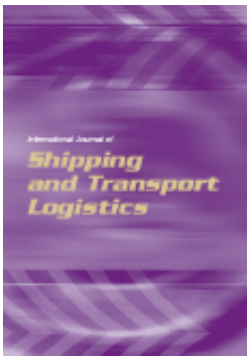

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Ling Sun, Wenjing Zhang, Zijiang Hu

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Constructing maritime incoterms quotation judgment criteria in the post-epidemic era

Ling Sun*

College of Transport and Communications,
Shanghai Maritime University,
1550, Haigang Avenue,
Lingang New Town, Pudong New Area,
Shanghai, 201306, China
Email: sunl@shmtu.edu.cn
and
School of Management,
Fudan University,
670 Guoshun Road, Yangpu District,
Shanghai, 200433, China
and
UMR 7235 EconomiX,
French National Centre for Scientific Research (CNRS),
Université Paris Nanterre,
200, Avenue De La République,
92001, Nanterre, France
*Corresponding author

Wenjing Zhang

College of Transport and Communications,
Shanghai Maritime University,
1550, Haigang Avenue,
Lingang New Town, Pudong New Area,
Shanghai, 201306, China
Email: vera_wj516@163.com

Zijiang Hu

School of Management,
Fudan University,
670 Guoshun Road, Yangpu District,
Shanghai, 200433, China
and
School of Economics,
Jiangsu University of Technology,
1801, ZhongWu Avenue, Changzhou,
Jiangsu, 213001, China
Email: 79838495@qq.com

Abstract: The COVID-19 has brought about drastic fluctuations in maritime trade quotations. This has prompted the focus of attention on how to rebuild a new mode of maritime quotations and stabilise the maritime transport market in the post-epidemic era. This paper takes CIF and FOB as examples to discuss the establishment of a quotation selection judgment criteria from the perspective of transportation. By using a Bayesian network model, a quantitative calculation of probability was conducted. The final construction of the CIF/FOB quotation selection judgment criteria will provide a replicable model and scheme. From the perspective of the development trend of the maritime industry in the post-epidemic era, it not only helps export traders make a more reasonable choice, but also provides a new means for market sustainability.

Keywords: FOB; CIF; quotation selection judgment criteria; maritime transport; post-epidemic era; sustainable development.

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Biographical notes: Ling Sun is an Associate Professor, College of Transport and Communications, Shanghai Maritime University. His teaching areas are liner transport theory and practice, charter transport theory and practice, etc. His research interests include international shipping management, logistics and supply chain management, shipping trade economics, and logistics carbon footprint. Since 2020, he has conducted post-doctoral research in Business Administration at the School of Management, Fudan University. He has been a visiting scholar at the French National Centre for Scientific Research (CNRS) and laboratory UMR 7235 EconomiX since November 2022. His research papers have been published in various academic journals, including transport policy, frontiers in marine science, frontiers in sustainable food systems, environmental impact assessment review, and others.

Wenjing Zhang a Master's student in College of Transport and Communication at Shanghai Maritime University. Her research interests include international shipping management, logistics and supply chain management, and shipping trade economics. She received her Bachelor's degree in International Shipping Management from Shanghai Maritime University in 2021. She has participated in many international conferences and published relevant academic papers.

Zijiang Hu is a postdoctoral Fellow of Business Administration, Fudan University, and an Associate Professor of Jiangsu University of Technology. His research interests include agricultural carbon footprint, economy of transport, and industrial finance. His research papers have been published in various academic journals, including *Frontiers in Sustainable Food Systems*, *Journal of Intelligent and Fuzzy Systems*, and others.

1 Introduction

Global trade in goods and services is severely impacted by the COVID-19 pandemic that erupted in early 2020 (WTO, 2020). Global trade requires maritime transport. However, the emergence of COVID-19 has also brought new challenges for shipping operation and management. For example, security check of port can result in extra waiting time for berthing operations, inland seaport transhipment operation, hinterland transportation management, etc. (Yazir et al., 2020). All these changes have contributed to changes in the cost of export seaborne trade, especially bringing about a rapid rise in trade quotations. And now in the post-epidemic era, freight rates are gradually falling back. The maritime industry urgently needs to establish a criteria model for relevant trade quotations. On the one hand, it can reduce the market volatility brought by speculative behaviour. On the other hand, it can deal with the impact of more uncertain political and economic events on maritime transport in the future.

To facilitate commerce around the world, the International Chamber of Commerce (ICC) publishes a set of international commercial terms (Incoterms). Globally recognised, Incoterms prevent confusion in foreign trade contracts by clarifying the obligations of buyers and sellers (Segal, 2022). The trade terms quoted for maritime trade are interpreted by Incoterms. Currently, traders have different levels of awareness of the specific cost components of quoting in different terms in their actual business. Moreover, traders frequently trade according to their experience in the choice of international trade terms. This also leads to the situation that after the emergence of the epidemic, traders' trade quotations are vulnerable to losses caused by fluctuations in the maritime market. Hence, the study of Incoterms is of great importance to guide the division of risk responsibilities among traders and also to improve the efficiency of international trade. However, current studies focus more on terminology revision and risk differential analysis (Chung and Leeb, 2013; Mudrić, 2011). As Vogt and Davis (2020) show, there are presently no in-depth studies on term selection and conflict. Shipping trade and other industry participants remain confused about the application of incoterms in practice. In particular, 'free on board' (FOB) and 'cost, insurance, and freight' (CIF) terms are the most commonly used trade terms (Bergami, 2006). So, most current studies on incoterms tend to focus on FOB and CIF. For example, Fahmy (2019) used FOB and CIF in international trade terms to study the change mechanisms in commodity prices. According to Sourdin and Pomfret (2012), FOB and CIF are the most appropriate measures of international trade costs. Therefore, this paper also focuses on FOB and CIF to discuss the establishment of a quotation selection judgment criteria.

Both FOB and CIF are subject to varying degrees of risk. Bergami (2013) analysed the differences between the selection of incoterms, the actual trade practices, and banking operations from the perspective of risk. He suggested that considering the risk of transportation, traders were not advised to trade on the basis of FOB. However, when it comes to rights, obligations and risks, exporters bear more obligations under the CIF quotation, which involves more business processes. Under the FOB quotation, onshore and domestic transport links need to be considered. Nevertheless, maritime transport

links are not included and the exporter will lose control over the transport of the goods under FOB. Moreover, the risk associated with the delivery of the goods will be greater under FOB than CIF. It can be seen from the above studies that the risks affecting FOB and CIF are mainly analysed from the perspective of transportation. Therefore, in export trade, it is necessary to further understand the cost composition of FOB and CIF quotations from the perspective of transportation.

Both the World Trade Organisation (WTO) and the United Nations Conference on Trade and Development (UNCTAD) adopt an optimistic outlook, predicting that maritime trade will recover in the future. However, blind selection of quotations by export traders in the traditional method hinders the development of enterprises and trade. Engler and Nahuelhual (2008) directly identify CIF as the import quotation and FOB as the export quotation in their study on the dairy market structure and prices. Similarly, Fleischer (2018) analysed the FOB export of Romania in 2017 and 2018, as well as the national CIF imports in 2018 (Fleischer, 2019). In practice, quotation selection is often based on the experience of traders, or only considers the risk of freight rates and other factors. It often leads to legal cases such as the release of goods without documents due to collusion between shipping companies and freight forwarders under FOB terms. As a result, traders lose both money and goods.

In the aftermath of the 2020 COVID-19 pandemic, freight rates fluctuated significantly. The choice of quotation has also seriously affected the costs of export traders and the normal development of export trade. It is imperative to construct a selection judgment criterion for CIF and FOB under export maritime trade. While incoterms have gained increasing attention in export maritime trade, it is necessary to analyse the current research on incoterms quotation selection in export trade. From the perspective of trade, most of the models studying quotation selection use game theory in their analysis. For example, Fousekis (2011) used a two-stage game to analyse the choice faced by competitive enterprises when selecting between FOB and 'uniform delivery' (UD) pricing. Uniform-delivered pricing refers to a geographical pricing strategy where the company charges the same price plus freight to all customers, whatever may be their location. The author found that there is a mixed FOB-UD pricing equilibrium in the middle market structure. This study uses the thinking method of game theory to consider the equilibrium situation of the CIF/FOB ratio (set as M_0) and to establish a selection judgment criterion. The same cost factor in CIF and FOB can be excluded by calculating the ratio. Since different quotations are explored from the perspective of transportation, traders can calculate different according to different transportation routes. The ratio will be in the form of a range to meet the shipping market fluctuations from a transport perspective. The influence of the relationship between cost and total quotation on the calculation of the effective interval of the CIF/FOB ratio and the selection of the final quotation should also be considered.

The remainder of this paper is organised as follows: Section 2 summarises the specific explicit and implicit costs under CIF and FOB based on the existing literature. It discusses the calculation of the CIF/FOB quotation ratio considering all explicit and implicit costs from the perspective of transportation. Section 3 presents the composition of CIF and FOB quotations and constructs the model. Section 4 calculates the effective

interval of the CIF/FOB ratio at the equilibrium point and improves the quotation selection judgment criteria. Section 5 analyses the application of judgment criteria in management practice. Finally, the conclusions are provided in Section 6.

2 Literature review

The ICC provides a list of 'one-stop fees' for FOB and CIF in the 2020 version of incoterms (ICC, 2019). The cost of goods comprises the main part of the quotation, and the list does not distinguish between explicit and implicit costs. The explicit cost refers to the actual expenditure of factor purchase and capital lease. In maritime trade, it can be expressed as the visible actual expenditure, such as sea freight and insurance, while the implicit cost is not reflected in the book, such as the opportunity cost generated by the overstock of goods. At the same time, the current research on cost factors affecting quotation selection focuses more on the analysis of a single cost, or on the economic or expository analysis of a factor, such as distance (del Rosal, 2013) and nature of goods (Pomfret and Sourdin, 2009). To date, studies have not considered the complete impact of explicit and implicit costs on quotations, which suggests that export traders still lack a comprehensive understanding of cost factors.

Table 1 summarises the specific explicit and implicit costs in CIF and FOB quotations based on existing literature and incoterms. Among them, the implicit costs are noted in the table, and the remaining costs are all explicit costs.

According to the literature, the FOB quotation includes risk cost, transaction cost, information cost, and opportunity cost. Meanwhile, the CIF quotation includes risk cost, foreign trade staff cost, opportunity cost, transaction cost and information cost. In addition, based on the definition of explicit and implicit costs, the opportunity costs in FOB and CIF belong to implicit costs, while the others are explicit costs. Although the costs under both CIF and FOB quotations are similar, the specific costs are different. In considering how to analyse the influence and relationship between factors, the Bayesian network model is generally used for probability, as well as to analyse the logical relationship between different influencing factors (Benkovskis et al., 2020). The Bayesian network model is more suitable for the quantitative analysis of relationships between variables. In this paper, the Bayesian network will be used to obtain the probability ratio between uncertain variable factors, especially the probability of the impact of different costs under CIF and FOB in the total quote.

Table 1 Costs included in CIF and FOB export quotations based on incoterms and the existing literature

Classification of trade terms	*Cost categories*	*Cost breakdown category*	*Related literature*
FOB	Risk costs	Foreign exchange risk: there is foreign exchange risk in the case of documents against acceptance in collection and remittance. Changes in foreign currency exchange rates also affect the amount of foreign exchange exporters receive	Cho and Doblas -Madrid (2014), Miroudot and Shepherd (2014)
		Tariff equivalents, whether within or outside regional trade agreements (RTAs), are always between 100 and 125%	
		Insurance-related risks: Release of goods without documents, backdated bills of lading and other non-indemnity clauses, the risk of an insurance claim being rejected due to insufficient evidence, and the risk of insurance carelessness	Liu (2009), Zhao (2019)
		Appointed agent risk: the importer may appoint a freight forwarder may cause the exporter to lose property rights or take the risk of being overcharged	Chou (2014)
		Shipment connection risk: if the port is blocked or the exporter's goods are not delivered on time, the exporter may bear more time costs and terminal storage expenses	Havenga et al. (2017), Sánchez et al. (2003), Wilmsmeier et al. (2006)
		Fraud risk: it is difficult for the exporter to investigate the shipping company or the shipping agency's credit. There is a risk that the importer may collude with the shipper to defraud the goods	Zhao (2019)
		Trust risk: the importer company's credit problems and its failure to take out insurance promptly, resulting in the risk of goods encountered at sea and unable to get claims.	Elsilä (2015)
	Transaction costs	Domestic transportation costs include the total of all expenses involved in the transportation, storage, packaging, loading and unloading of goods	Pomfret and Sourdin (2009), Martí and Puertas (2017), Antonio (2001)
		Domestic customs documents handling costs, production costs, staff wages, and other costs. Traditional tariffs of liner-shipping companies strongly distinguish between different commodities	Wilmsmeier et al. (2006)
	Information costs	Fees are incurred for the collection and processing of importer information; information costs are influenced by the openness, geographical location, and enterprise cluster level of the importing country (region)	Cavinato (2004), ICC (2019)
	Opportunity costs (implicit cost)	Service trade profit: opportunity costs are lost benefits, not expenses. Due to the COVID-19 pandemic, sea freight has skyrocketed while FOB exporters do not provide transportation services. Even if the exporters resell in transit or at the destination, they cannot realise the transaction and miss the opportunity for profit growth	Niu et al. (2021)
		Inventory profit: overstocking of goods can tie up capital and thus incur opportunity costs	Ghadge et al. (2020)
		Rebate profit: additional profit opportunities for deferred rebates are reduced	Barber (1914)

Table 1 Costs included in CIF and FOB export quotations based on incoterms and the existing literature

Classification of trade terms	*Cost categories*	*Cost breakdown category*	*Related literature*
CIF	Risk costs	Shipping market fluctuation risk: sea freight surge; if the contract is signed before the rise, it will reduce the seller's profit. At the same time, sea freight will also be affected by the supply and demand of the shipping market, fuel prices, weather, wharf conditions and other factors	Fahmy (2019)
		Failure of negotiation and risk of business loss: the operation of freight forwarder and unfamiliarity with customs and other problems lead to risks	Chou (2016)
		Risk of delayed shipment: port closures and dockworkers' strike due to COVID-19 pandemic. Risk of cargo connection: risk of cost increases due to port efficiency problems	Pomfret and Sourdin (2009), Branch (2010)
		Risk of accidental insurance: the exporter has insufficient land transportation insurance, or the marine transportation insurance has a lower level	Branch (2010), Zhao (2019)
		Risk of higher inland shipping costs abroad: inland carriers use the opportunity to raise prices, especially in the USA and Europe	Tran et al. (2016)
	Foreign trade staff costs	Hiring talents with knowledge of foreign trade, finance, and transportation	Yang et al. (2020)
	Opportunity costs (implicit cost)	Working capital occupancy cost: the occupancy of working capital under freight collection reduces investment opportunities, etc.	Niu et al. (2021)
		Inventory profit: goods overstock occupies the capital in logistics and also can produce the opportunity cost	
	Transaction costs	There is not only the transaction cost under FOB but also the cost of insurance.	Sánchez et al. (2003)
		Domestic transportation section cost, logistics performance, etc.	Martí and Puertas (2017), An (2014)
		Overseas sea freight and loading and unloading charges at the destination port. Integration of supply chain transportation and communication costs	Tran et al. (2017)
	Information costs	Information acquisition and qualification examination for destination port and consignee	Gallagher (2013)

3 Establish CIF/FOB quotation selection judgment criterion

Firstly, this section obtains the equations for CIF and FOB quotations with different costs based on the literature review. From the perspective of transportation, the value of different goods and the various pathways lead to different quotations. Then in order to build a universal CIF/FOB quotation selection judgment criterion, this paper gives the CIF/FOB ratio of different goods under normal market conditions from the perspective of transportation. The effective interval is used to construct the implementation criteria of the selection.

In addition, it is necessary to quantify the impact of the explicit and implicit costs of CIF and FOB on the total quotation due to obtain the CIF/FOB ratio. We conducted a questionnaire with the staff involved in the business of international trade. The subjective effect of their assessment of the overall price of the total price was obtained by the questionnaire scale. This ensures that the impact of different explicit and implicit costs on the total quotation can reflect the actual situation.

3.1 The basic quotation composition of FOB and CIF

In the export maritime trade, how the trade participants choose the trade term quotations can be viewed in terms of a price game. In the selection judgment criteria of CIF and FOB quotations under the export maritime trade, quotations are the result of different cost combinations. The strategy of export trade participants is to compare and to determine the final use of the quoted trade terms based on the actual quotation situation. In the 2020 version of the Incoterms® Rules published by the ICC, the basic quotation equation (1) and equation (2) for CIF and FOB are as follows:

$$FOB = C + D + N \tag{1}$$

$$CIF = C + D + F + I + N \tag{2}$$

where

C Purchase cost

D Domestic cost, including the packaging and storage of goods, etc.

F Overseas freight

I Foreign insurance

N Net profit.

According to the survey of freight forwarders, there is not much difference between the estimated profits under CIF and FOB. The main factor affecting export quotations is cost. When determining the quotation judgment criteria, this article focuses more on the impact of cost factors on the quotation. Moreover, the analysis of goods quotation from the perspective of transportation needs to consider the nature of goods. The current customs supervision uses international convention for harmonised commodity description and coding system (HS) to classify the nature of goods. However, from the perspective of transportation, the nature of goods can often be divided into several categories, and there is no need to make a more specific classification of goods according to HS. Shippers pay more attention to the economic benefits of goods, so the value of goods and different

nature of the impact on the offer is crucial. It is necessary to comprehensively consider multiple factors to provide the final quotation choice. Establishing the selection judgment criteria requires calculating. By subtracting the equations of (1) and (2), the conversion equation (3) for calculating CIF and FOB quotations commonly used in international maritime transportation is:

$$FOB = CIF - F - I \tag{3}$$

Nevertheless, the basic international quotation is discussed from the perspective of explicit costs, and the implicit cost is basically not discussed. The freight and insurance premiums in the actual quotation conversion are not static prices. Given the equilibrium point of the terms of the quotation, the double calculation of the same cost can be reduced and the impact of profit can be avoided. Therefore, based on the relevant literature on the explicit and implicit costs in the previous article, the equation (4) for calculating M_0 is:

$$\begin{aligned} M_0 = CIF/FOB = 1/(1-(&\text{Proportionof CIF Overseas freight} \\ &+ \text{Proportion of Foreign insurance}) \end{aligned} \tag{4}$$

where, the proportion of *CIF* sea freight and proportion of *CIF* insurance premium are calculated after considering the overall situation of explicit cost and implicit cost under CIF.

3.2 Application of Bayesian network model

After obtaining the CIF and FOB quotation conversion equation, the next step is to calculate M_0. M_0 is affected by the probability of different explicit and implicit costs on the total quotation. On the basis of the influence degree data obtained from the questionnaire, the Bayesian network model is used to calculate the probability of explicit cost and implicit cost to the total offer. After calculation, the quotation selection judgment criteria are established.

First, the questionnaire was conducted with the business personnel of trading companies and freight forwarding companies. Not all business people have a complete understanding of the costs behind CIF and FOB quotations. In order to obtain sufficient data, data sources are not limited to a single enterprise or several enterprises, and the personnel positions for relevant research should also be middle and senior management positions or operators involved in sales operations. To this end, this paper uses an online crowdsourcing platform called 'Wenjuanxing' in mainland China to place questionnaires. The objects of the questionnaire are business personnel and management personnel engaged in the maritime transportation of goods, and whether the personnel meet the requirements is screened in the early stage through the setting of inspection questions. At the same time, considering the diversity of international trade terms, before the formal questionnaire questions, the business managers who actually apply FOB and CIF for trade are screened out to ensure the authenticity and validity of the follow-up question answers. The questionnaire was in online form and lasted for half a year. The questions were asked using a five-point Richter scale. Through this survey, data were obtained on the impact of different explicit and implicit costs on the total quotation based on the answers of the business personnel. 175 questionnaires were distributed, 25 of which failed the consistency test.

Based on the 150 valid questionnaires collected, SPSS was used to conduct a descriptive analysis, as well as reliability and validity tests. In the descriptive analysis, the Pearson correlation coefficient (P) was used to obtain the correlation between the frequency of FOB quotes and CIF quotes used by both parties in the export trade. Results show that $P = -0.429 < 0.001$, indicating a negative correlation between FOB and CIF. When further analysing the reliability of the data, the Cronbach Alpha coefficient value of exported FOB was 0.803, and the coefficient value of CIF was 0.714. Both values exceed 0.7, which meets the reliability requirements. The Kaiser-Meyer-Olkin (KMO) and Bartlett's sphericity tests were conducted using SPSS for validity analysis. Results show that KMO = 0.787 under the FOB quotation, KMO = 0.609 under the CIF quotation, and the significance of the Bartlett sphericity test for FOB and CIF was 0. The KMO > 0.6 and the significance of Bartlett's sphericity test < 0.005, indicating that the validity of the data is acceptable.

Second, after testing and analysing the questionnaire data, a Bayesian network model was constructed. The model was established based on the impact of cost on the total quotation. Prior to constructing the model, however, this article considered the cost of the goods involved in the quotation. From equation (4), it can be obtained that the main factors affecting the quotation are the freight and insurance costs generated by the transportation segment. In the cost of the goods themselves, it is often the nature of the goods that affect the transportation. It is necessary to consider the nature of the goods when analysing the factors influencing the quotation. In terms of the nature of goods, trade costs for goods within RTAs are the average bilateral trade costs in the manufacturing industries of countries that are party to an RTA covering goods (Miroudot and Shepherd, 2014). In particular, for higher valued goods, a shipper is likely to pay a higher freight. The value of the goods leads to an increase of 0.34% in the freight charged (Bergami, 2006).

Pomfret and Sourdin (2009) considered the impact of distance and commodity characteristics on trade costs. They also mentioned that countries selling bulky and high-value/bulk goods will have differences in costs. Additional elements such as corrupted goods, bulk commodities, time-sensitive, easily pilfered, or institution-sensitive goods also affect the shipping choice of exporters. Therefore, the model in this article further divides the properties of goods into three types, namely freshness and perishability, refrigeration, and timeliness. There are seven combinations of properties, including some common marine goods and special types of goods. Among them, perishable goods need to be transported in cold storage (Panozzo and Cortella, 2008). Therefore, fresh, and perishable goods often need to be transported in time (Huber et al., 2017). Goods that need to be refrigerated are not necessarily time-sensitive or fresh and perishable, such as electronic components or frozen food. At the same time, due to the different transportation volumes of goods, in order to ensure the comparison in the same dimension, the calculation of the ratio only considers the cost of unit goods.

The model is constructed after analysing some preconditions and assumptions from a transportation perspective. A Bayesian network consists of a directed acyclic graph with multiple nodes and a conditional probability table. The circle node in the directed acyclic graph is a description of the characteristic state of real events, and the conditional probability table represents the correlation degree between the nodes at present. First, this paper distinguishes between CIF and FOB to establish two theoretical model structures. Second, under different combinations of goods, different costs have a different impact probability on the total quote. Third, the model structure is adjusted and rebuilt using

machine learning. Finally, the Bayesian network model with a parameter probability table can be obtained. Two types of variables were considered: the nature of the goods and the cost factor. Therefore, the Bayesian network model established in this paper has a two-tier structure. The nature of the goods is divided as the input node variable of the model. The specific variables are set as shown in Table 2.

Table 2 Input node variables

	Input node variable		
Variable name	*A1*	*A2*	*A3*
Nature of the goods	Fresh and perishable	Require refrigeration	Timeliness
Examples	Animals and plants, etc.	Drugs, etc.	Public goods

The cost variables of FOB and CIF output are corresponding according to different cost factors. Because of the quotation equations (1) and (2) provided by Incoterms® Rules, and considering the explicit implicit cost problem, the output variables for FOB and CIF in real export operations cannot be the same. The output node variables are shown in Table 3 and Table 4.

Table 3 The output node variable under the FOB

	Output node variable			
Variable name	*A2*	*C1*	*C2*	*C3*
Interpretation	Require refrigeration	Foreign exchange risk	Appointed agent risk	Insurance-related risk
Variable name	*C8*	*C9*	*C10*	*C11*
Interpretation	Other domestic transaction costs	Cost of domestic transportation	Importer credit qualification review	Obtaining relevant information about importing country
	Output node variable			
Variable name	*C4*	*C5*	*C6*	*C7*
Interpretation	Shipment connection risk	Fraud risk	Trust risk	Cost of goods
Variable name	*C12*	*C13*	*C14*	
Interpretation	Service trade profit	Rebate profit	Inventory profit	

It should be noted that the service trade profit, rebate profit, and inventory profit that appear in it are in the form of profit to represent the size of the opportunity cost of traders in the case of CIF and FOB.

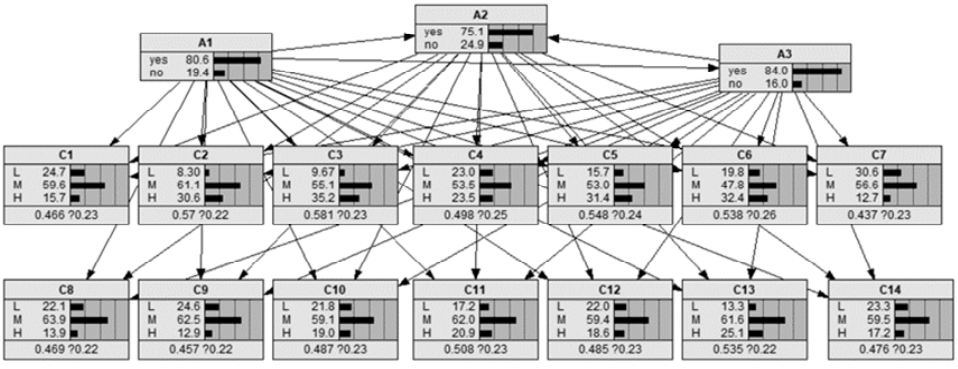
In this paper, the input and output variables are discretised by classification. Since the likert scale (five scales) of the questionnaire is divided by five subjective degree nouns that are progressively increasing (from very satisfied to very dissatisfied) and are not direct values or proportions. For this reason, the likert scale (five scales) was first converted into probabilities. They were then divided into three types of variables – L, M, and H – where L represents the values between 0 and 0.33, M the values between 0.33 and 0.66, and H the values between 0.66 and 1. The sample data was further processed to

obtain a sample set, and the screening of the sample set takes FOB as an example. This paper screened 150 samples of data. The FOB dataset contains 70 sample data, 65 of which were used as training data, and five random samples were used as test data.

Table 4 The output node variable under the CIF

	Output node variable				
Variable name	*A2*	*C1*	*C2*	*C3*	*C4*
Interpretation	Require refrigeration	Shipping market fluctuation risk	Shipment connection risk	Accidental insurance risk	Business loss risk
Variable name	*C9*	*C10*	*C11*	*C12*	*C13*
Interpretation	Other domestic transaction costs	Cost of domestic transportation	Importer credit qualification review	Obtaining relevant information about importing country	Working capital occupation cost
	Output node variable				
Variable name	*C5*	*C6*	*C7*	*C8*	
Interpretation	Risk of rising costs of domestic transportation	Cost of goods	Foreign sea freight	Foreign insurance premium	
Variable name	*C14*	*C15*	*C16*		
Interpretation	Inventory profit	Training fees	Employment costs		

Figure 1 Bayesian network of goods property and cost under the fob



Notes: The questionnaire of the five scales was converted into probability and divided into three variables L, M and H. C_1–C_{14} represents different explicit and implicit costs under FOB price.

Source: Computation using Netica

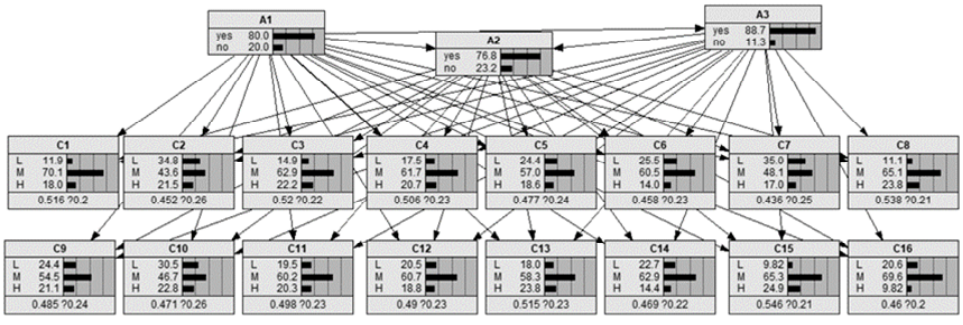
The framework of the two-layer Bayesian network constructed according to the association relationship between the variables is shown in Figures 1 and 2. Bayesian network is extended on the basis of Bayesian formula. Taking the first-layer Bayesian

network structure formed by A1-A3 as an example, its full probability equation (5) is as follows:

$$P(A_1, A_2, A_3) = P(A_1)P(A_3 / A_1)P(A_2 / A_1, A_3) \tag{5}$$

At the second layer of the Bayesian network structure, each Ci is associated with the Ai. In this paper, Netica (the world's most widely used Bayesian network development software) is used for model building and probability calculation. After importing the training dataset, the corresponding probability value of each cost was obtained through the model structure constructed in the early stage and the relationship between the nature of goods and cost. Figure 1 and Figure 2 also show the probability of each variable under the consideration of three goods properties.

Figure 2 Bayesian network of goods property and cost under the CIF



Notes: The questionnaire of the five scales was converted into probability and divided into three variables L, M and H. C_1–C_{16} represents different explicit and implicit costs under CIF price.

Source: Computation using Netica

4 Calculation and analysis

The basic implementation plan of the CIF/FOB quotation selection judgment criteria is determined through calculation and the analysis of M_0 from the perspective of transportation, combined with trade conditions.

The Bayesian network model can be used to obtain the impact ratio of different costs to the total price (L, M, H) under different properties, as well as to further calculate the M_0 value under different goods properties. The different combinations of goods properties were divided into seven categories, covering all types of export goods. The detailed classification and M_0 value are shown in Table 5. Among them, the transportation of goods with the nature of A1 is considered too risky in the actual transportation process, and maritime transportation is rarely carried out in the general business process, so M_0 calculation in this case is not considered.

By using Netica, the probability statistics tables of L, M and H corresponding to the seven categories of goods are obtained, and the probability values are assigned. The probability of the L interval (0–0.33) was assigned a value of 0.165, the probability of the M interval (0.33–0.66) was assigned a value of 0.495, and the probability of the H interval (0.66–1) was assigned a value of 0.83. C_1–C_{16} is assigned according to its corresponding L-M, and after processing with the same dimension, the *weight ratio* C_i of different costs in the total quotation is obtained according to equation (6), as shown in Table 6.

Table 5 Summary of CIF and FOB, and Their Corresponding M_0

A_1	A_2	A_3	*Examples of goods*	M_0	*Inspection*
0	0	1	General cargos that are considered to meet the importer's requirements for timely transportation, such as daily necessities, etc.	1.1349	M_0 is similar to the average value of M_0 for the six different types of goods, which can represent the quotation of general goods
0	1	0	Only needs refrigerated goods, such as general medicine, etc.	1.1569	The value of the goods is high, and the quotation includes the value of the goods, so M_0 is the highest
1	0	0	Only consider the goods as fresh and perishable	-	Transportation is risky. M_0 is not calculated because there is no CIF quotation
1	1	0	Fresh and perishable goods that required refrigeration at the same time, such as the transportation of frozen foods with a long shelf life	1.1416	-
1	0	1	Goods that are fresh and perishable but require timeliness and do not require refrigeration, such as grains and other goods that need to be kept active	1.1251	The goods are of low value and in large quantities. The goods in the market are based on FOB to collect freight and the shipper gets a lower CIF quotation. M_0 is lower than in the general cargo case
0	1	1	Refrigerated goods that need to be transported in time but not fresh and perishable goods, such as some chemical reagents that require refrigerated transport	1.1367	-
1	1	1	Fresh and perishable goods that require both refrigeration and timeliness for general CIF transport goods, such as fresh food	1.1478	-

Table 6 A summary of the weight ratio of different costs (C_i) in the total quotation (values taken to three decimal places)

The nature of the goods			*Weight ratio* C_i															
Fresh and perishable	*Require refrigeration*	*Timeliness*	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}	C_{12}	C_{13}	C_{14}	C_{15}	C_{16}
0	0	1	0.059	0.059	0.059	0.069	0.069	0.059	0.049	0.069	0.069	0.069	0.059	0.069	0.059	0.059	0.069	0.049
0	1	0	0.055	0.064	0.064	0.064	0.081	0.055	0.064	0.072	0.055	0.055	0.064	0.064	0.064	0.055	0.064	0.064
1	1	0	0.074	0.058	0.066	0.066	0.058	0.066	0.058	0.066	0.058	0.066	0.058	0.058	0.066	0.058	0.066	0.058
1	0	1	0.067	0.056	0.067	0.059	0.059	0.056	0.040	0.071	0.067	0.067	0.059	0.067	0.067	0.059	0.079	0.059
0	1	1	0.065	0.060	0.070	0.070	0.060	0.060	0.055	0.065	0.060	0.060	0.060	0.070	0.051	0.070	0.065	0.060
1	1	1	0.066	0.057	0.066	0.065	0.060	0.058	0.060	0.069	0.061	0.057	0.066	0.060	0.069	0.058	0.069	0.058

$$WeightRatio\ C_i = C_i \text{ expected probability} \Big/ \sum_{i=1}^{16} C_i \text{ expected probability} \quad (6)$$

According to equation (4), the calculation of M_0 needs to be based on the *weight ratio* C_7 sea freight and *weight ratio* C_8 insurance premium in Table 6 in the total cost. The M_0 value is further calculated after probability (Table 5). Among them, the value of [0, 1] corresponding to A1-A3 indicates whether to consider this property. Taking A_1–A_3 as (0, 1, 0), that is, only refrigerated goods are considered as an example, $C_7 \approx 0.064$, $C_8 \approx 0.072$, $M_0 = 1/(1–(C_7 + C_8)) \approx 1.1569$. C_7 and C_8 are shown in Table 6 with three decimal places. Table 5 provides representative examples of goods with different properties and determines whether all the values of M_0 obtained through calculation and data analysis are in line with reality.

5 Discussion

The basic implementation plan of the CIF/FOB quotation selection judgment criteria is determined through calculation and the analysis of M_0 from the perspective of transportation, combined with trade conditions.

Under the export trade, according to the nature of the goods traded by the importer and exporter, M_0 is obtained in the selection judgment criteria. The calculation of the M0 can help the cargo owner to make a suitable quotation choice when he has just entered the market or does not understand the market conditions. This also reduces the financial losses caused by information mismatches. After the freight forwarder gives the exporter the CIF quotation, the exporter estimates the FOB quotation based on the current freight and insurance in the market. If the ratio deviates from the M_0 value, the exporter must judge whether to use CIF as the quotation term of the export trade to sign a contract with the importer. It is assumed that the actual CIF/FOB quotation value is R. For exporters, R and M_0 are compared for each transaction. For some goods that are less affected by the actual shipping trade situation, the corresponding selection results of the quotation are shown in Table 7.

But the actual maritime transport and trade environment is not simple. Therefore, in addition to quantitatively providing the ratio of the equilibrium point, the actual situation of maritime trade should also be taken into consideration. The COVID-19 pandemic has led to constant fluctuations in freight rates and insurance for the vessel. Even though the fluctuations in freight rates have stabilised in the post-pandemic era, it has given rise to concerns among traders about how to further rationalise their quotations and how to cope with possible future fluctuations.

Combined with actual business data, this paper also finds some special proportion phenomena. Since there are more general goods in maritime transportation and the quotations of such goods are affected by freight and other factors, the quotation of freight forwarders fluctuates greatly. This paper takes the freight quotation of general goods and the corresponding calculated equilibrium point ratio as an example. The ratio calculated after considering the explicit and implicit costs of such goods is 1.1349. Since each question in the questionnaire is designed only for the proportional relationship between a single cost in the total cost, it is less affected by time changes. For this purpose, 1.1349 can be used as a criteria ratio to compare with the actual ratio for different periods. Taking into account the freight factors under the influence of the pandemic, the freight

forwarding of Shanghai Pudong Lucky Shipping Co., Ltd. shows that the FOB of CMA CGM on the US route in May 2021 exceeded 6,000USD/40HQ (HQ is the high container in the container), and the CIF were more than 7,000 USD/40HQ. Because under CIF and FOB quotation, the operating cost of freight forwarder to help the owner of the transaction is not much different, and considering the large amount of freight can be ignored.

Table 7 Analysis of the selection judgment criteria

Compare	*CIF or FOB*	*Explanation*
$R > M_0$	FOB	The actual quotation ratio exceeds the balance point ratio of the corresponding goods, indicating that the actual CIF quotation of the importer or its forwarder is higher than the FOB quotation and exceeds the reasonable range. If the owner uses the CIF quotation, it will become uneconomical and the cost risk will be high
$R = M_0$	Combined with actual choices	There is no difference in quotation when choosing the FOB or CIF terms for both parties to the trade. There is a balance between the psychological estimates of the two sides. At this time, the exporter should judge the quotation based on the future situation of the market
$R < M_0$	CIF	The ratio of the quotation obtained by the exporter from the freight forwarder is lower than the ratio of the equilibrium point, indicating that the cost of the exporter under the CIF quotation is low. When exporters and importers trade, CIF quotes will also be lower than the importers' psychological expectations. The freight and insurance premiums that importers need to pay will be reduced accordingly

Therefore, if the same kind of goods is quoted in CIF or FOB, the ratio at the equilibrium point is mainly affected by the freight. According to the quoted price in May 2021, the equilibrium point ratio was 1.1667, which is higher than the criteria equilibrium point ratio calculated by cost. By September 2021, CMA CGM's FOB had reached 16,000 USD/40HQ, and CIF reached 17,500 USD /40HQ, which is an increase of nearly three times compared to May. However, the ratio of quotations did not increase exponentially. Instead, it showed a trend of gradual decline from a high level. Therefore, considering the influence of the fluctuation of ocean freight, the explicit and implicit cost of the quotation, M_0 should fluctuate within a range. At the same time, the freight rate from China to the USA and the West Coast of the USA has been fluctuating since 2022, but it has not reached the high freight rate in September 2021. It is difficult to bring the current freight rate down to the value it had in May. So, when the quotation is selected, the equilibrium point ratio is between $M_0 = [1.1349, 1.666]$. On this basis, the exporter of the goods will choose the trade terms according to the quotation of the current period.

There are additional special circumstances in the actual shipping situation. The FOB price reported by the freight forwarder to the importer of the destination port is often thousands of dollars higher than the CIF quotation given to the exporter or its agent, and this part of the cost will be returned to exporters and their agents. Therefore, importers also likely prefer to use CIF to sign contracts with shippers to protect their rights in the event of a pandemic.

6 Conclusions

This paper summarised all explicit and implicit costs involved in CIF and FOB quotations. With particular attention to the costs incurred in the transport link. From the perspective of sea transport, the Bayesian network model was used to obtain the probability of the influence of different cost levels on the quotation under different types of goods. On this basis, the effective interval [M_0] of the CIF/FOB ratio was calculated. For example, the effective interval [M_0] of the quotation for general goods quotation was between 1.1349 and 1.666. Traders can make a reasonable choice between CIF and FOB based on the quotation criteria provided by the equilibrium ratio range. When the actual CIF/FOB ratio exceeds the effective range of, the export trade should be traded at the FOB quotation, and vice versa. When the actual ratio falls within the effective range, the exporter shall choose between CIF and FOB according to the actual transportation market situation and their risk tolerance.

Inevitably, the current CIF/FOB quotation selection judgment criterion has certain limitations. First, the incoterms quotation selection judgment criteria established in this article used the most common trade terms, CIF and FOB, in export trade quotations. There are many more Incoterms in actual business. Depending on the quotation terms, traders can get the effective range of equilibrium ratios by the same model. Second, this article only considers the explicit and implicit costs and the nature of the goods from the perspective of transportation to establish a selection judgment criterion. In reality, many factors affect the quotation. The factors considered by different trading parties are not the same. As far as possible, other unconsidered influencing factors are hypothesised and explained in this paper to ensure that the methods provided herein have a certain accuracy and universality.

Stressors such as the COVID-19 pandemic and the volatility of export trade (especially in the shipping sector) require traders to re-examine their choice of maritime incoterms quotation. The judgment criteria outlined in this paper can effectively help traders in export maritime trade to reasonably choose between CIF and FOB quotations. It can also help traders cope with the impact of cost fluctuations on the final quotations in the face of emergencies such as global pandemics. At the same time, the judgment criteria outlined here expands the analysis of international trade terms, as it comprehensively considers the explicit and implicit costs in the selection of quotations in export trade. Even in the post-epidemic era, the future development trend of the maritime industry is bound to be inseparable from international trade. The research of this paper hopes to provide some constructive reference for the sustainable development and management practice of maritime transport market.

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Appendix

Questionnaire

Investigation of cost factors under the export FOB and CIF quotation

First of all, thank you for taking time out of your busy schedule to participate in this questionnaire survey. The purpose of this questionnaire is to explore the use of 'FOB and 'cost, insurance, freight' (CIF) terms in the actual export trade business, and the understanding of the exporters about the costs under the different terms. It takes about 15 minutes to complete this questionnaire. I hope you can fill it in carefully according to the actual working situation and your own experience. The data obtained from the questionnaire survey will only be used for academic research, without any commercial use. I promise to keep the personal information involved in the questionnaire confidential. Each of your answers is crucial for this study. Thank you again for filling in!

---

1. Are you engaged in or have been engaged in export trade or export agency industry () [single choice]*

□ A. Yes

□ B. No

2. Your position category is () [single choice]*

□ A. Operation agent position

□ B. Sales communication positions

□ C. Operation management position

According to your experience in foreign trade export business, we will evaluate the export quotation terms of the exporter of goods

3. Frequency of your company or your agent company using FOB quotation in export trade [single choice]*

Very high □1 □2 □3 □4 □5 Very low

4. Frequency of using CIF quotation in the export trade of your company or your agent [single choice]*

Very high □1 □2 □3 □4 □5 Very low

In view of the company's current export trade of the value of the nature of the goods on the choice of some problems

5. Do you think the company's FOB or CIF quotation is related to the nature of the goods? [single choice]*

□ Relevant

□ Irrelevant

6. What do you think is that the nature of the company's goods affects the choice of quotation? [Multiple choice] *

□ fresh and perishable

□ refrigerated

□ timeliness

□ Others (please example) _____

Investigation of cost factors under the export FOB and CIF quotation (continued)

7. Is the value of the goods you have represented high? Is the export selection offer a FOB or a CIF? [single choice]*

□ High, FOB (please jump to question 8)

□ High, CIF (please jump to question 22)

□ Low, FOB (please jump to question 8)

□ Low, CIF (please jump to question 22)

The costs required by the exporter under the export FOB quotation include risk cost, transaction cost, opportunity cost and information cost. For some subdivided risks of risk cost, score the probability of the following risks according to your business experience

8. The risk of foreign exchange collection caused by the importer's failure to make payment under different settlement methods (such as collection, remittance payment and telegraphic transfer) [single choice]*

Very important/very high	○1	○2	○3	○4	○5	Very unimportant/ very low

9. Risk probability of the company's foreign exchange collection amount change caused by foreign exchange rate changes [single choice]*

Very important/very high	○1	○2	○3	○4	○5	Very unimportant/ very low

10. Probability of no single delivery and reverse bill of lading in business [single choice] *

Very important/very high	○1	○2	○3	○4	○5	Very unimportant/ very low

11. Risk probability that export business needs to pay additional fees due to port blockage or delayed arrival of goods at the port [single choice]*

Very important/very high	□1	□2	□3	□4	□5	Very unimportant/ very low

12. The risk probability of collusion between the buyer and the ship to cheat goods due to the difficulty of reviewing the importing country credit and the negligence of work [single choice] *

Very important/very high	□1	□2	□3	□4	□5	Very unimportant/ very low

13. Risk probability of the loss of goods at sea due to the buyer's failure to timely insure the maritime transportation insurance under FOB [single choice]*

Very important/very high	□1	□2	□3	□4	□5	Very unimportant/ very low

Under the export FOB quotation, according to some subdivided costs of transaction costs, score the impact of the following costs on the total quotation according to your business experience

Investigation of cost factors under the export FOB and CIF quotation (continued)

14. Cost price of products [Single choice] *						
Very important/very high	□1	□2	□3	□4	□5	Very unimportant/ very low
15. The goods involve the export of domestic tariffs, document fees, employee wages and other expenses [single choice] *						
Very important/very high	□1	□2	□3	□4	□5	Very unimportant/ very low
16. Domestic transportation section involves the cost of goods transportation, storage, packaging, etc. [single choice] *						
Very important/very high	□1	□2	□3	□4	□5	Very unimportant/ very low
Under the export FOB quotation, for some segments of the information cost, score the impact of the following costs on the total quotation according to your business experience.						
17. Understand the importer qualification information and communicate the freight forwarding costs arranged by the importer [single choice] *						
Very important/very high	□1	□2	□3	□4	□5	Very unimportant/ very low
18. Information acquisition and processing costs of the importing country [single choice]*						
Very important/very high	□1	□2	□3	□4	□5	Very unimportant/ very low
Based on your understanding of the opportunity cost of export FOB quotation, evaluate the impact of the profits lost by choosing FOB						
19. The company arranges profits from transportation services and market volatility opportunities to resell goods during transportation [single choice]*						
Very important/very high	□1	□2	□3	□4	□5	Very unimportant/ very low
20. Additional profit opportunities obtained from postponing the tax rebate system (exporters can sign long-term cooperation with tax rebates with shipping companies under CIF terms) [single choice]*						
Very important/very high	□1	□2	□3	□4	□5	Very unimportant/ very low

Investigation of cost factors under the export FOB and CIF quotation (continued)

21. Other investment opportunities brought by inventory occupation of its own funds [single choice] *

Very important/very high	□1	□2	□3	□4	□5	Very unimportant/ very low

The costs required by the exporter under the export CIF quotation include risk cost, transaction cost, opportunity cost, information cost and foreign trade personnel cost. For some subdivided risks of risk cost, give the following risk probability of scoring according to your business experience

22. Changes in the shipping market such as the risk reduction probability caused by the increase in sea freight after the signing of the contract [single choice]*

Very important/very high	□1	□2	□3	□4	□5	Very unimportant/ very low

23. Risk of insufficient product competitiveness and failed price negotiation [single choice] *

Very important/very high	□1	□2	□3	□4	□5	Very unimportant/ very low

24. Risk probability of port blockage and strike goods by port workers [single choice]*

Very important/very high	□1	□2	□3	□4	□5	Very unimportant/ very low

25. Less investment in domestic land transport insurance or the risk caused by the low insurance level of Marine transport insurance [single choice]*

Very important/very high	□1	□2	□3	□4	□5	Very unimportant/ very low

26. Lack of importing country branches or agents promotes the price raising risk of foreign inland carriers (making importers prefer to use FOB) [single choice]*

Very important/very high	□1	□2	□3	□4	□5	Very unimportant/ very low

Under the export CIF quotation, based on some subdivision costs of transaction costs, score the impact of the following costs on the total quotation

27. Cost price of products [single choice *

Very important/very high	□1	□2	□3	□4	□5	Very unimportant/ very low

28. Foreign shipping freight [single choice] *

Very important/very high	□1	□2	□3	□4	□5	Very unimportant/ very low

29. Insurance premiums to help importers insure [single choice] *

Very important/very high	□1	□2	□3	□4	□5	Very unimportant/ very low

Investigation of cost factors under the export FOB and CIF quotation (continued)

30. The goods involve the export of domestic tariffs, document fees, employee wages and other expenses [single choice]*						
Very important/very high	□1	□2	□3	□4	□5	Very unimportant/ very low
31. Domestic transportation section involves the cost of goods transportation, storage, packaging, etc. [single choice]*						
Very important/very high	□1	□2	□3	□4	□5	Very unimportant/ very low
Under the export CIF quotation, based on your business experience in the information cost, score the impact of the following cost on the total quotation						
32. Understand the importer qualification information and communication arrangement of freight forwarding and other expenses [single choice]*						
Very important/very high	□1	□2	□3	□4	□5	Very unimportant/ very low
33. Information acquisition and processing costs of the importing country [single choice] *						
Very important/very high	□1	□2	□3	□4	□5	Very unimportant/ very low
According to your understanding of the opportunity cost of the export CIF quotation, and evaluate the impact of the lost profits in choosing the CIF on the quotation						
34. In the case of freight payment [single choice]*						
Very important/very high	□1	□2	□3	□4	□5	Very unimportant/ very low
35. Inventory cost caused by the backlog warehouse of export goods and the investment profit lost by the occupied funds [single choice]*						
Very important/very high	□1	□2	□3	□4	□5	Very unimportant/ very low
Since CIF involves more foreign businesses and has a large demand for foreign trade personnel, you will score the subdivided cost in the cost of foreign trade personnel according to your experience						
36. Training cost [single choice]*						
Very important/very high	□1	□2	□3	□4	□5	Very unimportant/ very low
37. Employment cost [single choice] *						
Very important/very high	□1	□2	□3	□4	□5	Very unimportant/ very low

Thank you sincerely again for your active cooperation.