Game Analysis of Risk Factors under Export Credit Insurance Finance

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Abstract

As a non-benefit political-oriented business, export credit insurance is usually operated by government to promote exportation, and thus it represents a guarantee of payment receivable. Export credit insurance not only offers a good way to disperse and release risk caused by uncertainty of foreign countries and importers' credit, but also inspires a good way of finance for export companies.

Export corporations can apply loan in bank easily with the guarantee of export credit insurance. Characterized with lower threshold, export credit insurance finance became a good finance choice especially for small and medium companies and brought considerable intermediate businesses to commercial banks.

Despite the benefits of export credit insurance finance, false trade appears frequently due to the intricate risks that are hard to measure by quantitative method. The risks covered by export credit insurance include credit risk and political risk. Credit risks can be classified by two reasons: importer bankruptcy and importer moral hazard. The risk of solvency can be measured by modern credit risk models, however, the possibility that importer breach a contract due to dishonesty is hard to discern because of the information asymmetry and high cost of research. In export credit insurance finance, the risk is even harder to measure as risks form both importer and exporter are involved.

Game theory is widely used in adverse selection and moral hazard. The application of game theory inspired a microeconomic way of risk analysis in export credit insurance finance. The case of export credit insurance finance can be a seen as a game among the export enterprise, insurer and bank. This paper will figure out the utility of each party under certain default situation and analyze each risk factor. We adopt joint game approach and tree model to obtain the equilibrium result. The purpose is to maximize the expected utility of each party and minimize the possibility of exporter and importer's moral hazard as they are the core reason that cause loss in commercial bank and export credit insurance agency.

Since the export credit insurance industry and risk research is still in the early stage in China, we hope this study can inspire a new way of risk analysis in export credit insurance finance.

Key words： Game Analysis, Export Credit Insurance Finance

1. Background and Purpose

The development of international trade has accelerated the economic growth while at the mean time has also increased the risk faced by companies involved. Export credit insurance offers a good way to disperse and release these risks. Export credit insurance covers the importer's credit risk and import country's political risk. The main purpose of export credit insurance is to facilitate international trade, protect exporter's accounts receivable from loss due to credit risks such as protracted default, insolvency or bankruptcy, as well as the political risks such as international trade restriction. In China, export credit insurance is a non-benefit policy-oriented insurance operated by SINOSURE. It plays an increasingly important role in international trade. By 2016, the scale of international trade supported by export credit insurance exceeds 2.8 trillion dollars, 90 thousand enterprises.

Export credit insurance is usually operated by government as a non-benefit political-oriented business, and thus it represents a guarantee of payment receivable, which inspires a good way of international trade finance. The Export Credit Insurance Financing ("ECIF") is a short-term trade financing provided by commercial bank to the exporter by which exporters transfer the insurance beneficiary ownership to bank after they have arranged the export credit insurance for the goods or services. When importer default happens, commercial banks can claim compensation from export credit insurance agency directly.

ECIF can be classified as ECIF bill purchase and ECIF receivables purchase. ECIF bill purchase means that exporters transfer the beneficiary ownership of the insurance to bank; ECIF receivables purchase means that exporters transfer both beneficiary ownership of the insurance and receivables under export contract to bank, bank will advance a certain percentage of the invoice directly to the exporter. This study will be based on ECIF bill purchase case.

Export Credit Insurance Finance can help businesses access the liquidity needed to fulfill orders and pay for day-to-day operations. ECIF turn the same collateral into a greater borrowing base. Characterized with lower threshold, ECIF became a good finance choice especially for small and medium-sized enterprises and brought considerable intermediate businesses to commercial banks.

Despite the multiple benefits of ECIF, false trade appears frequently due to the intricate risks which are hard to be measured quantitatively. The risks covered by export credit insurance include credit risk and political risk. Credit risks can be classified by two reasons: importer bankruptcy and importer moral hazard. Importer's financial status and risk of insolvency can be measured by modern credit risk models. However, the possibility that importer breaches a contract due to credit problem is hard to discern because of the information asymmetry and high cost of investigation.

In export credit insurance, the risk of importer's contract breach has been transferred to export credit insurance agency. The risk of ECIF faced by commercial bank mainly derives from exporter's credit. Since three parties involved, the risk is even harder to measure.

Game theory is widely used in adverse selection and moral hazard. Given the information asymmetry situation, the application of game theory inspired a microeconomic way of risk analysis in export credit insurance finance. The case of ECIF can be a seen as a game among the export enterprise, insurer and bank. Based on the game theory, the source and influence of each risk is clearer to explain and easier to evaluate.

Based on the background above, this study tries to figure out the risk allocation of ECIF thus maximize the utility of three parties and minimize the possibility of moral hazard. We hope this study could contribute to ECIF risk measurement and risk management approaches for commercial bank.

2. Literature Review

2.1 Export Credit Insurance Finance

SY He (2012) [7]gave a comprehensive study of multiple risks faced by export credit insurance agency, and illustrated the approaches to measure the commercial credit risk and country risk from SINOSURE's point of view. Based on the research of 300 representative SMEs in Tianjin province, TT Wang (2008)[8] attributed the imbalance of supply and demand to the high cost of ECIF and multiple risks of small and medium-sized enterprises. M Liu (2015)[9] summarized the different business patterns of ECIF and illustrated the potential modes of false trade, its features and prevention strategies based on the case study.

2.2 Application of Game Theory in Credit Risk Analysis

GJ Wang and DB Wang (2016)[10] initiatively used game theory to analysis the factors influence the development of ECIF industry. GJ Wang and DB Wang (2016) assumed that in ECIF, enterprise could be honest and dishonest; export credit insurance agency could perform or breach the agreement; commercial bank could control the debt effectively and ineffectively (determined by the cost of control). QH Ma (2014)[13] built two-party (commercial bank and enterprise) and three-party (commercial bank, enterprise and government) game models to analyze the credit debt behavior of commercial bank. According to the conclusion, when government supervises positively, commercial bank should increase the benefit and decrease the cost of government supervision; when government supervises negatively, commercial bank should center on the game with enterprise. GL Chen and R Fan (2006)[15] classified the credit debt into short-term and long-term debt, and separate the competition

behavior of commercial bank into price competition and non-price competition. Finite game and infinite game is used to solve the short-term and long-term credit debt respectively.

2.3 Commercial Credit Risk Measurement Models

Researches on risk measurement models and their applications such as Z-score model (1968 by Edward Altman), Riskcale model, KMV model (1997 by KMV) are reviewed.

Y Xia (2013)[16] in <Research on the Measurement of the Overall Risk of the Export Risk Insurance> compared these models according to their data source, feasibility, and efficiency, and made conclusion that for listed company, when $2.675<Z_1<3.0$ (company is relatively safe), we use Riskcale model and then KMV model to enhance the precision of the measurement; otherwise, when $Z_1<1.8$ (company is going to bankrupt), $Z_1>3.0$ (company is safe from bankrupt) and $1.8<Z_1<2.675$ (company is likely to bankrupt), we only need to recalculate by Riskcale model. L Zhang, WH Zeng (2004)[17], and XJ Yu (2015)[18] did the empirical research of Chinese listed companies risk rating by Z score model and KMV model respectively.

2.4 Political Risk Measurement Approaches

Institute of World Economics and Politics (2013)[21] inspired us with the five indicators of the country-risk rating of overseas investment from China: economic fundamentals, debt paying ability, social flexibility, political risk, and relation with China. YC Jin (2011)[23] presented and compared methods of authoritative rating agencies to evaluate the country risks.

Based on researches above, it can be found that the risk analysis of export credit insurance and ECIF is mainly based on statistic models, which may not be consistent with the reality. Although game theory is widely used in credit debt in commercial bank, the application in ECIF is still not well developed. Game analysis is comprehensive and applicative in ECIF case, it is important to adopt game theory in ECIF risk analysis.

3. Business Process of Export Credit Insurance Finance

Based on the contract between exporter and importer, exporter applies export credit insurance in export credit insurance agency to protect against importer's non-payment. After credit investigation of the importer's commercial credit risk and import country's political risk, export credit insurance agency will arrange the insurance. Exporter then provides the required documents to commercial bank, ask for finance support, and meanwhile exporter applies a credit limit in export credit insurance agency. Under ECIF bill purchase pattern, the credit limit amount should be equal to a

certain percentage of the invoice value. After the credit limit is granted, the three parties will sign a beneficiary ownership transfer agreement, which means commercial bank becomes the beneficiary of the export credit insurance. Bank will provide finance service to exporter, and exporter should repay the financing funds after receive the payment from importer. If importer defaults, bank could claim compensation from export credit insurance agency directly.

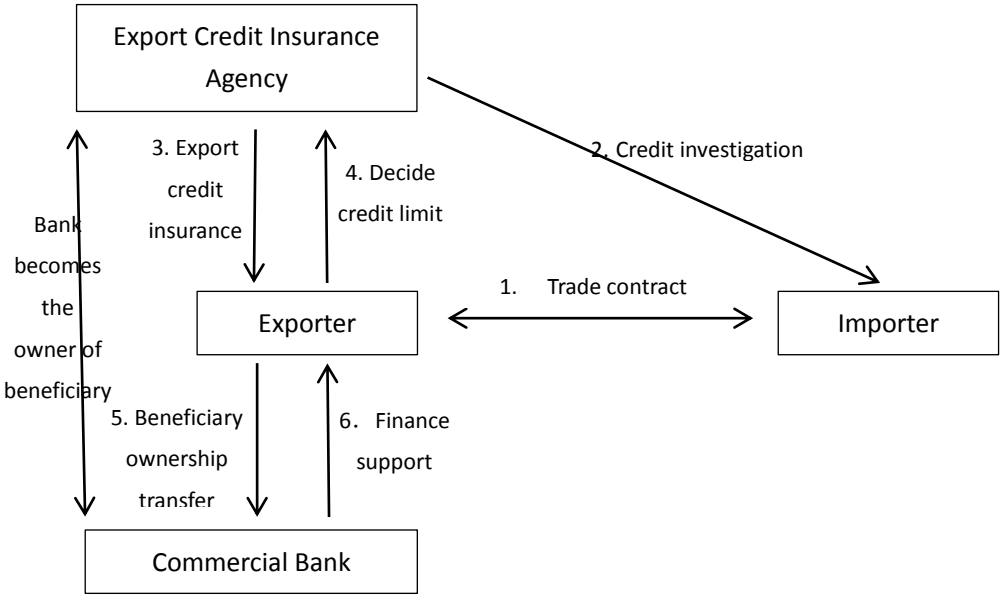

Fig. 2.1 Business Process of ECIF (ECIF bill purchase)

4. Risk Allocation Path of ECIF

4.1 Export Credit Insurance Exempt Clause

4.1.1. The loss caused by the exporter's behavior

For example exporter fails to deliver the goods as required by the agreement with importer. Under this condition, insurance agency can refuse compensating and commercial bank has to take the loss.

4.1.2. The loss caused by third party

Since international trade is overseas, shipment risk and deliver risk can't be ignored. More and more international traders apply international cargo insurance to cover the risk of shipment and deliver. Since it is an example of external risk, we don't consider this condition but only focus on the internal risk.

4.1.3. Collusion

Since the market is imperfect and not well developed, there are many examples that exporter and importer cooperate to fake a trade, and they get bank advancement or insurance compensation.

4.1.4. Exporter changes the account of receivables

The biggest characteristic of ECIF is its self-liquidating nature, that is, the first source of repayment is receivables. But commercial bank cannot effectively control the remittance path. Exporter can negotiate with importers to change the account of receivables, remit the payment to the other bank. Once the initial account is changed, importer transfer the payment to another bank, the insurance responsibility is terminated and commercial bank who offers the finance service to exporter is faced with bad debt loss.

4.2 Risk Allocation of ECIF

Export credit insurance covers import country's political risk and importer's commercial risk. Commercial risks covered by export credit insurance include customer insolvencies and bankruptcy, cash flow problems, failure or refusal to take delivery of goods.

Export credit insurance doesn't cover the loss caused by dispute between importer and exporter; third party liability; exporter's fault and non-credit risk (for example fire risk). Since the third party liability and non-credit risk can be covered by other insurance, in this study, we only consider the controllable risk, exporter's default risk. In ECIF case, debt collateralized by export credit insurance transfers the risk of exporter default to commercial bank.

According to the risk transfer path in the process of export credit insurance finance, we can see the risks allocation in each party are as following:

Table4.1 Risk Allocation of ECIF

Exporter	**Export Credit Insurance Agency**	**Commercial Bank**
Risk uncovered by export credit insurance	1. Political risk of import country and Credit risk caused by importer's insolvency or cash flow problem(α_2)	1. Exporter financial risk and operational risk(β_2) 2. Exporter moral hazard (β_1) 3. Importer moral hazard(α_1), e.g collusion with exporter

We assume that the possibility of exporter moral hazard, β_1, and the possibility of exporter default because of its own financial risk or operational risk, β_2, are linearly related and mutually exclusive. That is to say, if exporter defaults, the default reason must belongs to either moral hazard or financial risk and operational risk. And the possibility of exporter non-default is simply $1 - \beta_1 - \beta_2$.

For importer, we assume that possibility of importer moral hazard, α_1, and the possibility of importer default because of its own credit risk or political risk, α_2, are linearly related and mutually exclusive. That is to say, if exporter defaults, the default

reason must belongs to either moral hazard or risk covered by export credit insurance. And the possibility of importer non-default is simply $1 - \alpha_1 - \alpha_2$.

5. Game Process

Since our analysis is about ECIF, we only care about exporters who have applied export credit insurance. Based on export credit insurance that protects against importer's non-payment, exporter applies finance support in commercial bank. Commercial bank can decide whether to lend or not lend to exporter. If bank lend to exporter, the case is a ECIF model. When bank refuses to advance cash to exporter, the condition will be a pure export credit insurance case. As bank want to expand their business coverage and range, as well as earn a premium provided by government as a reward for supporting exportation, they will choose to lend to exporter if its credit record is qualified.

We first analyze the ECIF case. The beneficiary ownership of export credit insurance has been transferred to commercial bank and exporter gets the money advanced by bank. Exporter, firstly choose whether to perform the contract with importer, or to default. For exporter, we classify the default reasons as operational risk and moral hazard. Operational risk can be measured by modern risk measurement models, but moral hazard is hard to determine. Same as importer, we classify the default reasons as moral hazard and risk covered by export credit insurance (credit risk and political risk). If both exporter and importer default, we consider it is a fraud trade with purpose to get bank loan and escape interest expense. And fraud trade happens only when both importer and exporter default because of moral hazard. Under this condition, if export credit insurance agency is efficient, it is able to figure out the truth and avoid paying compensation to bank. Exporter's behavior will thus be punished. Otherwise, export credit insurance agency has to pay compensation to bank. When exporter defaults at first and was not able to perform the contract, we consider it as operational risk, and importer is irresponsible. Bank has to take the loss of bad debt and exporter will be punished.

If exporter delivers goods as required in the contract with importer, we consider two conditions: importer defaults or not default. If importer defaults, export credit insurance agency will pay the compensation directly to bank. If importer doesn't default and pays exporter receivable on due, exporter still has choices of whether to repay commercial bank or not. Since neither importer nor exporter default, the insurance agreement ends, export credit insurance agency doesn't take responsibilities any more. Bank is exposed to exporter's moral hazard, and has to take the bad debt loss if exporter doesn't repay the principle and interest on due. Exporter is to be punished.

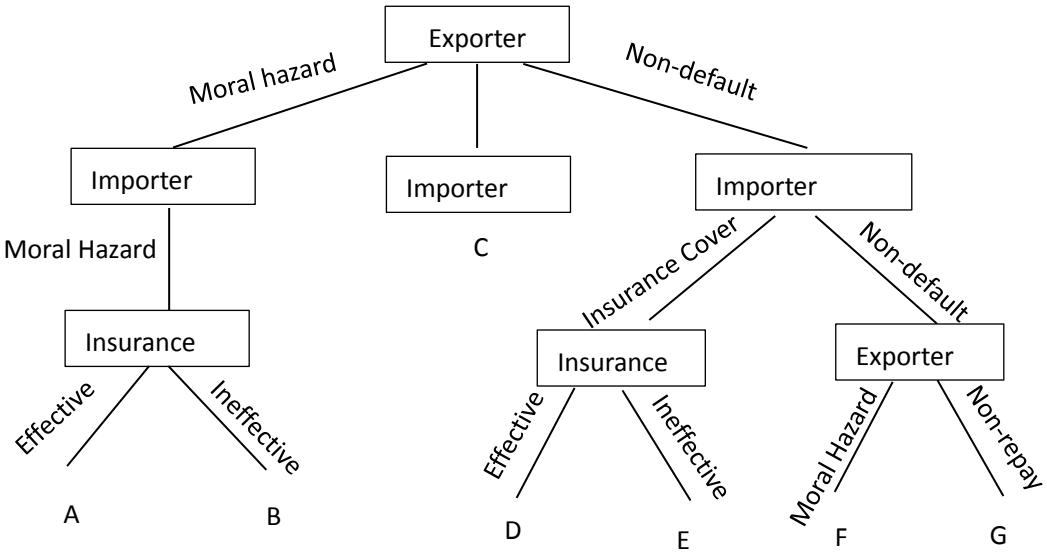

Figure 5.1 ECIF Game Tree

If bank refused to lend to exporter at first, the conditions will be as following. Exporter first chooses whether to perform the contract or not. If both exporter and importer default, we consider it is a fraud trade with purpose to get insurance compensation. And fraud trade happens only when both importer and exporter default because of moral hazard. Export credit insurance agency's effectiveness determines if it is able to figure out the real default reason. If export credit insurance agency is effective, it will find out the fraud trade and refuse the compensation claim, exporter will be punished. Otherwise, export credit insurance has to pay the compensation. If exporter is to blame as it is incapable of fulfilling the contract. Export credit insurance ends since it only covers the importer's credit risk and import country's political risk. If exporter doesn't default and fulfills the contract, importer then defaults and doesn't pay exporter, export credit insurance agency is supposed to pay the compensation. If importer doesn't default, the whole trade contract ends.

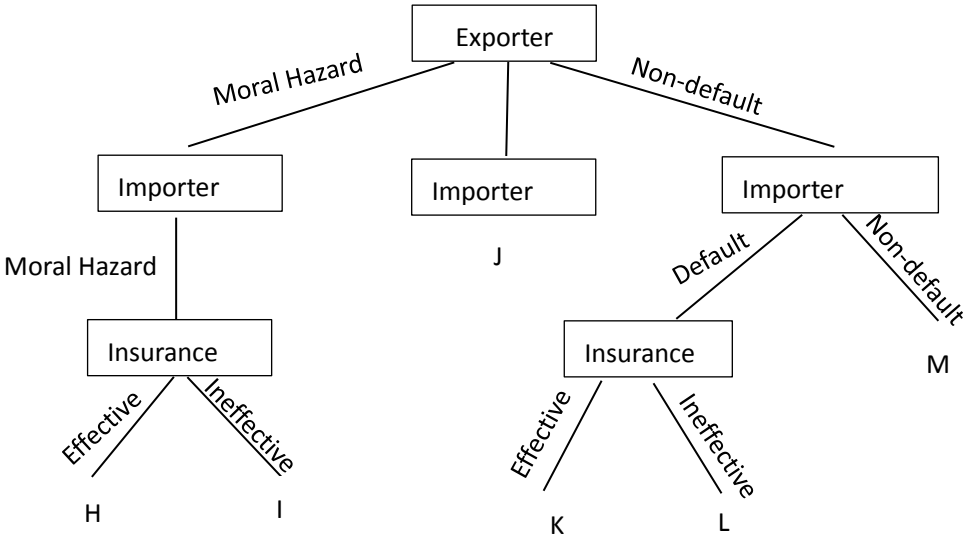

Figure 5.2 ECI Game Tree

6. Game Model Assumption

6.1 Mixed Strategy Game Model

We assume that the game is among the export credit insurance agency, exporter and commercial bank. The three parties are all rational economy person who pursue their utilities maximization. We don't consider the importer's utility maximization problem since importer is not included in the ECIF activity. But the importer's behavior is highly related to the utility of the three parties, so we will discuss the results under different circumstances.

The three parties is in a Mixed Game, which means that each of them decide their choices randomly at a given probability. When decide their choice, each party have to consider not only their utility and purpose, but also the effect on other parties' choices. Based on mixed game model, we will acquire the mixed strategy Nash equilibrium. The solution of the mixed strategy is an optimized combination of possibilities which maximize the expected utilities of ach party.

6.2 Variables Definition

6.2.1 Variables of Commercial Bank

p is the possibility for commercial bank to lend to exporter, in another words, is the possibility that ECIF stands. 1-p is the possibility for commercial bank to refuse the finance application of exporter, in that case.

Since export credit insurance is a policy-oriented insurance to support exportation, we consider an invisible value m for bank as a premium if it advanced money to exporter, otherwise its utility will be zero.

eX is the principal of the ECIF, e is the ratio in which the bank gives credit to exporter with respect to the export credit insurance; the amount of the beneficiary ownership of export credit insurance transferred to commercial bank is also eX, exporter keeps the beneficiary ownership of the rest of the contract amount, (1-e)X. r is interest rate, thus the interest income of bank is reX

6.2.2 Variables of Exporter

During the trading, exporter can choose whether to default or fulfill the agreement. We classify the default reason into unwilling and unable to fulfill its duty. We assume β_1 is the possibility of exporter moral hazard, which means that exporter is unwilling to fulfill its duty. And β_2 is the possibility that exporter defaults because of operational risk or finance risk, which means that exporter is unable to fulfill its duty. $1 - \beta_1 - \beta_2$ is the possibility that exporter fulfills its duty stated in the contract with exporter.

After the trading is completed, exporter can choose whether to repay bank loan on time or default. We assume that the possibility of default equals to β_1 as default is still caused by its moral hazard, such as embezzle fund to other projects. Since importer has paid their payables to exporter, we can eliminate the possibility of exporter operational risk and finance risk. The possibility that bank receive their principal and interest income is $1-\beta_1$.

δ is the cost ratio of exporter, the cost of goods to sale is δX, thus exporter's gross profit is$(1-\delta)X$. We don't consider the tax or other fiction expense. φ is the loss of the company due to short of cash. n is the loss of exporter if it is found out default.

6.2.3 Variables of Export Credit Insurance Agency

c is possibility that risk control system of export credit insurance agency is effective, thus (1-c) is the possibility of ineffective. We define that effectiveness means export credit insurance agency is able to find out the default reason behind compensation claim on time. Ineffectiveness means that export credit insurance is incapable of finding out the default reason and has to pay compensation.

t is cost of being effective, for instance the research and development cost since effective risk control requires a strong database of credit records both domestically and abroad. t could include the technology development, human resource, operational cost, etc.

In a contract with amount of X, export credit insurance will charge at a ratio of ε. εX is insurance fee.

6.2.4 Variables of Importer

The utility of importer is not considered in our game model, but the possibilities of its choices are highly related to the equilibrium. We consider three conditions for importer: moral hazard, default because of the risks covered by export credit insurance, and non-default. If importer defaults because of moral hazard, for example, importer and exporter fake a trade to get bank advancement or insurance compensation, the effectiveness of export credit insurance's risk management is the determinant of their success. We define α_1 as the possibility that importer chooses to collusion. If importer defaults because of credit risk or political risk, exporter credit insurance will cover the loss of bank or exporter. We define this possibility as α_2. Otherwise, the possibility that importer doesn't default is $1-\alpha_1-\alpha_2$. We take α_2 as measurable by modern risk measurement models, but α_1 is hard to measure.

6.3 Utilities of Different Conditions

6.3.1 Case A

Bank advances cash to exporter and become the beneficiary owner of export credit

insurance. Exporter and importer cooperate to fake a trade with the purpose to get bank credit advancement. To simplify the game, we assume that the expense of the fraud is zero.

When importer defaults and counterparty claims compensation, export credit insurance agency is either effective or ineffective. Effective export credit insurance agency is able to figure out the real default reason and pay compensation on time, no liquidity loss will be adjusted to insurance beneficiary owner. Ineffective export credit insurance agency would not be able to figure out the default reason and has to pay compensation claimed.

In case 1, export credit insurance agency is effective and able to figure out the fraud trade. If exporter doesn't repay the advancement on due, bank will claim compensation to export credit insurance agency. Export Credit Insurance agency will refuse to pay the compensation, bank has to take the bad debt loss itself. Bank will earn the invisible premium m but lose its principal and interest income, (1+r)eX. We assume that importer and exporter will separate the earning evenly, each of them will get half of the net earnings. Since the exporter will be punished, we assume it will suffer a loss of n. Both exporter and importer's utility is

$$1/_2\,(eX - \varepsilon X - n)$$

Export credit Insurance agency, who paid the cost t of being effective and earn the insurance fee εX, will have a utility of $-\mathrm{t} + \varepsilon\mathrm{X}$.

Table6.1 Utilities of each party under case 1

	Bank	**Exporter**	**Insurance Agency**	**Importer**
Possibility	p	β_1	c	α_1
Utility	m-(1+r)eX	$1/_2\,(eX - \varepsilon X - n)$	$-\mathrm{t} + \varepsilon\mathrm{X}$	

6.3.2 Case B

Same as above mentioned condition, the only different part is that export credit insurance agency is ineffective, and will not be able to figure out the fictitious trading. When commercial bank claims compensation, insurance agency has to pay directly to bank. We assume that once importer default due to the risk covered by export credit insurance, export credit insurance agency will pay the compensation of the whole contract amount, X. Exporter will pay the interest to bank to cover its fraud and will not be punished since export credit insurance agency is not able to find out the fraud. Although doesn't need to pay for the risk management cost, export credit insurance agency will lose the compensation amount X. Its utility is $-(1-\varepsilon)\mathrm{X}$.

Table6.2 Utilities of each party under case 2

	Bank	**Exporter**	**Insurance**	**Importer**

			Agency	
Possibility	p	β_1	1-c	α_1
Utility	m+reX	$1/2\,(1-re-\varepsilon)X$	$-(1-\varepsilon)$X	

6.3.3 Case C

In case C, we analyze the condition that exporter default due to its operational risk and finance risk, that is, even with the advancement from commercial bank, exporter still incapable of fulfill the contract, or exporter embezzle the advancement for other use and short of cash. Export credit insurance doesn't cover the risk of exporter behavior. Bank has to take the loss of both principal and interest. Exporter, who has paid the insurance fee and get the bank advancement eX, will have a utility of $(\mathrm{e}-\varepsilon)$X. Insurance agency will earn the insurance fee. We don't consider the importer's utility.

Under this condition, no matter export credit insurance agency is efficient or not, exporter's default is punished since it has caused the bad debt loss to bank. Export credit insurance is not involved in the game and exporter will have to suffer a punishment of n although it has already get the credit of eX from bank. Since it is exporter who needs to perform the contract first, and importer will decide its behavior after it has received the goods or services, importer will not proceed the cooperation for sure after exporter's default. Importer's choice is not involved in the game.

Table6.3 Utilities of each party under case 3

	Bank	**Exporter**	**Insurance Agency**	**Importer**
Possibility	p	β_2	1	1
Utility	m–(1+r)eX	$(e-\varepsilon)X$-n	εX	

6.3.4 Case D

If exporter doesn't default and fulfill its duty as required in the contract with importer, importer, however, is unable to pay exporter receivable due to risk covered by export credit insurance agreement, insurance agency has to pay the compensation directly to bank. Actually the outcome will be the same for both bank and exporter no matter export credit insurance is effective or not, but the choice of being effective or not is a pre-action, and needs efforts and time to achieve, we still consider the choice of export credit insurance agency. The possibility that exporter fulfill its duty is $1-\beta_1-\beta_2$, eliminate the possibility of any defaults.

Export credit insurance agency, who takes the cost of being efficient, will spend the risk management cost t and suffer a loss of compensation amount. Export credit insurance agency's utility is $-\mathrm{t}-(1-\varepsilon)$X. Although get the bank advancement, exporter needs to pay for the insurance fee, cost of goods sold, as well as the interest payment. Its utility is $(1-\varepsilon-\delta-er)X$.

Table6.4 Utilities of each party under case 4

	Bank	**Exporter**	**Insurance Agency**	**Importer**
Possibility	p	$1-\beta_1-\beta_2$	c	α_2
Utility	m+reX	$(1-\varepsilon-\delta-er)X$	$-\mathrm{t}-(1-\varepsilon)\mathrm{X}$	

6.3.5 Case E

Similar as the case D above, exporter performs the contract with importer, importer fails to pay exporter receivables due to its credit risk or political risk covered by export credit insurance. Export credit insurance agency is not effective to find out the default reason but will anyway pay the compensation. Thus, the utility of export credit insurance agency is $-(1-\varepsilon)\mathrm{X}$. Bank, as the beneficiary owner of the insurance, will finally get its principle and interest payment. Its utility equals to m+rXe. Exporter, who has get the bank advancement and provided the goods or service as required by the trade contract, will pay for the insurance fee, cost of goods/service sold, and interest expense. Its utility is $(1-\varepsilon-\delta-er)X$.

Table6.5 Utilities of each party under case 5

	Bank	**Exporter**	**Insurance Agency**	**Importer**
Possibility	p	$1-\beta_1-\beta_2$	1-c	α_2
Utility	m+reX	$(1-\varepsilon-\delta-er)X$	$-(1-\varepsilon)\mathrm{X}$	

6.3.6 Case F

Under the ECIF game model, even if bank lend to exporter, exporter fulfill its duty of the contract with importer, importer pays exporter on due, there are still risks of exporter's insolvency. That is to say, exporter doesn't repay bank's advancement and interest after the international trade ends. This case applies to condition where exporter changed its receivable account to another bank, the initial bank that has advanced money to exporter will not receive the principal and interest. Once the initial receivable account has been transferred, export credit insurance ends and insurance agency no longer on duty.

Commercial bank has to undertake all the loss itself. Its utility is m–(1+r)Xe. The utility of export credit insurance agency remains $\varepsilon\mathrm{X}$ as its insurance fee income. For exporter, it has paid the insurance fee and delivered the goods/ service as stated in the contract, earned the revenue X but fails to repay bank advancement eX due to its moral hazard. Its utility is $(1-\varepsilon-\delta)\mathrm{X}+\mathrm{eX}-\mathrm{n}$ since it has a punishment loss n.

We assume that the possibility of exporter moral hazard after international trade remains the same as it is before the trade, β_1. After exporter delivered the goods or services as required in the contract, we can eliminate the possibility of importer moral hazard or collusion. Importer's choices can either be default because of credit risk and political risk that is covered by export credit insurance, or non-default. Thus the possibility of importer non-default is $1-\alpha_2$.

Table6.6 Utilities of each party under case 6

	Bank	**Exporter**	**Insurance Agency**	**Importer**	**Exporter moral hazard**
Possibility	p	$1-\beta_1-\beta_2$	1	$1-\alpha_2$	β_1
Utility	m-(1+r)eX	$(1-\varepsilon-\delta+e)X$-n	εX		

6.3.7 Case G

Case G assumes that every process goes smoothly under ECIF: bank advances money to exporter, exporter fulfills to contract with importer, and importer pays to exporter on due, exporter then repays commercial bank advancement on due. No one suffers any unexpected loss.

Since importer has paid their payable on due, we can eliminate the condition that exporter fails to repay bank advancement because of operational risk. The only reason for exporter default is moral hazard. Thus the possibility of non-default is $1-\beta_1$.

Commercial bank's utility is m+rXe which equals to its invisible premium plus interest income. Export credit insurance agency gets its insurance fee income εX. Exporter need to pay for the insurance fee, interest expense, and cost of goods sold. Thus its utility is $(1-\delta-\mathrm{er}-\varepsilon)\mathrm{X}$.

Table6.7 Utilities of each party under case 7

	Bank	**Exporter**	**Insurance Agency**	**Importer**	**Exporter repay**
Possibility	p	$1-\beta_1-\beta_2$	1	$1-\alpha_2$	$1-\beta_1$
Utility	m+reX	$(1-\varepsilon-\delta-er)X$	εX		

6.3.8 Case H

Above 7 cases states the utility assumption under ECIF case, which means that commercial bank advances cash to exporter. From case H, we analyze the pure insurance case in which commercial bank refuses to lend to exporter. We assume that the possibility that bank refuse the finance request from exporter is 1-p. If bank refuses to lend to exporter, its utility is 0 no matter what other parties' choice is.

If both exporter and importer default, we consider it a fraud case where the two parties collusion to fake a trade agreement to get the insurance compensation. Their utility depends on whether export credit insurance agency is effective or not. When export credit insurance agency is effective, it will find out the fraud, and refuse to pay compensation to exporter. Same as before, we assume the cost of being effective is t. Thus, export credit insurance agency's utility is $-\mathrm{t}+\varepsilon\mathrm{X}$. Exporter will lose its insurance expense εX and be punished. Its utility is:

Table6.8 Utilities of each party under case 8

	Bank	Exporter	Insurance Agency	Importer
Possibility	1-p	β_1	c	α_1
Utility	0	$1/2\,(-\varepsilon X - n)$	$-\mathrm{t} + \varepsilon\mathrm{X}$	

6.3.9 Case I

Case I illustrates the condition where both importer and exporter default and export credit insurance agency is ineffective. Export credit insurance agency would not be able to figure out the fraud trade and finally have to pay the compensation claimed by exporter. Exporter's utility is $-(1-\varepsilon)X$. For exporter, it has to pay for the insurance fee and share the gain with importer, thus its utility will be $1/2\,(1-\varepsilon)X$.

Table6.9 Utilities of each party under case 9

	Bank	Exporter	Insurance Agency	Importer
Possibility	1-p	β_1	1-c	α_1
Utility	0	$1/2\,(1-\varepsilon)X$	$-(1-\varepsilon)\mathrm{X}$	

6.3.10 Case J

Case J shows us the condition where exporter fails to perform the contract with importer and importer doesn't take any responsibility. Since this case is not covered by the export credit insurance, export credit insurance agency is not on duty. When exporter is short of cash flow, it will affect the operation of the company. We assume this loss is φ. For exporter, its utility is the amount of both is insurance expense $\varepsilon\mathrm{X}$ and illiquidity loss φ. Export credit insurance agency will earn the insurance fee. Importer doesn't need to choose a strategy since exporter has failed the contract, so we don't need to consider its choice.

Table6.10 Utilities of each party under case 10

	Bank	Exporter	Insurance Agency	Importer
Possibility	1-p	β_2	c	1
Utility	0	$-\varepsilon X - \varphi$	$\varepsilon\mathrm{X}$	

6.3.11 Case K

In case K, when exporter fulfills the contract with importer at a possibility of $1-\beta_1-\beta_2$, importer default due to its credit risk or political risk, export credit insurance agency has to pay for the loss of exporter. Since export credit insurance agency is effective, its utility is $-t-(1-\varepsilon)X$. Exporter, who paid the insurance and produce cost, will suffer a liquidity loss since commercial bank refused to advance cash.

Table6.11 Utilities of each party under case 11

	Bank	Exporter	Insurance Agency	Importer
Possibility	1-p	$1-\beta_1-\beta_2$	c	α_2
Utility	0	$(1-\delta-\varepsilon)X-\varphi$	$-t-(1-\varepsilon)X$	

6.3.12 Case L

In case L, we analyze the condition that importer default and exporter is ineffective. We assume under this condition the utility of exporter is $X(1-\varepsilon-\delta)-\varphi$. The liquidity loss φ is adjusted during produce stage because commercial bank refused to advance cash t exporter. For export credit insurance agency, the loss is $-(1-\varepsilon)X$ as it doesn't make efforts of risk management.

Table6.12 Utilities of each party under case 12

	Bank	Exporter	Insurance Agency	Importer
Possibility	1-p	$1-\beta_1-\beta_2$	1-c	α_2
Utility	0	$(1-\delta-\varepsilon)X-\varphi$	$-(1-\varepsilon)X$	

6.3.13 Case M

The last condition we consider the case that without bank advancement, export fulfill the contract duties and importer pays on due. The utility of exporter equals to $X(1-\varepsilon-\delta)-\varphi$ since during produce stage it is short of cash and affects the other business operation. Export credit insurance agency is not involved in the game model since there is no default. Export credit insurance agency will earn the insurance fee εX.

Table6.13 Utilities of each party under case 13

	Bank	Exporter	Insurance Agency	Importer
Possibility	1-p	$1-\beta$	1	$1-\alpha$
Utility	0	$(1-\delta-\varepsilon)X-\varphi$	εX	

7. Equilibrium of the Game Function

7.1 Equilibrium of Export Credit Insurance Agency

We now get the equilibrium result of the game model by maximize the utility of each party.

For every condition, the possibility equals to the multiple of every party involved.

$$P_i = \prod p_{*,i} \tag{1}$$

Where i=A,B……M, means the different case condition. And * represents the game parties, which is bank-B, exporter-E, importer-M or export credit insurance agency-I.

For example, in case A, where bank lend to exporter, exporter and importer default due to moral hazard, and export credit insurance agency is effective to detect the default reason, we have

$$P_1 = p_{B,A} \times p_{E,A} \times p_{M,A} \times p_{I,A} = p\beta_1\alpha_1 c$$

For export credit insurance agency, we have

$$U_I = \sum_{i=1}^{13} P_i \times U_{I,i} \tag{2}$$

To maximize the utility of export credit insurance agency, we have

$$\frac{\partial U_I}{\partial \mathrm{c}} = 0 \tag{3}$$

To maximize the utility of export credit insurance agency, we solve the equation (1) (2) and (3), we get:

$$\mathrm{t} = \frac{\alpha_1\beta_1 X}{\alpha_1\beta_1 + (1-\beta_1-\beta_2)\alpha_2} \qquad \text{i}$$

That means, for export credit insurance agency, the amount invested in the risk management in order to be effective, we assume it is the cost of insurance, should equals to a portion of the contract amount X. Interestingly, that portion has nothing to do with insurance fee ε, the return ratio of insurance agency. But it is highly related to $\alpha_1 \cdot \beta_1$, the possibility of importer and exporter collusion; $(1-\beta_1-\beta_2)\alpha_2$, the possibility that exporter perform the contract but importer default due to its credit risk and political risk, which are both covered by the export credit insurance.

In order to simplify the analysis, we transform equation i into:

$$\frac{\mathrm{X}}{\mathrm{t}} = 1 + \frac{(1-\beta_1-\beta_2)\alpha_2}{\alpha_1\beta_1}$$

This equation can be seen as a cost coverage ratio for export credit insurance agency. As X is the amount of the contract insurance covered, t is the cost of being effective in detecting default reason. In order to maximize the utility of export credit insurance agency, this ratio should equal to 1 plus a percentage of two possibilities: the possibility of importer default covered by export credit insurance, and the possibility that importer and exporter collusion.

7.2 Equilibrium of Commercial Bank

For commercial bank, we have

$$U_B = \sum_{i=1}^{13} P_i \times U_{B,i} \tag{4}$$

To maximize the utility of commercial bank, we have

$$\frac{\partial U_B}{\partial \mathrm{p}} = 0 \tag{5}$$

To maximize the utility of commercial bank, we solve the function (1), (4) and (5), and get result ii:

$$\frac{m}{Xe} = \frac{\alpha_1\beta_1 c(1+2r) - \alpha_1\beta_1 r + \beta_2(1+r) + (1-\beta_1-\beta_2)[(2+r)(1-\alpha_2)\beta_1 - r]}{\alpha_1\beta_1 - \beta_1 + 1}$$

We express $m/_{Xe}$ as the subsidiary margin for commercial bank, as it has advanced eX amount currency to exporter and earned a subsidiary m from government. This ratio should be equal to the above shown equation of α_1, α_2, β_1, β_2, c, and r. In fact, we assume that the possibility of importer default due to credit risk or political risk, α_2 , and the possibility of export default due to operational risk and finance risk, β_2, can be measured by modern risk measurement models, thus these two parameter is known. But the possibility of importer moral hazard, $\alpha_1$and export moral hazard, β_1, is unknown.

7.3 Equilibrium of the Exporter

For exporter, we have

$$U_E = \sum_{i=1}^{13} P_i \times U_{E,i} \tag{6}$$

$$\frac{\partial U_E}{\partial \beta_1} = 0 \tag{7}$$

$$\frac{\partial U_E}{\partial \beta_2} = 0 \tag{8}$$

To maximize the utility of exporter, we solve the equation (1), (6), and (7) , and get result iii:

$$\beta_1 = \frac{{}^1\!/_2\,\alpha_1[(1-c)(1-\varepsilon)X - c(\varepsilon X + n)] - (1-p)[(1-\delta-\varepsilon)X - \varphi] + P \cdot Z}{2p(1-\alpha_2)(eX + erX - n)}$$

$$Z={}^1\!/_2\,\alpha_1 eX[c - r(1-c)] - \alpha_2(1-\varepsilon-\delta-er)X + (1-\alpha_2)[3(1-\varepsilon-\delta)X + eX(1-2r+\beta_2-r\beta_2) + n(\beta_2-1)]$$

Our purpose is to maximize the utility of three parties while at the same time minimize β_1, α_1. In order to minimize β_1, we partially differentiate β_1, we have the following equation (9) and (10).

$$\frac{\partial \beta_1}{\partial \mathrm{p}} = 0 \tag{9}$$

$$\frac{\partial \beta_1}{\partial \mathrm{c}} = 0 \tag{10}$$

Solve equation (10), we have

$$-\mathrm{X} + \mathrm{peX}(1+\mathrm{r}) = \mathrm{n} \tag{iv}$$

This result can be used to determine the value of n, which represent the punishment the exporter will get if it is found out default. Value "n" usually depend on how developed the society is and how restrict the law is, etc.

Solve the equation (9), we can get:

$${}^1\!/_2\,\alpha_1[(1-c)X - \varepsilon X - cn] + (1-\delta-\varepsilon)X - \varphi = 0$$

That equation can be transformed to:

$$\alpha_1 = \frac{2[(1-\delta-\varepsilon)X - \varphi]}{(1-\varepsilon)X - c(X+n)} \tag{v}$$

We can see that if the numerator is positive, the value of α_1, the possibility of importer moral hazard, is getting bigger along with n, the punishment of exporter default. That is to say, the more severely the punishment, the more likely for the importer to default due to moral hazard. If the numerator is negative, the result is different. α_1 is negatively related to n, the more severely the punishment, the less likely for an importer to default due to moral hazard. That is to say, the punishment policy or regulation, laws, etc. is effective to relieve the possibility of moral hazard default only under certain condition. This condition is $(1-\delta-\varepsilon)X - \varphi < 0$. Considering that α_1 is positive, we also need to keep the denominator negative:

$(1-\varepsilon)X - c(X+n) < 0$. The same relationship is also applicable to c, the possibility of export credit insurance agency being effective.

Solve equation (1), (6) and (8), we have

$$\beta_1 = \frac{(\delta-1)X}{(1-\alpha_2)(eX+erX-n)} + \frac{p}{1-\alpha_2} \qquad \text{vi}$$

Since the numerator $(\delta-1)X$ is always negative, we can see that β_1 is negatively related to n, the punishment. β_1 is positively related to e, the ration of bank advancement. That's to say, the larger the bank advancement amount, the more likely the exporter default due to moral hazard.

β_1 is positively related to p, the possibility of bank advancement. This may be a negatively signal that the more likely an exporter get bank advancement, the more likely it will default due to moral hazard. Actually, we failed to consider the possibility as dynamic: with bank advancement, the possibility of exporter default due to operational risk and financial risk, β_2, is smaller.

8. Conclusion and Suggestion

In this paper, we try to solve the equilibrium of the game among export credit insurance agency, exporter, and commercial bank. To maximize each party's utility, we have their utility function differentiated with their choice possibility. We then get the result of each equation.

For export credit insurance agency, we conclude that the expenditure on risk management in order to effectively detect the default reason, t, and the contract amount covered, should be proportionally related. This proportion should equal to 1 plus a percentage of $(1-\beta_1-\beta_2)\alpha_2$, the possibility that exporter has to pay the compensation claimed, and $\alpha_1\beta_1$, the possibility that export credit insurance agency should be exempted from duty if it is effective and be able to find out the fraud truth .

For commercial bank, we get its subsidiary margin expressed by α_1, α_2, β_1, β_2, c, and r. Among them α_2, β_2 are known. r is determined by commercial bank and is usually pre-settled. α_1, β_1 are shown in equation v, and vi. We assume that m is externally determined by government, thus the advancement ratio, e, is to be decided by commercial bank. When received credit application from exporter, bank can decide the ratio of advancement relative to the contract amount according to equation ii, v, and vi.

For exporter, we differentiate its utility to β_1 and β_2 respectively to express β_1 and α_1 as a new equation. We are most interested in the value of α_1 and β_1. To minimize α_1 and β_1, we then differentiate c, the export credit insurance agency's choice of being effective, and p, the commercial bank's choice of advancing cash to

exporter based on that new equation.

Interestingly, we found out that under certain condition, α_1 is positively related to c, the possibility that export credit insurance agency being effective, and n, the punishment of default. Only when the below equations stand, can we suppose that the market regulation, law effectiveness stands.

$$(1-\delta-\varepsilon)X-\varphi<0$$
$$(1-\varepsilon)X-c(X+n)<0$$

That's to say, exporter's earning before interest should be smaller than its illiquidity loss due to short of cash.

Another valuable outcome is that the punishment imposed to exporter if it is found default n, should be equal to $\mathrm{X}+\mathrm{peX}(1+\mathrm{r})$, which can be an reference for regulatory organization to determine the related punishment of default.

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