply chain benefits is displayed. In our analysis we found that increasing the performance variable will lead to an increase in supply chain benefits. Moreover, from Figure 15 can be seen that the performance variable must be significantly high to generate overall benefits for the supply chain. This substantiates our claim that only supply chain with high reliability are eligible for pre-shipment FSCM.

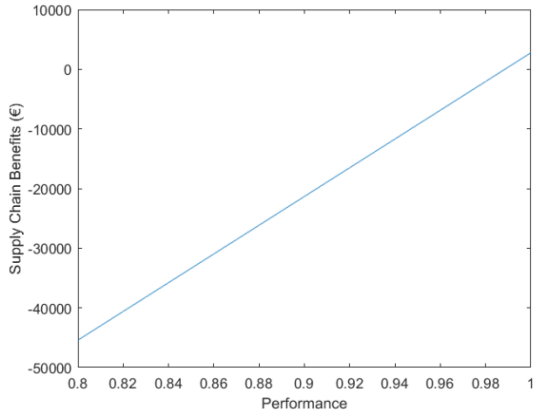

Figure 15: Sensitivity analysis - Performance

7.5.2.2. Loan principal

The loan principal indicates the amount of money the supplier receives from the bank by participating in the BPOF scheme. Note that in POF like FSCM solutions the loan principal is based on the value of the PO. In our analysis we found that the loan principal behaves as a moderating variable relative to supply chain benefits. This is also displayed in Figure 16. Figure 16 shows that under some circumstances the loan principal has a positive relationship with supply chain benefits, but under other circumstances has a negative relationship. Moreover, there exists a threshold value for which the supply chain benefits variable is indifferent towards the loan principal.

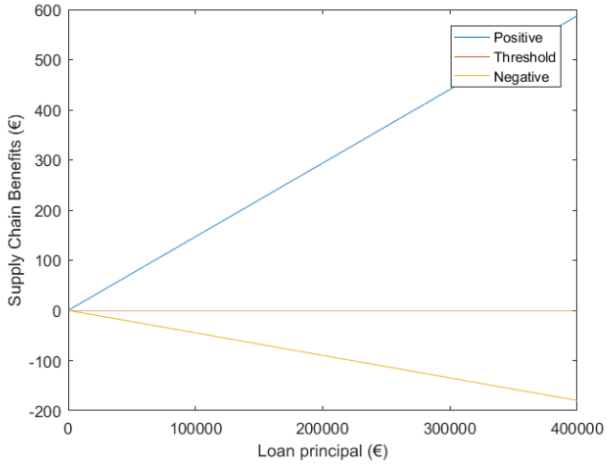

Figure 16: Sensitivity analysis - Loan principal

Additionally, we investigated in which situations the loan principal increases supply chain benefits and in which situations it decreases. Moreover, we determined under which circumstances the supply chain benefits variable is indifferent towards the loan principal. We found that this is the case when the following holds:

$$r_s = (2 - P) * r_{BPOF} + \frac{365(1-\mathrm{P})}{t-n}$$

Subsequently, this indicates that the loan principal is positively related to supply chain benefits if:

$$r_s > (2 - P) * r_{BPOF} + \frac{365(1-\mathrm{P})}{t-n}$$

Meanwhile, the loan principal is negatively related to supply chain benefits if the following is true:

$$r_s < (2 - P) * r_{BPOF} + \frac{365(1-\mathrm{P})}{t-n}$$

Therefore, to construct Figure 16 we used the default values for all variables to construct the positive graph, we set the supplier yield variable (r_s) to 0,07 instead of 0,08 to create the negative graph, and we used the equality above to construct the threshold value.

The moderating effect of the loan principal has some major implications for involved parties. Hence remaining variables contribute to a positive relationship between the loan principal and supply chain benefits based on our threshold above, increasing loan principal will result in additional supply chain benefits. Therefore, banks might be willing to provide higher loans, since it creates a win-win situation for all involved parties. Meanwhile, in case the threshold is not reached, a negative

relationship exists. Therefore, it is in the best interest of involved parties to keep the loan as low as possible.

7.5.2.3. Supplier yield

The supplier yield variable (r_s) represents the riskiness of the supplier. Moreover, it indicates at which rate the supplier can obtain finance on its own. In our analysis we found that supplier yield is strictly positively related to supply chain benefits. This is also plotted in Figure 17. Thus, by increasing risk by choosing for suppliers with a higher yield, expected benefits are higher. This indicates that taking additional risk can pay off in the end.

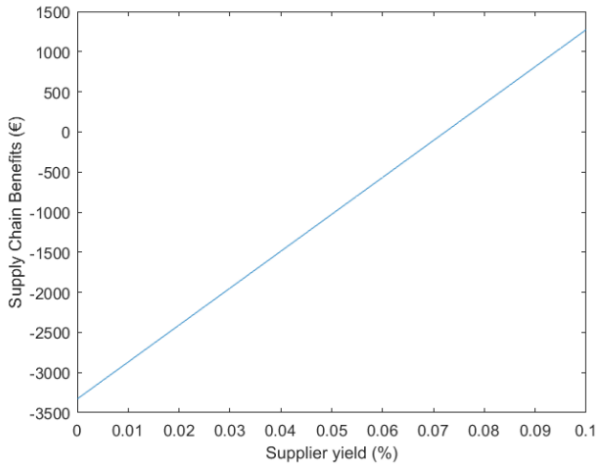

Figure 17: Sensitivity analysis - Supplier yield

7.5.2.4. Capital market rate

The capital market rate variable represents the interest rate that is charged for the loan the bank provides to the supplier under the BPOF scheme. We found that increasing the capital market rate strictly decreases supply chain benefits. This is also displayed in Figure 18. This implies that banks must be aware of the rate they set for the loan for the BPOF scheme. By increasing the rate the buyer and supplier become less eagerly to participate in the BPOF, since their benefits diminish. Therefore, a trade-off has to be made between the benefits off each involved party.

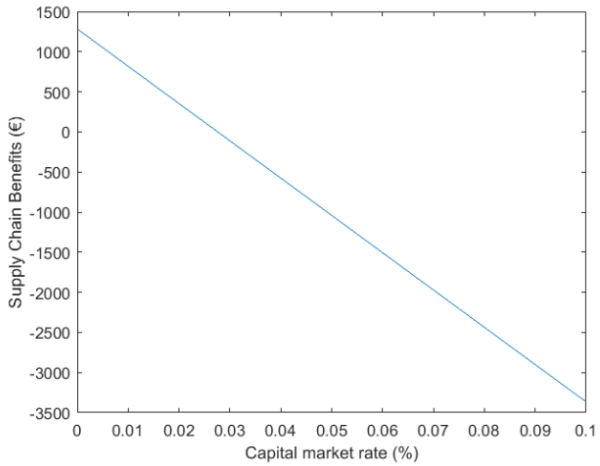

Figure 18: Sensitivity analysis - Capital market rate

7.5.2.5. Loan duration

The loan duration variable represents the amount of time the loan is outstanding, so this is the time over which the bank receives interest. In our analysis we found that the loan duration variable (d) is a moderating variable like the loan principal. Under certain circumstances increasing the loan duration will increase supply chain benefits, but under other circumstances benefits decrease. This is also shown in Figure 19.

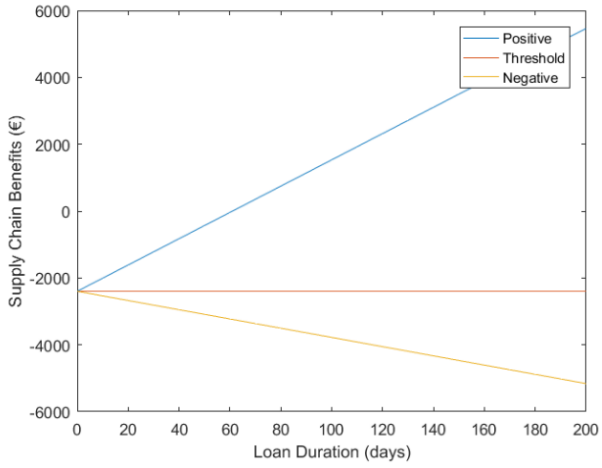

Figure 19: Sensitivity analysis - Loan duration

Like for the loan principal variable, there exists a threshold for which the supply chain benefits variable is indifferent towards the payment term variable. This threshold is described as follows:

$$r_s = (2 - P) r_{BPOF}$$

Additionally, there exists a positive relation between the payment term and supply chain benefits as:

$$r_s > (2 - P) r_{BPOF}$$

There is a negative relation between as:

$r_s < (2 - P) r_{BPOF}$

Therefore, in order to construct Figure 19 we used the default values stated in Table 18 to construct the positive graph, we set r_{BPOF} equal to 0,10 to construct the negative graph, and we used the equality above to construct the threshold value for which the supply chain benefits variable is indifferent towards loan duration.

Therefore, the involved parties must consider relevant variables for setting the loan duration for the BPOF. It is more beneficial to set longer payment terms if the threshold value is reached, but if this is not the case, a shorter payment term is recommended by our model. However, note that our model does not take into account working capital goals of the buyer and supplier. Increasing or decreasing payment terms might interfere with these goals, so practitioners must be aware of this by interpreting our findings.

7.5.2.6. Conclusion variable sensitivity analysis

In our analysis we discussed the behavior of the five variables we use to determine supply chain benefits. We found that the performance variable and supplier yield are positively related to supply chain benefits, whereas the capital market rate is negatively related to supply chain benefits. Meanwhile, we found that the loan principle and loan duration behave as moderating variables in our model. This indicates that under some circumstances these variables are positively related to supply chain benefits, but under other circumstances they can be negatively related. Furthermore, we determined for both variables the threshold for which their relationship changes form positive to negative.

7.5.3. Bank's perspective on supply chain benefits

In this subsection we take a closer look to the supply chain benefits equation from the bank's perspective. In total we distinguished six variables that are used to calculate supply chain benefits. However, only the capital market rate and to a certain extend the loan duration are decision variables for the bank. In section 7.5.2.5 we already discussed that the loan duration is a moderating variable in our model and we determined its threshold value. Meanwhile, we found that increasing the capital market rate will result in lower supply chain benefits. However, the capital market rate determines the profitability of the BPOF scheme for the bank, so just lowering the rate is not a valid strategy for the bank. Therefore, in this section we will further analyze the capital market rate variable.

For our analysis we assume that the bank wants to set the capital market rate as high as possible, since this maximizes profit. Meanwhile, we also assume that the supplier and buyer are only willingly to participate in the BPOF if it creates benefits, so $SCB > 0$. This will result in the following equation:

$$x * r_s * \frac{d}{365} - (2 - P) * x * r_{BPOF} * \frac{d}{365} - (1 - \mathrm{P}) * x > 0$$

By rewriting the supply chain benefit formula we found a threshold for the capital market variable. The interest rate the capital market charges for the BPOF solution must be below the threshold in order to create supply chain benefits. The capital market threshold can be calculated by the following equation:

$$r_{BPOF} < \frac{r_s}{(2-P)} - \frac{(1-\mathrm{P})}{(2-P)\frac{d}{365}}$$

Thus, from the bank's perspective the threshold indicates the maximum interest rate they can ask for the loan, so the supply chain is still able to generate some benefit by participating in the BPOF scheme. In the remainder of this subsection we will further analyze the influence of the different variables we use in our model on the threshold value for the capital market rate. Note that the threshold can result in negative values. This indicates that the bank must give additional money to the supply chain in order it to be beneficial to participate in the BPOF. However, in a real life scenario the bank will never do this, so the negative values can be interpreted as non-feasible solutions.

7.5.3.1. Loan principal

A notable observation we made in our analysis is that the capital market rate threshold is not influenced by the loan principal. This indicates that the maximum interest rate the bank can set for the BPOF solution is not influenced by the value of the PO. However, note that the loan principal still influences the profit the bank makes. Receiving an interest rate of 5% over €100.000 will result in a higher cash flow as receiving 5% over €50.000.

7.5.3.2. Performance

In our analysis we found that increasing performance always results in a higher threshold value, so the a higher performance results in a higher maximum capital market rate. This is also displayed in Figure 20. For constructing Figure 20 we used again the input variables as stated in Table 18. Earlier we found that a high performance is required for the supply chain to experience benefits instead of costs. Additionally, this analysis shows that a higher performance results in a higher interest rate threshold for the bank. This indicates that all involved parties benefit from a higher performance. Moreover, an exceptional high performance is required for the threshold to be positive. Thus, this implies that only supply chains with high performance are eligible for BPOF. Meanwhile, if performance is 1 the threshold states $r_{BPOF} < r_s$. This indicates that if there is no performance risk, the supply chain only benefits from participating in the BPOF scheme if the interest rate for the loan is lower than the supplier's yield rate.

Note that by interpreting Figure 20 interest rates above the threshold line result in negative supply chain benefits. For our analysis we assumed that buyers and suppliers are not willingly to participate if their overall benefits are negative. Therefore, the area above the threshold line can be seen as non-feasible. Meanwhile, the area beneath the threshold line consists of all feasible solutions (positive supply chain benefits). However, note that for some instances the bank is required to set a negative capital market rate in order to obtain positive supply chain benefits. Since this makes the BPOF scheme non-lucrative for banks, we argue that only the area with $r_{BPOF} > 0$ should be considered the set of feasible solutions.

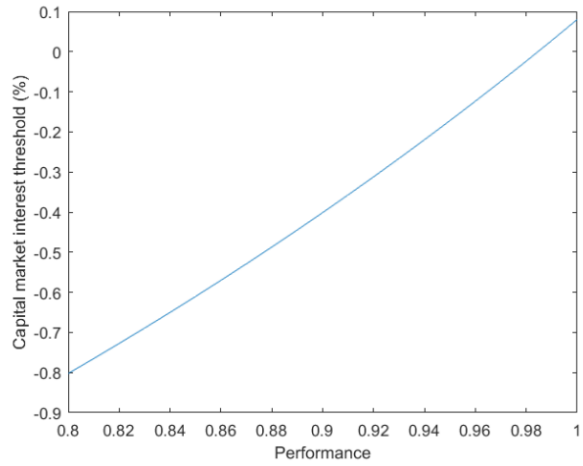

Figure 20: Capital market rate analysis - Performance

7.5.3.3. Supplier yield

We found that supplier yield is positively related to the capital market rate threshold, so the bank is allowed to set higher a higher interest rate for suppliers with a lower creditworthiness. The relationship between these two variables is also displayed in Figure 21. Note again that the area above the threshold line indicates negative supply chain benefits and the area below the threshold graph indicates the set of positive supply chain benefits. Since yield indicates the riskiness of the supplier, this relationship shows that the bank is allowed to increase their interest rate for more risky suppliers.

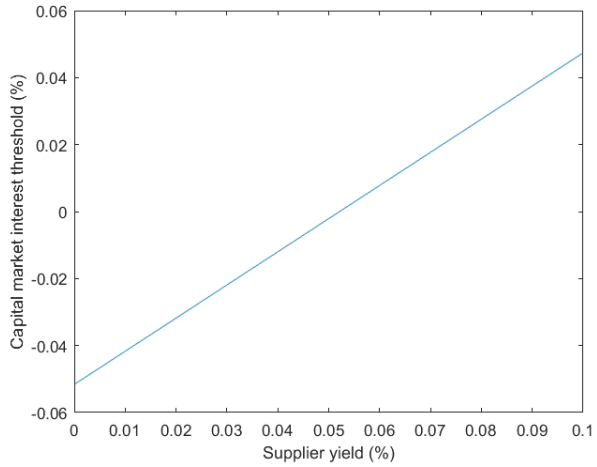

Figure 21: Capital market rate analysis - Supplier yield

7.5.3.4. Loan duration

The relationship between the payment term and the maximum capital market rate is displayed in Figure 22. This is a reciprocal (or hyperbolic) function with two asymptotes. The vertically asymptote is equal to 0, so a loan of 0 days is not possible in our model. Meanwhile, the horizontally asymptote is equal to $\frac{r_S}{(2-P)}$. From Figure 22 we can deduce that increasing the payment term will result in a higher maximum capital market rate. Furthermore, the hyperbolic relationship shows that increasing

short payment terms result in a higher increase of the threshold, as long payment terms. This indicates that for banks steering on payment terms is most beneficial for supply chains with short payment terms. The longer the payment term is the less influence additional changes have. Moreover, it indicates that a loan must be outstanding for a significant amount of time in order to be lucrative for the bank. However, we assumed a performance risk independent from the loan duration for this analysis, so practitioners must be aware of this by interpreting these findings.

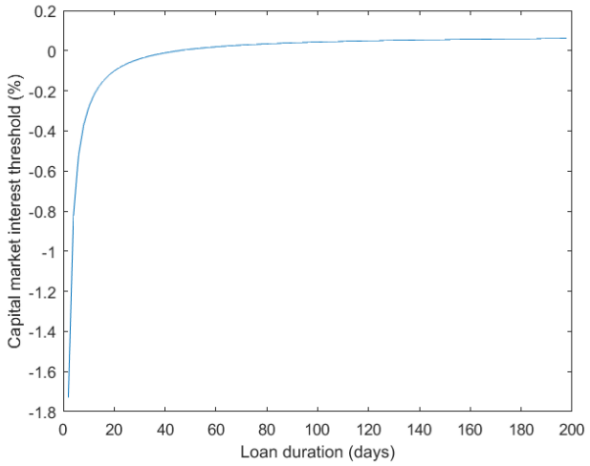

Figure 22: Capital market rate analysis - Loan duration

7.5.3.5. Conclusion bank's perspective on supply chain benefits

In this section we determined the maximum interest rate the bank can set for a loan under the BPOF scheme. We found that the threshold depends on supplier yield, the performance of the supply chain, and on the time the loan is outstanding. The performance, supplier yield, and loan duration variables are all three positively related to the threshold value, so banks can set a higher interest rate for supply chain's with these characteristics.

8. Conclusion

In this section the overall conclusions of this master thesis project are given. The conclusions are based on the research questions we proposed in section 2 of this report. First the answers for the sub-questions is given and after that overall conclusions are made to answer the main research question.

8.1. Research question 1

The first sub-question is mainly discussed in section 3 and is described as follows:

Which pre-shipment FSCM solutions are known in literature and practice and what are their characteristics?

We found two main types of pre-shipment FSCM solutions: POF and tolling. In the POF solution a financial institution provides funds to a supplier based on the PO of the buyer. Subsequently, the buyer pays back the loan to the bank after he has received the goods he ordered. Under the tolling solution the buyer has ownership over the goods throughout the whole trade process with its first-tier supplier. The supplier is only responsible for performing some operations on the goods against a fee (the fee is called a toll). Concluding, for this research project we focus our analysis on these two types of pre-shipment FSCM solutions. Note, that section 3 more in-depth discusses the characteristics of both solutions.

8.2. Research question 2

The third research question is mainly discussed in section 5 and is described as follows:

How does FSCM interact with Supply Chain Risk Management (SCRM)?

This research question is analyzed by creating a framework that describes the different risk drivers that can be found in the trade process. To create the framework, we first identified the different phases in the trade process. Subsequently, we identified 31 risk drivers and allocated them to the different phases. This results in a framework that helps describing the overall risk exposure of a trade process in the pre-shipment domain.

Moreover, based on the risk framework we constructed a model that describes the overall risk exposure of ING for pre-shipment financing. The model gives ING different insights in the relationships between variables that ultimately describe their risk exposure.

Concluding, by looking at the interaction of FSCM and SCRM, 31 different risk drivers can be identified for pre-shipment FSCM solutions. Subsequently, their probability of occurrence and their severity determine ING's overall risk exposure.

8.3. Research question 3

The fourth research question is mainly discussed in section 0 and is described as follows:

Which pre-shipment FSCM solution is most suitable for banks in the Netherlands to implement?

Based on the risk framework that was constructed we first analyzed the risk mitigating mechanics of both POF and tolling. We found that both POF and tolling have very limited risk mitigating characteristics, so almost all risk drivers are still relevant for both solutions. Thus, determining the most suitable solution based on the risk framework does not make any sense. However, while risk mitigation is very limited for both solutions, the mechanics of both solutions allow to transfer risk from lower creditworthy supply chain members to high creditworthy parties.

Meanwhile, looking at the mechanics of both POF and tolling we found that offering POF is more convenient. While POF only requires a PO to be initiated, tolling requires the buyer to extend its operations and responsibility.

Furthermore, we determined that ING is currently only able to determine the default risk of their own customers, which we assumed is the buyer in this setting. Thus, ING is not able to make reliable estimates of the other 30 risk drivers we identified. Therefore, based on their current capabilities, ING can only determine their risk exposure for POF if the buyer takes on these 30 remaining risk drivers and if the buyer is responsible for paying back the loan to ING. This suggests that ING will only provide the BPOF solution with a full guarantee of the buyer.

8.4. Research question 4

This research question is discussed in section 7 and is described as follows:

How will the most suitable look like if implemented within ING?

To answer this question, we proposed a use case that gives ING insights on how a pre-shipment FSCM solution behaves if it is implemented. First, we discussed different supply chain characteristics which indicate the eligibility of a supply chain for pre-shipment FSCM. The following characteristics were discussed:

- Reliability of supplier operations: unreliable suppliers jeopardize the trade process and put the loan at risk.
- Collateral value: higher collateral value will result in less risk for ING.
- Collateral claimability: collateral has only value for ING if it is claimable.
- Order size: orders must be of sufficient size to compensate the set-up costs of the FSCM program.

In the use case we used the BPOF scheme, since we concluded earlier that this is the most suitable FSCM solution for ING at the moment. Subsequently, the benefits of the supplier, the costs of the buyer, and the risk exposure of the bank were determined. Moreover, we determined a break-even discount at which the FSCM solution also becomes lucrative for the buyer.

Based on these calculations we found that all involved parties can benefit from the FSCM solution. However, the costs of the buyer suffer from a very high standard deviation. Therefore, the buyer is exposed to a significant degree of uncertainty. This results from the fact that the buyer has to cover all losses of the bank.

Additionally, to the use case, we described different methods ING could use to extend the FSCM solution. For all these extensions we discussed how this will improve or change the benefits and/or

costs the different supply chain members experience. We considered the following extensions in this research project:

- Asset based financing solution
- Providing the loan progressively
- Initial situation requires the buyer to provide cash in advance

Using the produced assets as collateral will always result in a lower expected risk for the buyer and the bank under the described BPOF scheme. Moreover, the benefits for the supplier stay the same. Providing the loan progressively will also reduce the expected risk of both the buyer and the bank, but this is at the costs of the benefits the supplier experiences. Furthermore, If the FSCM solution is offered to a supply chain that uses cash advances, the additional risk exposure of the buyer is lower in comparison with a supply chain that does not use cash advances. By offering an advancement in the initial situation the buyer is already exposed to performance risk, so the additional risk pre-shipment FSCM causes is relatively smaller.

Furthermore, in our sensitivity analysis we found that supplier yield and supply chain performance are positively related with overall supply chain benefits. Meanwhile, the capital market rate is negatively related with supply chain benefits. Additionally, we found that the loan principal and loan duration act as moderating variables regarding supply chain benefits.

In our sensitivity analysis we also determined the maximum capital market rate the bank can charge for the BPOF scheme. We found that the loan principal is not related to this rate. Additionally, we found that performance, supplier yield, and loan duration are all positively related to maximum rate the bank can charge. Therefore, for offering the BPOF scheme, banks should target supply chains that are characterized by high supplier yield, high performance, and long durations in order to increase revenue.

8.5. Main question

The main research question of this research project is formulated as follows:

What are the opportunities for banks regarding pre-shipment Financial Supply Chain Management (FSCM)?

In this research project we found that ING is currently only capable of making reliable estimates for 1 of the 31 identified risk drivers in the trade process. Meanwhile, ING will only provide financing for products/services for which they can determine their risk exposure. Therefore, currently ING is only willingly to provide pre-shipment FSCM, if the buyer takes on the performance risk of the supply chain. This results in ING only taking on the default risk of the buyer, which is known to them. However, in our use case we showed that a BPOF solutions with the buyer giving a full guarantee to the bank can be beneficial for all involved parties. Therefore, ING can choose to offer this FSCM in the future.

Meanwhile, the greatest opportunities for ING in the pre-shipment domain lie in the extension of their risk assessment capabilities. ING's business model is based on taking risks and receiving interest rates for that. Therefore, if ING is capable for determining all 31 identified risk drivers, they can offer a significant more versatile product to their customers and they can earn interest for all the risk they take. Moreover, the less risk the buyer and supplier are exposed to, the more lucrative the FSCM solution becomes for them. Thus, ING taking on risk will also increase the willingness of their customers to take part in the FSCM solution.

Additionally, ING can investigate which parties are willingly to take which risks. As mentioned before, supply chain members have in general a better understanding than ING of their risk exposure. Thus, if for example the buyer is not willingly to take a portion of the performance risk of the supply chain, this might be an indicator for ING that the supply chain lacks sufficient performance. Moreover, external parties can play a role here. For example, insurance companies can bear the responsibility for a portion of the overall risk of the supply chain. Thus, ING creating the capabilities to address the different risk drivers, forms a stepping stone for determining which risks they will take in the end.

Meanwhile, in our use case we showed how ING can offer a pre-shipment FSCM solution based on their current capabilities. In our use case we analyzed the benefits the BPOF scheme can offer to a supply chain. We found that using produced assets as collateral will increase the overall benefits the supply chain perceives. Moreover, pre-shipment financing is especially beneficial for supply chains that require the buyer to provide payment advancements to the supplier. Additionally, banks can increase their revenue by targeting supply chains with high supplier yield, high performance, and long duration of the trade process.

9. Discussion

In this section an overall discussion is given for this research project. First, in section 9.1 we will discuss the limitations of this research project. Subsequently, in section 9.2 different future research directions will be discussed based on these limitations.

9.1. Limitations

SCRM perspective

In this research project the we mainly looked at pre-shipment FSCM from a SCRM perspective. For ING this is an important indicator of the opportunities of pre-shipment FSCM solutions, since ING's business model is based on taking risks to earn interest. However, since this research project is mainly from a risk perspective, our conclusions are also taken from a risk perspective. Meanwhile, for the successful implementation of new product/services ING might also want to look at pre-shipment FSCM from other perspectives. For example, ING must also look at pre-shipment FSCM from a marketing perspective to fully capture its market potential. Furthermore, ING must further investigate the legal implications of pre-shipment FSCM to discover what is possible within the boundaries of regulations. Moreover, ING must perform an internal business case fully capture the potential pre-shipment FSCM has for them. Setting up a pre-shipment FSCM needs significant investments, so ING must investigate if such a program can be profitable for them. Concluding, looking at pre-shipment FSCM can offer additional insights to ING and other opportunities might occur from that.

ING's capabilities

In this research project we look for opportunities in the pre-shipment domain based on the current capabilities of ING. Based on that we concluded for instance that ING is currently only able to make reliable estimates for the default risk of the buyer. Meanwhile, we did not explicitly investigate the role new technologies can play to improve ING's capabilities. For example, many companies use information systems to collect and keep track of data. Therefore, a lot of information regarding the flow of the trade process is already available in the information systems of involved parties. Subsequently, ING can extend its capabilities by constructing tools that can collect this kind of data and that can translate it in meaningful information.

Considering new technologies might result in different opportunities for ING in the future. However, looking at ING's current capabilities enables us to investigate the opportunities pre-shipment FSCM offers at this moment.

Economic implications

In our use case the benefits of pre-shipment FSCM are mainly investigated from an economic perspective. The benefits for the buyer, supplier, and ING are basically focused on financial measures. However, FSCM also offers other benefits for a supply chain additionally to the financial benefits. Considering other benefits of FSCM might offer different insights regarding the opportunities pre-shipment FSCM offers. Bernabucci (2007) acknowledges the following five additional benefits of FSCM:

- Risk cost savings: Transferring risks to higher creditworthy supply chain members results in lower risk premiums.
- Administrative cost savings: FSCM require standardized processes, so less manual labor is required.
- Reporting benefits: Many FSCM make use of reporting platforms. These platforms offer supply chain members real time information regarding document flows, cash flows, and delivery statuses. This will also result in an improved transparency of the supply chain.
- Enhanced supply chain relationships: In order to offer FSCM solutions a focal firm leverage its own financial position to provide financing to a weaker player in the supply chain. This can be seen as offering an additional service, which could improve the relationship between involved parties as the focal firm is helping the weaker player gaining cheap financing.
- Enhanced compliance with regulations: Since FSCM solutions are standardized and well-managed processes, it offers involved parties to more easily manage compliance with regulations (Hoffman & Belin, 2011).

However, since FSCM is mainly focused on optimizing working capital along the supply chain, analyzing benefits from a financial perspective seems obvious. For example, in the articles of Lange et al. (2012) and Wu et al. (2014) the benefits of pre-shipment FSCM are also investigated from a financial perspective.

9.2. Future research directions

Considering different research perspectives

In section 9.1 we discussed that this research project is mainly focused on the risk aspects of FSCM. Therefore, conclusions and implications must also be interpreted from a risk perspective. However, ING might also want to look at pre-shipment FSCM from different perspectives. By considering the whole spectrum of FSCM ING can in the end better grasp which opportunities FSCM offers. Some potential research perspectives that can be considered are:

- **Marketing:** ING can investigate the market potential of the different pre-shipment FSCM solutions. Moreover, ING can investigate which industries and/or supply chain types have the highest needs for pre-shipment FSCM.
- **Legal:** ING must further investigate the legal implications of a pre-shipment FSCM product. Regulations might obstruct the implementation of certain aspects of FSCM solutions and other solutions might become more relevant because of that.
- **Strategic:** ING must further investigate if introducing a FSCM program is profitable. In the current research project we did not consider the costs of constructing the FSCM itself. The potential customer base that will make use of the FSCM program must at least offer enough revenue to cover the costs of constructing and maintaining the program.
- **Product portfolio:** ING must also consider the place pre-shipment FSCM will obtain in their current product portfolio. Cannibalization of existing products/services might occur. For example, ING is already offering trade finance service, which aim to mitigate risks in the supply chain. Thus, further research must indicate how the implementation of a pre-shipment FSCM solution affects other products/services of ING.

Information in the supply chain

Based on the risk analysis we concluded that ING is currently only able to determine the Default risk of the buyer. Therefore, ING only wants to offer financing in the pre-shipment phase if the buyer will cover losses that result from other risk drivers. In this way ING only requires to determine the default risk of the buyer, which is one of their core capabilities. However, that ING is currently not able to determine the 30 remaining risk drivers does not mean that the required information is not there. A risk expert of ING already acknowledged that the buyer and supplier have quite a good indication of the risks in their chain. Therefore, ING might want to investigate which information is available in the supply chain that can help to estimate the probability and severity of the different risk drivers.

Table 19 gives an overview of the information sources that are available in the supply chain, which can be used to assess the different risk drivers. The following instances are displayed in Table 19:

- In the first column an overview is given of all individual risk drivers.
- In the second column is displayed which party or parties have information available over the respective risk driver.
- In the third column the information source that can be used to assess the respective risk driver is displayed.

Risk driver	**Information holder**	**Information source**
Geographical location	ING	Country risk indicator
Availability of raw materials	Second-tier supplier, Supplier	Inventory data, Production data, Industry size
Quality of raw materials	Second-tier supplier	Inventory data, Production data
Price of raw materials	Public data, second-tier supplier, Supplier	Market prices
Supplier bankruptcy	Supplier's bank	Probability Default
Breakdowns of operations	Supplier	Machine lifetime data, Maintenance reports
Operating performance	Supplier, Buyer	Previous track record
Process variations	Supplier	Operational planning
Operating capacity	Supplier	Operational planning
Moral hazard	-	-
Goal conflict	-	-
Technological uncertainty	Supplier, Buyer	Product knowledge
Product complexity	Supplier, Buyer	Product knowledge
Frequency of design changes	Supplier, Buyer	Product knowledge
Transportation mode	Logistic service provider	Track record
Logistic service provider bankruptcy	Logistic service provider's bank	Probability Default
Handling of goods	Port, Logistic service provider	Track record

Table 19: Information availability in the Supply Chain

Table 19 suggests that different information sources can be used to gain better understanding in the overall risk profile of the supply chain. For almost all risk drivers an information is identified which can help to gain better understanding of the respective driver. Concluding, ING can investigate how current information in the supply chain can help them to make estimates for the different risk drivers in the supply chain.

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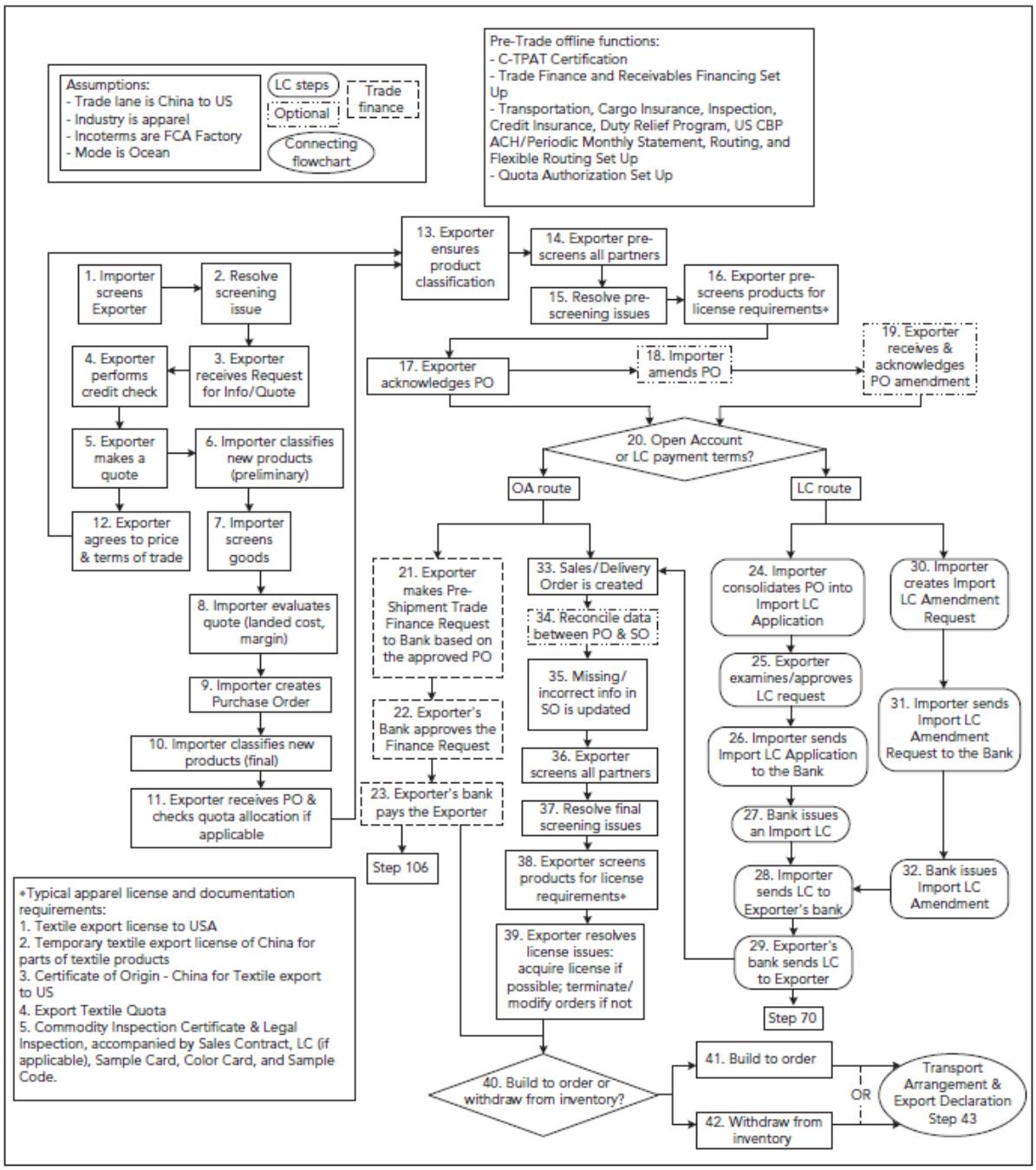
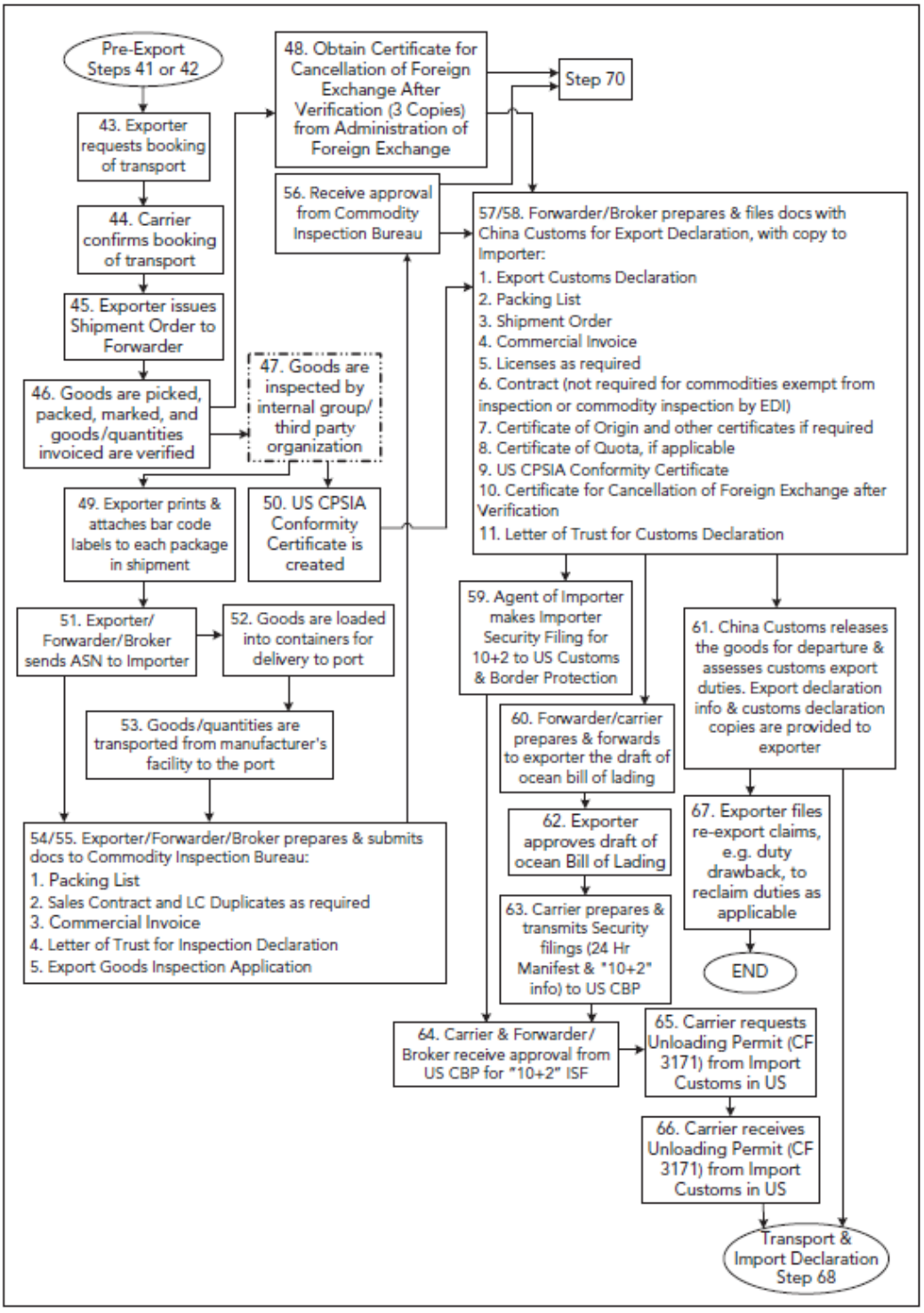
Appendix A: Flow chart of Hausman et al. (2010)

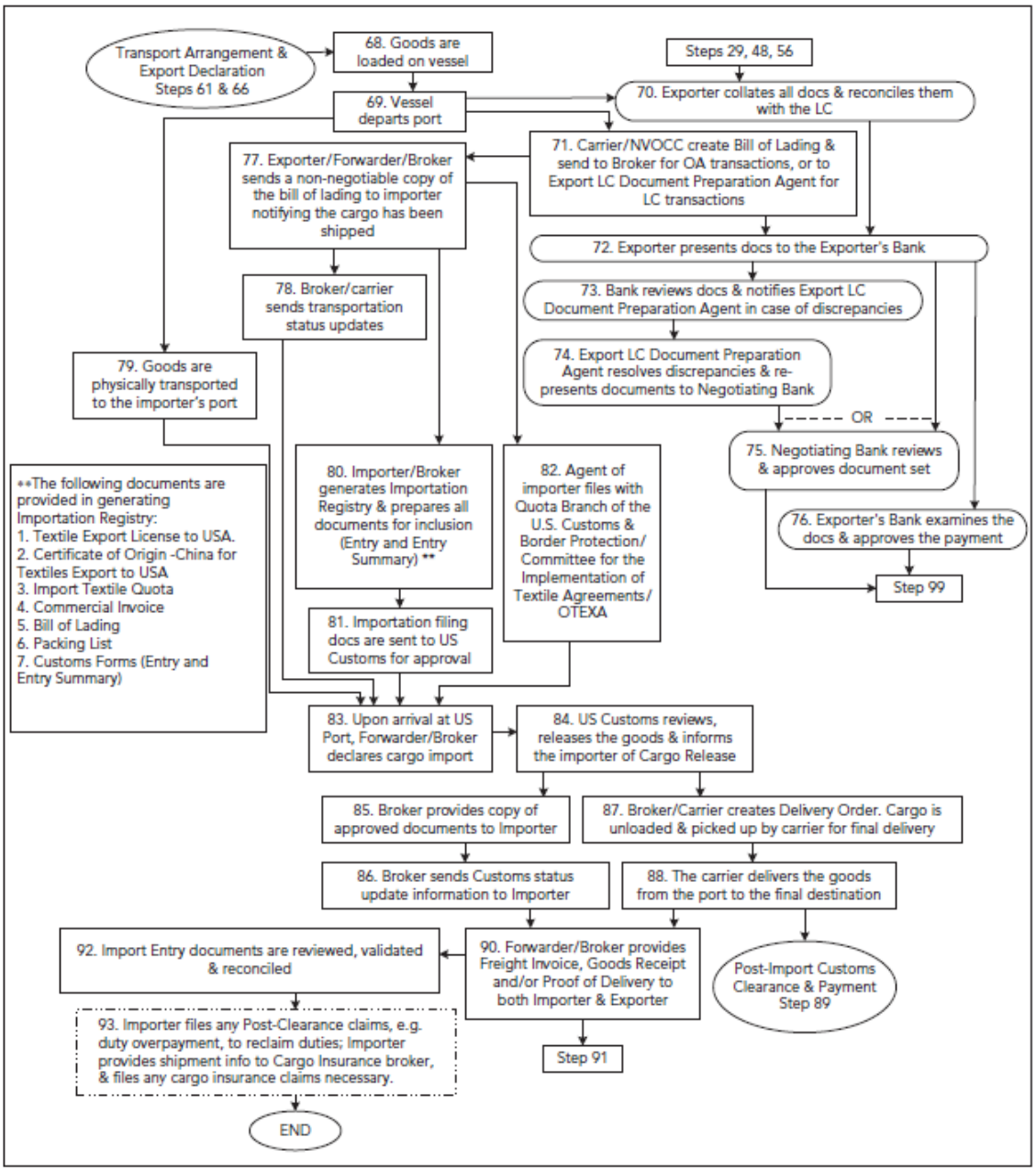
(1) Pre-Export



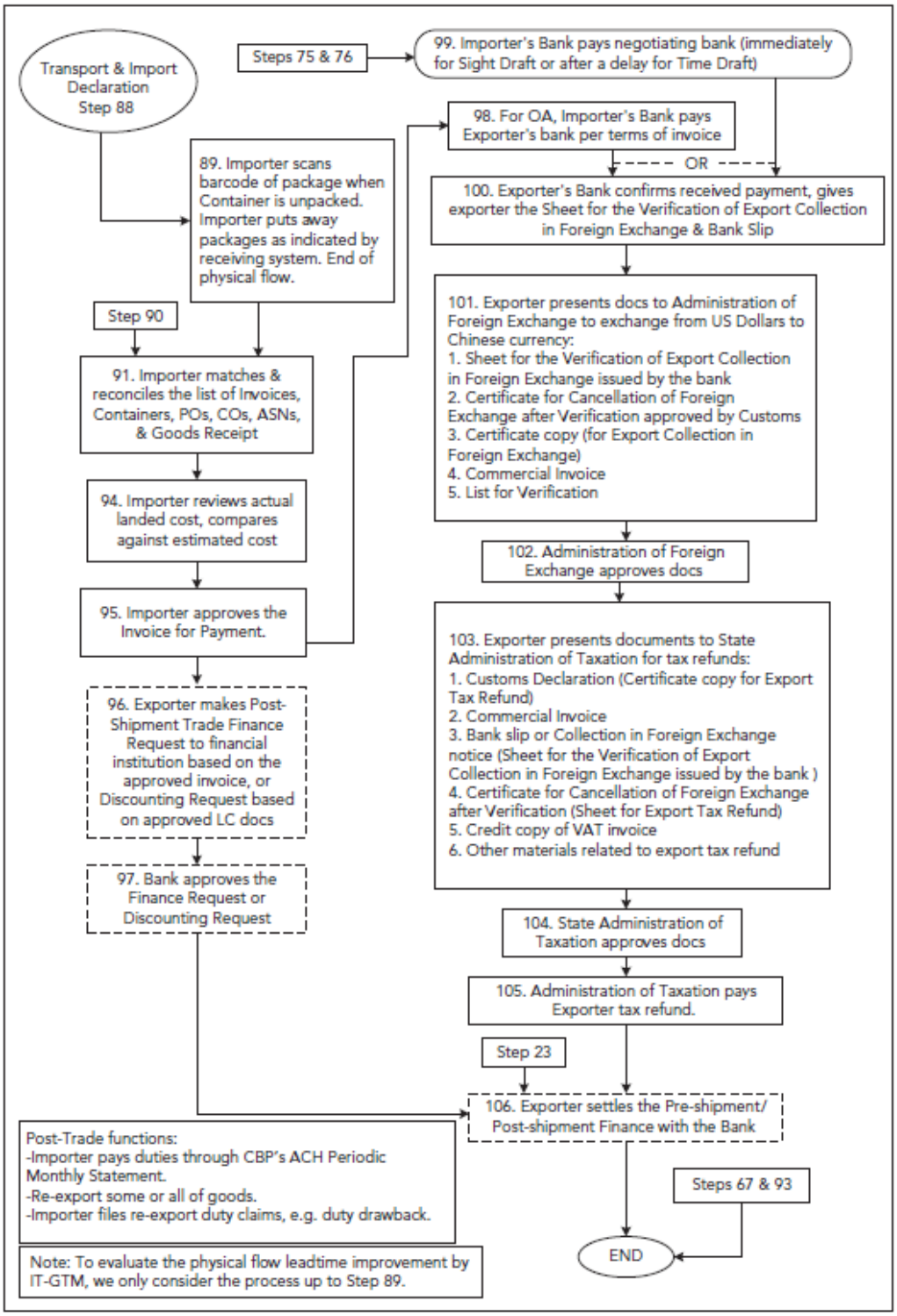
(2) Transport Arrangement & Export Declaration



(3) Transport and Import Declaration



(4) Post-Import Customs Clearance and Payment



Appendix B: Risk driver identification

In this appendix the different risk drivers that are identified in the trade process are more extensively discussed. First in section B.1. we discuss some final considerations we made before the identification and allocation process. in section B.2. we give a description of each individual risk driver. Lastly, in section B.3. we discuss more extensively which risk drivers are relevant for each individual supply chain phase.

B.1. Risk drivers: final considerations

In both studies disruptions are mentioned as risk source for the supply chain. Manuj and Mentzer (2008) described disruptions as events such as fires, sabotage, and bankruptcy of the supplier. Chopra and Sodhi (2004) have some additional drivers of disruptions: natural disasters, labor strikes, war, and terrorism. There can be argued that these disruptions are directly related to the geographical location they occur in. For example, the probability that the supply chain is jeopardized because of a war is much lower in the Netherlands than in Sudan. ING is already addressing the riskiness of countries. For all countries in the world ING has determined a so called 'Country risk'. Therefore, we introduce the 'geographical location' risk driver to stay close to the current capabilities of ING. This risk driver included risk sources such as: natural disasters, labor strikes, war, terrorism, crime, policy, wage rates, and exchange rates. Note that the 'Country risk' measure of ING is mainly focused on the stability of a specific country, so our 'geographical location' risk driver is not the exactly the same as the 'Country risk' driver of ING.

Furthermore, both articles describe bankruptcy of suppliers as a risk driver, but at the same time identify operational risk drivers of the supplier that which can lead to bankruptcy of suppliers. However, from a single transaction point of view this makes sense. If the transaction goes wrong due to operational risk drivers, the risk of bankruptcy does not play a role. The bankruptcy of the supplier will be a result of not fulfilling the transaction. On the other hand, it is possible that during operations of the trade process in question the supplier goes bankrupt. This is not necessarily caused by that specific transaction. Therefore, the risk of bankruptcy and operational risk of the supplier can be considered two independent risk drivers.

B.2. Risk driver description

Geographical location

The geographical location risk driver represents all hazardous events that originate from the geographical location the trade process is in. This includes disruptions such as: natural disasters, labor strikes, war, terrorism, crime, policy, wage rates, and exchange rates.

Availability of raw materials

This risk driver represents the risk of raw materials not being available harming the trade process. If the supplier requires a raw material which is not available, it limits its ability to fulfill the PO of the buyer. Therefore, the availability of raw materials can jeopardize the trade process.

Quality of raw materials

The quality of raw materials risk driver indicates the risk of low-quality raw materials jeopardizing the trade process. For many supply chains ordering and receiving raw materials takes significant time, therefore if the quality of raw materials does not meet required standards, the downstream supply chain can be severely harmed.

Price of raw materials

This risk driver considers the risk of price fluctuations harming the trade process. Several raw materials are exposed to significant price changes. Price escalations can result in the trade process not being profitable anymore. Therefore, there is no incentive for supply chain members to participate in the trade process. Agriculture products are an example of commodities that experience significant fluctuations of price.

Supplier bankruptcy

The supplier bankruptcy risk driver comprises the risk of the supplier going bankrupt during the trade process. If the supplier goes bankrupt, he is not able anymore to complete the trade process. This results in the buyer not receiving the goods he ordered. Moreover, if the supplier received a loan prior to its bankruptcy, banks also experience losses.

Breakdowns of operations

This risk driver represents the risk of machines, tools, and/or resources required for production experiencing a breakdown. If the machines of the supplier have major breakdowns, the supplier is unable to produce any goods for the buyer. Therefore, the trade process can be harmed as consequence of these breakdowns.

Operating performance

This risk driver represents the ability of the supplier to produce the requested goods. Not every supplier is equally capable for producing the requested goods. Therefore, the operating performance risk driver captures the performance of each individual supplier.

Process variations

This risk driver represents the risk of the trade process being jeopardized due to variations between processes. In a factory or manufacturing plant that produces a huge number of different products a lot of processes have to be alternated. Sub-optimal switching between processes and choosing wrong processes can significantly harm the production process. Meanwhile, in a factory that only focusses on producing one type of product significant less alternations are required. Therefore, the probability that a harmful event occurs due to process variations is significantly lower.

Operating capacity

The operating capacity risk driver represents the available amount of resources the supplier has available for performing the operations required to fulfil the PO. If the supplier has not enough resources available to perform the required operations the goods cannot be produced on time. Therefore, the trade process becomes jeopardized.

Moral hazard

The moral hazard risk driver represents the risk of the supplier not performing the operations the buyer requested. Accepting the PO does not necessarily mean that the supplier will indeed produce the required goods.

Goal conflict

This risk driver represents the risk that the goals of the buyer and supplier intervening harms the trade process. In the FSCM context the most notable goal conflict is about payment terms. The supplier wants to be paid as soon as possible to optimize its working capital. Whereas, the buyer wants to delay payment as long as possible, so his working capital position is optimized.

Technological uncertainty

This risk driver represents the probability that the goods requested in the PO can indeed be produced. This risk driver is especially relevant for new products or R&D projects.

Product complexity

The product complexity represents the risk of the complexity of the product causing production failures. Subsequently, this results in the buyer not receiving his requested goods. Products that are very complex to produce are riskier than simple products, because the probability the production process is successful is lower.

Frequency of design changes

This risk driver represents risks occurring due to changes in the design of the requested products. Design changes require the supplier to alter its production processes, which makes the process riskier. Meanwhile, for products that are always the same, the supplier can use the same production process every time the products are requested.

Transportation mode

This risk driver represents the risk of the trade process being jeopardized due to transportation. In the global trade domain several transportation modes can be distinguished. Each transportation

mode has its own benefits and risk factors. This risk driver takes these risk drivers into account. Some examples of transportation modes are: plane, ship, truck, pipeline, and train.

Logistic service provider bankruptcy

This risk driver represents the risk of the LSP going bankrupt during the trade process. If the LSP goes bankrupt while he is transporting the goods, the buyer and supplier might not be able to claim the goods as their own or it will cause significant delays.

Handling goods

This risk driver represents the risk of the goods being harmed due to port handling. For example, goods might be misplaced or damaged while they are moved. Therefore, this risk driver represents the probability of port handling jeopardizing he trade process.

Default risk based on creditworthiness

The default risk represents the risk of the buyer fulfilling its payment obligations. Note that in the pre-shipment FSCM solutions we discussed the buyer is required to make payment to the bank to compensate the bank for the loan it provides to the supplier. Therefore, from the bank's perspective the loan becomes at risk if the buyer defaults. Meanwhile, if no FSCM is used, the supplier does not receive payment for the goods he produced.

B.3. Risk drivers per supply chain phase

Inbound supply line

Based on supply chain risk management literature, several risk drivers for the inbound supply line phase can be identified. FSCM solutions in literature are focused on a buyer and its first-tier supplier (de Boer et al., 2015), so the operations of more upstream members of the supply chain are out of the scope of this master thesis. However, the quality, availability and price of raw materials of the first-tier supplier receives from its upstream supply chain partners must be considered, because these directly influence the end product. By considering the risk sources of the article of Manuj & Mentzer (2008) and Chopra & Sodhi (2004) the following risk drivers of "inbound supply line" can be identified:

- Geographical location
- Availability of raw materials
- Quality of raw materials
- Price of raw materials

Note that the article of Chopra and Sodhi (2004) argues that risks regarding the inbound supply line can be mitigated by using multiple supply sources and/or holding inventory. However, this can result in the loss of economies of scale and holding inventory is perceived as risky.

Supplier operations

In the supply operations risks are considered that can jeopardize the ability of the supplier to meet operational requirements for fulfilling the purchase order (PO). Manuj and Mentzer (2008) distinguish three categories of supplier risk: supplier reliability, risks regarding the sourcing strategy, and risk regarding the goods. In their article they extensively explicate risks associated to the operations of the focal firm, but the operational ability of the supplier is only addressed to by the risk driver adverse selection (i.e. the misinterpretation of the ability of the supplier). However, for this risk model there is chosen to model the risk regarding the operational ability of the supplier more extensively. In order to do so, the operational risks Manuj and Mentzer (2008) allocate to the operations of the buyer will also be considered to describe the risk drivers of the supplier's operational abilities. Furthermore, the risk drivers of the article of Chopra and Sodhi (2004) and the risk drivers regarding the goods of the article of Manuj and Mentzer (2008) are considered. Note that the sourcing strategy is not a risk of the supplier's operations, but a risk of the overall supplier base of the focal firm. Therefore, risks associated to the sourcing strategy are not considered, because the scope of the model is on a single buyer and supplier relationship and not on the whole supplier portfolio of the buyer. This results in the following risk drivers for the "supplier operations" phase:

- Supplier bankruptcy
- Geographical location
- Breakdowns of operations
- Operating performance
- Process variations
- Operating capacity
- Moral hazard
- Goal conflict
- Technological uncertainty
- Product complexity
- Frequency of design changes

Inland transportation

In the trade finance process inland transportation occurs two times: transporting the goods from the supplier to the port of shipment and transporting goods from the port of destination to the buyer (Hausman et al., 2010). During transportation no additional processing steps for the goods occur, because transportation is only focused on moving the goods from one location to the other. Thus, as the papers of Manuj & Mentzer (2008) and Chopra & Sodhi (2004) suggest, inland transportation risks are associated with the security of the goods during the transportation process. However, according to interviews with supply chain experts, the party that is responsible for transporting the goods must also be considered. During the period of transportation this party physically owns the goods, so if this party defaults goods might get lost for example. This result in the following risk drivers of "inland transportation":

- Geographical location
- Transportation mode
- Logistic service provider bankruptcy

Import/Export customs

During import/export customs there is checked whether all procedures and formalities are in accordance to the country's regulations (Hausman et al., 2010). Thus, during the import/export customs phase no processing steps occur. Because customs is related to the regulations of the country it is operating in, risks can be translated to the geographical location. For example, currently the European Union has put trade sanctions on Russia (Policy Department, 2017). Concluding, the main risk associated to the import/export customs phase is the change of regulations, which dismantle the trade process. This results in the following risk drivers of "import/export customs":

- Geographical location

Port handling

During this phase the goods are moved from the port of shipment unto the ship or in the case of unloading, moved from the ship unto the shore of the port of destination. Thus, the port handling phase occurs two times in the trade process: at the port of exports and port of imports. Chlomoudis et al. (2012) extensively discusses the several risks that could occur at a port. Five risk categories can be distinguished: human, machinery, environment, security, and natural. As mentioned before, environmental, security, and natural disruptions are related to the geographical location the entity is situated, so these categories of Chlomoudis et al. (2012) will be covered by the earlier introduced "geographical location risk". The human and machinery categories are related to the handling of the goods from a supply chain perspective, so this will be described as "handling goods". This results in the following risk drivers of "port handling":

- Geographical location
- Handling goods

Shipment of goods

This phase represents the transportation from the port of shipment to the port of destination. Similar as for the inland transportation, the main risks are associated with the security of goods during transportation (deduced from Manuj & Mentzer, 2008). Therefore, the risk drivers of "shipment of goods" are:

- Geographical location
- Transportation mode
- Logistic service provider bankruptcy

Note that the risks regarding the geographical location are associated with the route of transportation. For example, at the coast of Somalia a lot of pirates are active, so if a ship has to navigate through these waterways the geographical location risk is higher.

Buyer operations

For the risk model a transaction-based perspective is used, so the physical flow of goods is completed when the buyer (focal firm) has received the goods. However, to fully complete the transaction the buyer has to provide payment for the transaction. Thus, as mentioned before, the default risk of the buyer must be considered. Note that because the transaction ends after the goods are received by the buyer and payments are fulfilled, the downstream supply chain is not part of this model. However, the downstream supply chain can be considered by determining the creditworthiness of the buyer. ING performs a creditworthiness check for all its customers, so this information is already available. Concluding, the risk driver of "Focal firm operations" is:

- Default risk based on creditworthiness