The application of blockchain technology into E-commerce Return Freight Insurance

This dissertation is submitted as part of the requirements for the award of MSc in Actuarial Science with Business Analytics at Bayes Business School, City University of London.

Submitted by: Ming Hao; SID: 210003710
Supervised by: Mr. Oliver Manyemba
Time: September 2nd, 2022

ACKNOWLEDGMENTS

I would first like to thank my supervisor Mr. Oliver Manyemba. for his generous guidance throughout this project. He steered me in the right direction whenever he thought I needed it.

I would also like to thank all the staff in the Actuarial Science programme at Bayes Business School, especially Professor Russell Gerrard, for teaching me very valuable knowledge throughout this year.

I would also like to acknowledge Dr. Zhongwei at Northeastern University, and I am gratefully indebted for his very valuable instruction on this thesis.

Finally, I must express my very profound gratitude to my parents and to my girlfriend Weiqin Hu for providing me with unfailing support and continuous encouragement throughout my study and the process of researching and writing this thesis. This accomplishment would not have been possible without them.

ABSTRACT

In this paper, I researched how to construct a detailed solution with mathematical models for the application of blockchain in Return Freight Insurance (RI). In this e-commerce era, more and more people go shopping online, and a new insurance product – Return Freight Insurance was created to improve the return or exchange process. Although the industry grows fast, there are unavoidable problems faced by insurance companies – high claim ratios, claim fraud and short-term capital management. Meanwhile, the features of RI are compatible with the characteristics of blockchain technology, which leads to an idea of the application. Firstly, by leveraging the decentralized and automated system, customized pricing and claim model were constructed to reduce the high claim ratio. Next, a membership hierarchy was designed to avoid fraud. Furthermore, tokenomics and crypto staking pools were introduced to help capital management and keep the funds operating continuously. Although there are still risks of regulations and business development, the solution worked out most of the problems faced by RI and can be running perpetually because of the token burnt mechanism in the pricing and claim model. This solution is feasible and it can renovate the RI industry to the next age.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. Introduction

This work aims to construct a blockchain solution for Return Freight Insurance (RI) which can solve the current issues faced by RI companies. This section gives an overview of the history of the development of RI and details the challenges and benefits of blockchain applications in RI. In the second section, necessary components and processes are introduced: Tokenomics, Membership ladder, Claim Assessment model, Premium pricing model, Capital management strategy, and correction mechanism. In the final section, conclusions and recommendations are made along with a dialectical analysis of limits and risks.

1.1 Overview of Return-freight Insurance

In this E-commerce era, the postage fee has become a bottleneck of e-commerce development and restricts the cost of e-sellers. Online shopping always has disputes or concerns about who will bear the freight when returning goods. According to taobao.com, in the current refund transaction dispute, over 40% is due to the buyer and seller disagreeing on the postage return, adding a lot of unnecessary trouble for the after-sales issue.

According to the policies of Amazon, under circumstances of inconsistent description, misdelivered goods, goods damage, quality, return freight is borne by the seller; And in the case of dislike, poor effect, buyer's wrong and so on seller uncontrollable cases, the return freight is borne by the buyer. The rules seem clear, but apart from screens, the ambiguity is harder to discern. For an example of inconsistent description, the seller usually avoids the responsibility on the excuses of screen color difference, personal constitution difference, and buyers' wrong understanding, and some buyers are not willing to accept this excuse and compromise the cost of freight, resulting in disputes between the two sides.

In July 2010, Huatai Insurance corporated with taobao.com to launch the first online return freight insurance. Since the insurance product was put on the market, it has better solved the transaction disputes caused by the issue of the return freight in online shopping transactions and gradually become familiar with and recognized by the majority of consumers.

The RI has significant features as follows:

i. Embedded mode of insuring

RI can not be sold alone. The insuring is embedded with the online transaction to form a complete shopping process. In most cases, RI is insured for particular goods (14-day/30-day return without reason).

ii. Automated claims procedures

After the online shopping occurs, if the buyer returns the goods within the agreed period, the insurer will make compensation according to the agreed amount of the insurance policy. In most cases, as long as the buyer uploads the express tracking number, the claim will be compensated automatically without reports.

iii. Variable premium and claim amount

The premium depends on the credit of the insurant (claim ratio of the online store), the higher the number of claims of the store, the higher the premium. The Claim amount is decided by the weight of the item and the distance between the buyer and seller.

1.2 Development and issues in China

By far, the premium scale of return freight insurance has been rising rapidly. According to relevant reports in China, in the first half of 2017, return freight insurance premium income was 241 million dollars, which rose threefold to 727.7 million dollars in the first half of 2019. By the first half of 2021, this premium income had grown to 777.4 million dollars. Although the scale of

return freight insurance premiums is expanding, the insurance companies have been in the loss of underwriting for a long time.

The first issue is that the claim ratio keeps staying at a high level. Adverse selection and moral hazards are apparent, which directly lead to the increased loss rate. The buyer usually has a psychological choice before purchase. When the policyholder thinks that the return risk is high, they will tend to buy return freight insurance; When the insured has sufficient confidence in the goods, it is not considered necessary to purchase freight insurance. As my experience in ZhongAn Online Insurance showed, for now, the insurance company's solution is to adjust the premium rate once every month on the basis of the insurant's claim ratio and the category's average claim ratio. However, due to the timeliness limit and high decision-making cost, data analysts and pricing teams are in a difficult situation.

The second issue is that there are many cases of insurance fraud through the difference between postage fee and claim amount. Due to the ubiquitous discount price in the logistics industry, the principled minimum sum insured is often higher than the actual loss. From my experience in ZhongAn, the insurance companies compensate only based on the sum insured calculated automatically by the system, instead of checking how much the buyers actually pay for the return. In this case, the insurance companies pay for the arbitrage, and the sellers lose the cost of shipping. Professional fraud groups take advantage of the situation and disturb the order of the RI market, bringing insurance companies into a predicament.

The third issue is that capital management is difficult for RI. The profit model of the modern insurance industry mainly lies in risk pricing and capital management. The characteristics of small amount, short cycle and high loss rate of RI make the insurance company prepare a high amount of reserve to face the claim that may be required at any time. However, the liquidity and

security requirements of insurance funds are high, which causes many obstacles to the management of this part of funds in the capital market.

1.3 Benefits of blockchain into RI

The essence of blockchain technology is a public, decentralized ledger that facilitates the process of recording transactions and tracking assets across a network. According to the characteristics of blockchain, the above three issues can be solved effectively.

Firstly, the high claim ratio and pricing problem can be solved by the smart contract. Since the insurance ecosystem contains millions of insurers, e-sellers and buyers, the industry can easily slip into inefficiencies of time and money due to human error. According to a report from Mckinsey, around 35% of insurance premiums are lost due to frictional costs in the system. In fact, only 65% of premiums are returned to insurants via claims. The rest is used for operational expenses, regulatory costs, capital costs and companies' profits. The data are saved across the chain online by leveraging the decentralized ledger. Therefore, there is no need to pay for the high expenses of computer servers. Also, all insuring and claims are automatically processed by the smart contract, avoiding human errors. Besides, the regulatory-related costs can be saved because transparent code is much easier to supervise than humans. Furthermore, inspired by DeFi projects, a membership system and hierarchy can be introduced to assess return risk and determine the premium rate.

Secondly, the insurance fraud problem can be solved by the feature of transparency. The public ledger system enables blockchain to move fraud detection forward by consolidating claims data across insurers, quickly checking out any unusual behaviors and taking care of problems before they become significant issues. In addition, KYC verification is introduced to the system to avoid fraud rings.

Thirdly, the idea of crypto staking and liquidity mining can solve the capital management issue. Crypto staking is regarded as an alternative to mining with lower consumption of resources. Such a scheme involves placing the money held in a cryptocurrency wallet to support the security and operation of the blockchain network. Liquidity mining is similar to staking but provides liquidity to the token market. Simply put, crypto staking and liquidity mining are locking up cryptocurrency in exchange for a reward. The insurance premium can be locked automatically for staking or liquidity mining to provide rewards for developers and claim reserves.

Moreover, the feature of the decentralization of blockchain can safeguard sensitive information of growing concern. Since all ledgers are decentralized, the data can not be corrupted or manipulated by any institution.

2. RI Blockchain Solution

2.1 Solution Overview

The cryptocurrency token is named $RI in this paper. Necessary components are introduced as follows:

i. Tokenomics –Token price model and token functions.

ii. Membership and Identity - A membership hierarchy will be created; higher-level members would have lower premium rates and more governance rights, and an identity KYC module is required for the registration process.

iii. Claim Assessment Model - A model for determining the claim amount of each event and whether the claim should be approved or not.

iv. Premium Pricing Model - A model for determining the premium rate of each return event and a way to adjust over time.

v. Capital Model: Staking & Liquidity Pool - A model for determining how much reserve is required to back the risk and how the premium funds operate.

vi. Correction mechanism – An oracle mechanism for adjusting contract rules from off-chain data.

2.2 $RI Tokenomics

$RI will be created as an Ethereum-compatible token. Similar to the NXM(Nexus Mutual) model, a continuous token model will be used so that tokens can be purchased at various prices at any time instead of a fixed price during the ICO period.

The token price is based on 1) funds in Capital Pools; 2) the minimum reserve required to cover existing RI policies:

$$Token\ Price = A + \left(\frac{ETH}{C}\right) \times \left(\frac{CP}{MR}\right)^3 \qquad (1)$$

ETH *= The real-time Ethereum price.*

CP *= Funds in Capital Pools.*

MR *= Minimum Reserve Requirement, as RI has a short cycle(<1 month), this equals to the premium capital locked.*

A, C *= Fixed constants, to be calibrated based on the initial Ether price.*

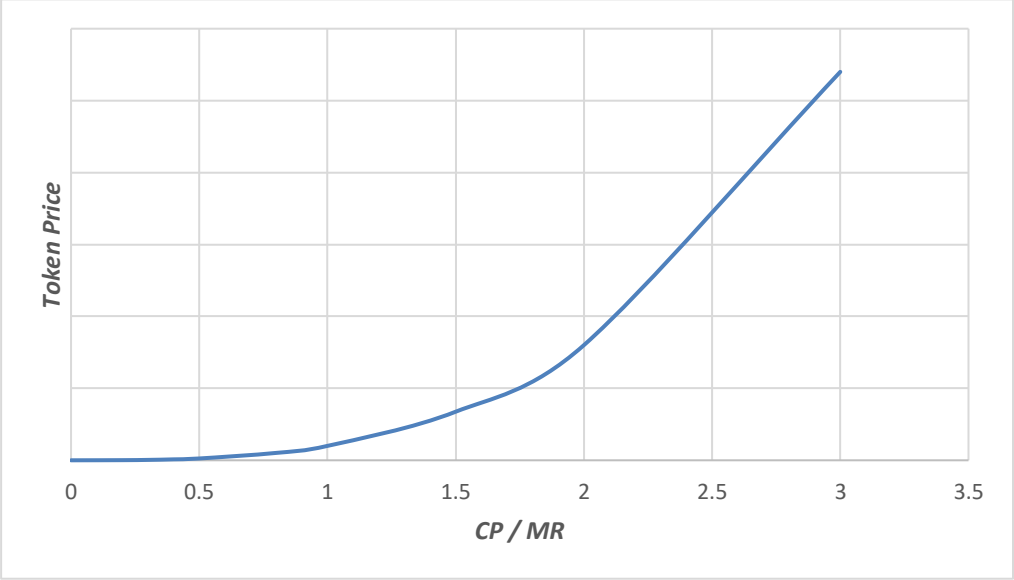

Figure 1

As funds in capital pools increase, the token price increases. Token price will be autonomically adjusted as the contract is deployed.

Token functions:

$RI tokens can be used in the following ways:

i. Purchasing Insurance:

$RI tokens can be used to purchase return freight insurance. In this case, 90% of tokens will be locked in the capital pool (staking or liquidity pool), and the other 10% will be burned to avoid inflation of token price.

ii. Claim Settlement:

Once members report returning their insured goods, an agreed amount of tokens will be compensated to members' wallets.

iii. Staking rewards:

Tokens can be locked in staking or liquidity pools for mining rewards.

iv. Exchange cryptos:

Initially, ETH can be exchanged with $RI based on the token price model.

v. Governance:

Token holders can vote to affect investment strategy of the reserve fund.

2.3 Membership and Identity

For the convenience of pricing and fraud avoidance, a membership hierarchy can be introduced. As the members pay more premiums without claims or stake more tokens into the capital pools, the level will be upgraded, which could reduce the premium rates for following insuring. In contrast, members' credit will be reduced when claims occur, which means a higher premium rate for the next insuring.

For example, the hierarchy can be as follows:

Member Level	Required staking tokens or paid premium	Premium rate discount
Level 1	None but KYC(identity) needed	Base rate in the pricing model
Level 2	1 $ETH staking Or 0.1 $ETH paid for premium	5% discount
Level 3	2 $ETH staking Or 0.2 $ETH paid for premium	10% discount

Table 1

Identity will be needed to ensure the uniformity of members' accounts on different e-commerce platforms. Also, an Ethereum wallet will be linked to each account. All sensitive data will be encrypted and saved on the chain.

2.4 Claim Assessment Model

i. Compensation Standards

For return freight insurance, the premium is evaluated when the seller sends the goods; however, the return freight bill arises when the buyer returns the goods. Therefore, the sum insured along with the premium can not be determined by the actual return freight bill; otherwise, the premium can not be calculated based on the sum insured. Thus, a fixed compensation standard table should be drawn up. An example in the UK is as follows, and the claim amount is based on the Royal Mail standard services rate:

Shipping address	Delivery address	Weight up to	Claim amount
London	Edinburgh	1kg	£3.20
London	Edinburgh	2kg	£5.30
London	Europe	1kg	£10.30
London	Europe	2kg	£13.00
London	Asia	1kg	£17.65
London	Asia	2kg	£23.30
……			

Table 2

However, since the price rate varies according to different express companies and logistics deals, the actual freight rate can be much lower than the compensation standard. As my experience in ZhongAn showed, fraud rings would like to make arbitrages by using the difference between the compensation and actual freight. Therefore, there is a need to construct new compensation pricing methods which could avoid arbitrage opportunities and solve the premium pricing problems.

According to economics rules, if the money supply grows faster than the economy's ability to produce goods and services, then inflation will result. Inspired by this rule, an idea to solve both arbitrage and inflation issues is came up: The claim amount would be settled as the minimum amount between compensation standard and actual freight cost. At the same time, if the actual cost is lower than the standard, the margin tokens will be burnt to avoid inflations and benefit the entire tokenomics:

$$Claim\ Amount = \text{MIN}(\ CS, AFC\ ) \qquad (2)$$

$$Token_{Burnt} = \ MAX(\ (CS - AFC), 0) \qquad (3)$$

CS = *Compensation Standard*

AFC = *Actual Freight Cost*

Note: If the actual cost is higher than the standard, no extra compensation will be paid to the insurant, as sometimes international freight cost can be extremely high.

ii. Claim Assessment process is as follows:

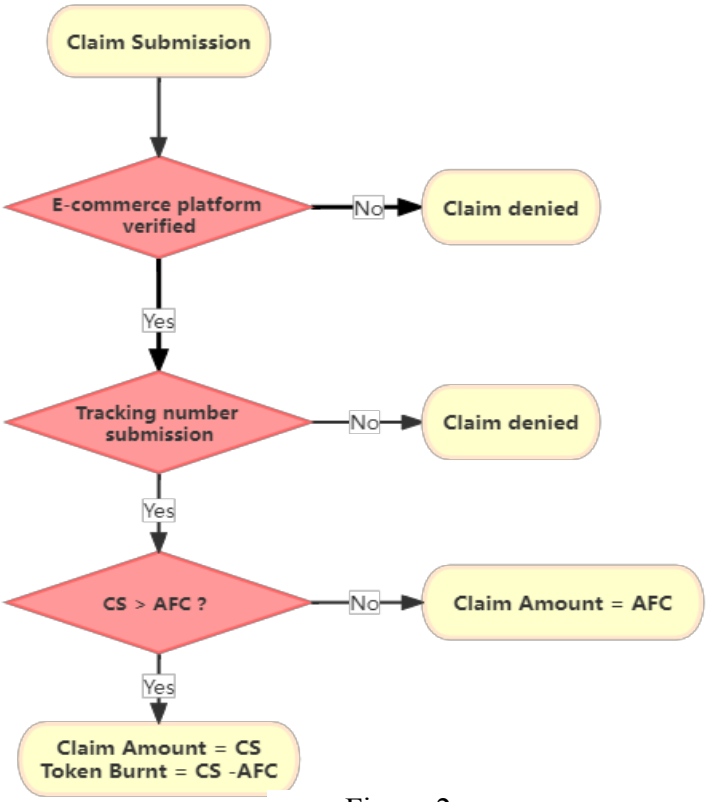

Figure 2

2.5 Premium Pricing Model

In ZhongAn Online Insurance, the traditional return freight pricing model is very complicated. In consideration of adverse selection and moral hazards, the Support Vector Machine model is used with goods' category, price level, seller's review rating, historical return rate, etc., as variables. However, by such a pricing method, insurers' premium income still barely covers the claim payments because the rate updating work requires lots of labour and time.

With the application of blockchain contract, pricing will be flexible enough to be adjusted with daily increments. According to current RI market data, the base rate of premium rate is set as 5%. This may cause most new contracts to start with a very high cost, which can be reduced over time as the algorithm is more battle-tested.

The premium rate adjustment will have two parts: 1) General adjustment according to the claim ratio of different e-commerce platforms, goods category, price level and rating; 2) Customized adjustment according to buyer/seller's insuring and claim history. For both parts, adjustments are made every 24 hours.

For the general adjustment part, the adjusted price rate of a specific e-commerce good is firstly set as follows:

$$P_{t+1} = P_t \times \frac{A \times EP\%_t \times GC\%_t \times PL\%_t}{rating_t} \qquad (4)$$

P_t *= Pricing rate on day t.*
$EP\%_t$ *= Average claim ratio of the e-commerce platform during day t.*
$GC\%_t$ *= Average claim ratio of the good's category during day t.*
$PL\%_t$ *= Average claim ratio of the good in specific price level during day t.*
$rating_t$ *= The review rating of the goods, normally from 0 to 5.*
A *= Fixed constants, to be calibrated based on the overall solvency.*

For example, given a iphone 13 selling on amazon:

Good = iphone 13, Platform = Amazon, Category = Electonics,

Pricing level = £1000-£1500, Ratings = 5, Set A = 5.

Time	Platform Claim Ratio	Category Claim Ratio	PricingLevel Claim Ratio	Ratings	Premium Rate
Day 1	95%	95%	120%	5	5%
Day 2	90%	90%	110%	5	5.42%
Day 3	…	…	…	…	4.82%
……					

Table 3

Day 2 premium rate = 5% * (5 * 95% * 95% * 120%) / 5 = 5.42%

Day 3 premium rate = 5.42% * (5 * 90% * 90% * 110%) / 5 = 4.82%

However, in consideration of viberation on a single day, a weekly average claim ratio would be a better choice. Also, since a multiple of three claim ratio numbers are chosen, there would be a repetition. A geometric average can be chosen instead:

$$P_{t+1} = P_t \times \frac{A \times \sqrt[3]{EP\%_{t,7} \times GC\%_{t,7} \times PL\%_{t,7}}}{rating_t} \qquad (6)$$

P_t *= Pricing rate on day t.*

$EP\%_{t,7}$ *= Average claim ratio of the e-commerce platform from day t-7 to t.*

$GC\%_{t,7}$ *= Average claim ratio of the good's category from day t-7 to t.*

$PL\%_{t,7}$ *= Average claim ratio of specific price level from day t-7 to t.*

$rating_t$ *= The review rating of the goods, normally from 0 to 5.*

A *= Fixed constants, to be calibrated based on the overall solvency.*

As the example start at day 1, the updated premium rate are:

Day 2 premium rate = 5% * 5 * (95% * 95% * 120%)$^{1/3}$ / 5 = 5.13%

Day 3 premium rate = 5.13% * 5 * (92.5% * 92.5% * 115%) / 5 = 5.11%

For the customized adjustment part, each member(seller or buyer) would have their own personal adjustment parameter which would change at the end of each insuring period:

$$Personal_{new} = \begin{cases} Personal_{old} \times \max\left(\frac{P}{5\%}, \frac{5\%}{P}\right), & if\ claim \\ Personal_{old} \times \min\left(\frac{P}{5\%}, \frac{5\%}{P}\right), & if\ no\ claim \end{cases} \quad (7)$$

P = *Pricing rate of the good insured.*

Personal = *Personal adjustment parameter(initially 1).*

Finally, the actual premium rate of a good insured by a member X is calculated as:

$$Actual\ Premium\ Rate = P_{good} \times Personal_X \times Membership\ Discount \quad (8)$$

Continuously to the example above, if the iPhone 13 is insured on day 3 by member X with Personal parameter 1.1 and member level 1:
Actual Premium Rate = 5.11% * 1.1 = 5.62%,
and if member X return the goods within the insuring period, then the new personal parameter would change as:
PersonalX = 1.1 * max(5.11%/5%, 5%/5.11%) = 1.1 * 5.11/5 = 1.12

2.6 Capital Management

Reserve investment is an essential part of insurance entities. Since return freight insurance has such a short cycle, it is difficult to invest in bonds, stocks and so on traditional financial derivatives. However, by using crypto currency staking or liquidity pool, the reserve fund would earn return sustainably.

Uniswap protocol can be used to start trades during the fully automated investment process. Trades will rebalance the pool as needed using a buy-and-hold investing strategy. Additionally, trade triggers will be used to address the liquidity requirements brought on by claim payment. The assets picked will need to change over time, and the governance module will be used to start and approve those modifications.

2.7 Correction Mechanism

By using the oracle mechanism technology of blockchain, pricing can be provided off-chain via an API. If the project team or members get further RI data from collaboration with e-commerce platforms, new pricing rates and adjustment strategies can be updated to the on-chain contract. In the meanwhile, when a capital crisis or other crises occur to the $RI funds, smart contracts can be interrupted or modified by developers.

3. Conclusion and Recommendation

3.1 Risks and limitations of the solution

i. Risks in the business development process

Collaboration with e-commerce platforms is significant for the project. Because of the embedded mode feature of RI, insuring channels or links should be embedded into the e-commerce websites. Also, verification of return should be confirmed during the claim process. Furthermore, the pricing model can be improved as more industry data is provided. However, such deep cooperation with platforms is difficult to carry out. One reason is that some platforms already have their signed RI insurance institutions. Nevertheless, the existing RI business can not sustain profitability for those insuers, which can be gradually taken over by the blockchain solution. Another reason is that blockchain solutions are resisted by some companies, but it can also be an advantage to attract blockchain e-commerce platforms and companies interested in emerging technologies.

ii. Legal Risks

$RI protocol is a decentralized guarantee structure instead of a literal insurance provider, which means it is not required to conform with all the insurance regulatory and legal requirements. However, it can still be restricted for various local legal reasons across the world, such as securities laws, insurance regulations and taxes. As more and more regulations and policies restricting cryptos are published, there are substantial potential legal risks for future operation and development.

iii. Premium inconsistency between seller and buyer

For the same good, the pricing model would offer different premium rate for seller and buyer according to their personal parameters. For examples, if the buyer's personal rate is 1.2 and the seller's is 1.3, then the premium is different between buyer insuring and seller insuring. In addition, customised adjustment is only made to either seller or buyer, which does not make much

sense. This can be solved with further cooperation with e-commerce platforms, by appending both seller's and buyer's information to the insurance policy.

3.2 Conclusion & Recommendation

We have applied blockchain technologies and ideas with return freight insurance. Firstly, token price is yoked to Ethereum price, funds in Capital Pools, and the minimum reserve. Secondly, a membership hierarchy is introduced to attract more staking funds for the ecosystem. Thirdly, the claim amount model is determined by both actual freight cost and compensation standard avoiding frauds. Then, premium pricing model is designed with premium rate of 5% as initial, and adjusts daily according to both general platform claim ratios and personal insuring history. Next, a capital management strategy is made to stake cryptos in staking or liquidity pools by an automated process with Uniswap or other decentralized exchange platforms. Finally, an idea of correction mechanism is introduced for future smart contract upgrades and modifications.

By the highly customized pricing model and membership system, the actual premium rate adjusts continuously, which can solve the deficit issue caused by inappropriate pricing. Also, the claim model with an idea of token burnt can solve the token inflation problem to some extent, and keep the tokenomics in continuous operation. Furthermore, the token staking strategy would make this project rather a financial investment product than only an insurance product, which can attracting both e-shoppers and crypto investors. Although the solution still has unavoidable limits and risks, I believe this solution is a revolutionary innovation and could be operating for a long time to bring the whole insurance industry into a new era.

REFERENCES

El Moyanery, R. (2013). Insurance Awareness. *The Macrotheme Review.* s

PwC. (2015). Top Insurance Issues 2015. Available at: http://www.pwc.com/us/en/insurance/publications/assets/pwc-top-issues-the-insurance-industry2015.pdf

Zhongwei Chen. (2021). Offering return-freight insurance or not: Strategic analysis of an e-seller's decisions. *Omega.* Available at: https://www.sciencedirect.com/science/article/abs/pii/S0305048321000566#

Zhongwei Chen. (2022). Extracting values from consumer returns: The role of return-freight insurance for competing e-sellers. *European Journal of Operational Research.* Available at: https://www.sciencedirect.com/science/article/abs/pii/S0305048321000566#

Yiming Li. (2018). Return Freight Insurance: Implications for Online Platforms, Third-party Retailers and Consumers. *IEEE.* Available at: https://ieeexplore.ieee.org/document/8593267

Helmut Gründl. (2016). The evolution of insurer portfolio investment strategies for long-term investing. *OECD Journal.* Available at: https://www.oecd.org/investment/Evolution-insurer-strategies-long-term-investing.pdf

Hugh Karp. (2020). Nexus Mutual Whitepaper. Available at: file:///Users/minghao/Desktop/nmx_white_paperv2_3.pdf

Shidao Geng. (2018). The Impact of Return-freight Insurance Pricing and Insure Mode on The Retailers' Sales Decision.

Dan Wang. (2016). The Research of the Return Freight Insurance Pricing Model Under the Asymmetric Information.

Liangdi Wang. (2017). Birth, Progress and Development -- Analysis of Taobao return freight insurance. *Peking University Finlaw Center.* Available at: https://www.finlaw.pku.edu.cn/flyxjr/gk_hljryfl_201810251-80041616718/2017_jrfy_20181029112500112638/zdsbq3y/239868.htm

IBM. (2020). The Total Economic Impact™ Of IBM And Red Hat For Telecommunications. Available at: https://www.ibm.com/downloads/cas/GRM324QX

Mckinsey. (2015). What drives insurance operating costs. Available at: https://www.mckinsey.com/industries/financial-services/our-insights/what-drives-insurance-operating-costs

Szabo, N. (1996). Smart Contracts: Building Blocks for Digital Markets. Available at: http://szabo.best.vwh.net/smart_contracts_2.html

Deloitte. (2020). Blockchain in health and life insurance. Available at: https://www2.deloitte.com/us/en/pages/life-sciences-and-health-care/articles/blockchain-in-insurance.html