

# Research on the Adaptability of Smart Customs Clearance in the Guangdong-Hong Kong-Macao Greater Bay Area

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**Abstract:** This study focuses on optimizing the facilitation of customs clearance models in the Guangdong-Hong Kong-Macao Greater Bay Area (GBA). Addressing the inefficiencies and suboptimal user experiences inherent in the current “two-stop, two-inspection” and “one-stop, two-inspection” models, we propose an innovative “Cooperative Inspection, One-time Release” model and construct an analytical framework based on game theory. Through field investigations of cross-border clearance practices and the analysis of quantitative and qualitative data, this research explores the impact of incentive mechanisms, information sharing, and other factors on clearance efficiency and collaborative willingness. The methodology combines game-theoretic modeling and regression analysis to model key variables and validate the feasibility of the new approach. Key findings demonstrate that the proposed model significantly enhances clearance efficiency, reduces processing time, and optimizes resource allocation. However, its implementation hinges on data interoperability and policy coordination among stakeholders. Theoretically, this study extends the application of game theory to cross-border clearance systems, offering a novel analytical lens for academia. Practically, it provides actionable recommendations for refining cross-border collaboration and customs policies, thereby advancing regional integration and trade facilitation in the GBA. This work contributes empirical evidence and policy insights to the optimization of customs mechanisms in transnational regional cooperation contexts.

**Keywords:** Trade Facilitation; Game Theory; Cross-border Collaboration

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## Introduction

As a key link in promoting the integrated development of the Greater bay Area and facilitating the flow of residents and commerce, the current “two-stop, two-inspection” and “one-stop, two-inspection” modes are faced with bottlenecks such as low efficiency, high cost and insufficient experience, which make it difficult to meet the growing demand for cross-border transportation, and so on. It is difficult to meet the growing demand for cross-border transportation. This study focuses on the feasibility of the “Cooperative Inspection, One-time Release” model, innovatively embeds game theory into cross-border customs clearance scenarios, and proposes systematic strategies from the perspectives of information sharing, policy synergy and dynamic incentives.

## 1. Literature Review

Existing research on cross-border customs clearance in Greater bay Area presents a dual-track vein of “practical exploration + theoretical support”: domestic research focuses on model innovation, Zhang Qiang (2018) and Lin Jing (2021) reveal the efficiency bottleneck of “Two-stop, Two-inspection” and the cost advantage of “One-stop, Two-inspection”, and Li Fuxiang et al. (2021) propose a path to optimize information flow and policy synergy. One-stop, Two-inspection” cost advantage, Li Fuxiang et al. (2021) put forward the information flow and policy synergy optimization path, Fu Bin (2016), He Bin (2024), etc. from the standardization of customs clearance, joint inspection point of view into the regional integration; foreign research to North America “Preclearance “information sharing model in North America, the EU “common border management” digital practice as a reference, combined with Smith's (2021) incentive mechanism and Ostrom's (2020) cooperation game theory, the formation of cross-border collaboration “benefit sharing - dynamic incentives - information synergy” three-dimensional. The three-dimensional framework of “benefit sharing - dynamic incentives - information synergy” is formed for cross-border collaboration.

## 2. Current status and problems of Greater bay area customs clearance

The current customs clearance mode in the Greater bay Area mainly includes “two-stop, two-inspection” and “one-stop, two-inspection”. Among them, Lo Wu Control Point, Man Kam To Control Point, Huanggang Temporary Control Point, Futian Control Point and Liantang Control Point are five control points under the “Two-stop, Two-inspection” mode of clearance, while Shenzhen Bay Control Point, West Kow-

loon Control Point and Sha Tau Kok Control Point are three control points under the “One-stop, Two-inspection” mode of clearance.” Two-stop, two-inspection” is the main mode of customs clearance in the Greater bay Area at present.

## 2.1 Comparative study of clearance modes in the Greater bay area

### 2.1.1 “Two-stop, two-inspection” model

The “two-stop, two-inspection” model means that travelers are inspected separately at the two border crossings to ensure the security and management of entry and exit.

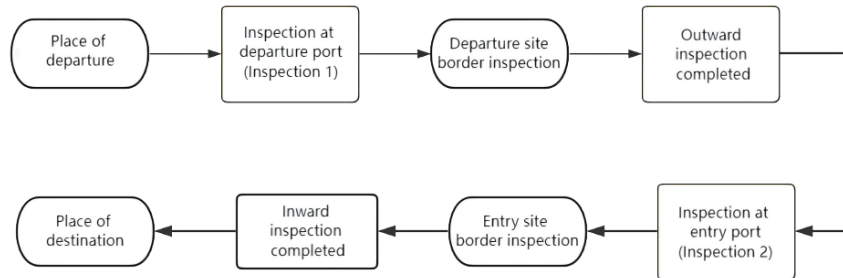


Figure 1. "Two-stop, Two-inspection" Model

### 2.1.2 “One-stop, Two-inspection” Model

The “One-stop, Two-inspection” model refers to the completion of the inspection process at the same location in both places, with both sides of the border jointly setting up inspection facilities at designated ports. The “One-stop, Two-inspection” mode significantly reduces the time required for customs clearance compared with the “Two-stop, Two-inspection” mode, thus enhancing the efficiency of customs clearance.

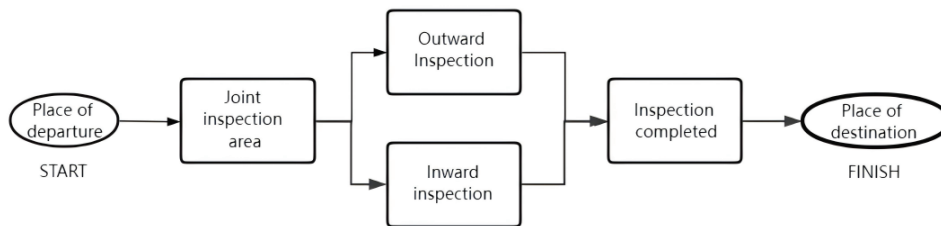


Figure 2. "One-stop, Two-inspection" Model

### 2.1.3 “Cooperative Inspection, One-time Release” model

The “Cooperative Inspection, One-time Release” model is an innovative customs clearance model that aims to achieve convenient customs clearance through unified inspection at the same place. Both sides complete the entry and exit inspection at one inspection point, which reduces repetitive procedures and effectively improves the efficiency of customs clearance.

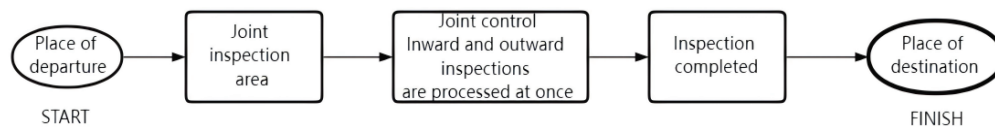


Figure 3. "Cooperative Inspection, One-time Release" Model

## 2.2 Main Problems of the Current Customs Clearance Model

### 2.2.1 Limitations on Customs Clearance Efficiency

According to the survey, the traditional “two-stop, two-inspection” mode has low clearance efficiency during peak hours, resulting in long queues of passengers. The average daily flow of passengers at Liantang Border Crossing is designed to be 30, 000, but since 2024, the average daily flow of passengers has reached 65, 000, with a peak of 102, 000 in a single day, which is 3.3 times the designed flow.

It was also learned in interviews that clearance efficiency is affected by aging facilities and understaffing. in 2024, of the 601 passenger express lanes in the Shenzhen Immigration Bureau, more than 400 were overdue for use with high failure rates, further reducing clearance speeds.

### 2.2.2 Resistance to Information Sharing and Cooperation

Under the “two-stop, two-inspection” model, there are differences in law enforcement, information sharing and regulatory priorities

between the two cross-border regions, which increases the complexity of cooperation. The lack of an efficient data sharing mechanism in the customs clearance process has resulted in the inability to update travelers' information in a timely manner.

In addition, the study found that the lack of information sharing with the law enforcement authorities of Hong Kong and Macau has slowed down the progress of the “cooperative inspection” model.

### 2.3 Exploration of “Cooperative Inspection, One-time Release” Model

To cope with the increasing cross-boundary demand, the two sides of the Greater bay Area have reached a consensus to implement the “Cooperative Inspection, One-time Release” model at the new Huanggang Control Point with a view to enhancing the efficiency of customs clearance. The key feature of this model is that passengers can complete immigration and quarantine procedures at the same location in one single queue. The model aims to reduce the time cost of customs clearance for travelers and minimize the duplication of inspection processes. According to research data, the innovative model is expected to reduce the average passenger clearance time from 15 minutes to 8 minutes.

## 3. Feasibility analysis of the clearance model based on game modeling

### 3.1 Theoretical model construction of this study

This study constructs a full-dimensional cooperation framework covering benefit distribution, continuous incentives and information sharing. The optimal strategy under benefit sharing is explored through the cooperation game model, the dynamic game is used to design a multi-stage incentive mechanism to maintain long-term cooperation dynamics, and the information asymmetry game model is used to identify the key information nodes and enhance information transparency to solve the cross-border trust problem, so as to break through the obstacles of cross-border cooperation and maximize the synergistic efficiency.

### 3.2 Research Design and Game Modeling

In this study, the cooperative game and the information asymmetry game model are used to simulate the strategic interaction between the two sides of Greater bay Area in the “Cooperative Inspection, One-time Release” mode. Specifically, the game model includes the following three levels of analysis:

#### 3.2.1 Model Assumptions and Parameter Setting

Participants: The Immigration and Customs of the Greater bay Area are the main players of the game. Strategy selection: Both parties can choose “cooperative” or “non-cooperative” strategies in the “Cooperative Inspection, One-time Release” model. Utility Function: The utility function of the Greater bay Area is based on the efficiency (E), cost (C) and the degree of information sharing (S). The objective of the utility function is to maximize the efficiency of customs clearance, minimize the cost, and improve the quality of information sharing.

#### 3.2.2 Analysis of Strategy Choice in Game Modeling

This study adopts a static game model to model the decision-making of the two parties in the Greater bay Area in the one-time strategy choice. Assuming that under the cooperative inspection model, the strategies of the two sides in the Greater bay area are “share information” or “do not share information”, the following game matrix is formed:

**Table 1. Static Game Model Matrix**

	HK shares information	HK doesn't share information
GD shares information	$(E1 - C1, E2 - C2)$	$(E1 - C1 - S, E2)$
GD doesn't share information	$(E1, E2 - C2 - S)$	$(E1 - S, E2 - S)$

**HK: Hongkong**

**GD: Guangdong**

**E1, E2:** The value of the improvement in customs clearance efficiency between the two sides of the Greater Bay Area.

**C1, C2:** Costs for both sides of the Greater Bay Area border.

**S:** Coordination costs of information sharing.

In analyzing this matrix, it is found that the utility is maximized when both parties choose to share information, i.e.  $(E1 - C1, E2 - C2)$ . However, if one party chooses not to share information, the other party will suffer a greater coordination loss, resulting in ineffective clearance efficiency.

### 3.3 Equilibrium solution and analysis of the game model

#### 3.3.1 Analysis of parties' willingness to cooperate and incentive mechanism

In order to further explore the long-term stability of cooperation, this study adopts a dynamic game model to analyze the strategy chang-

es of the two parties in multi-stage cooperation in the Greater bay Area cross-border area. In this dynamic model, incentives and penalties are introduced to maintain the parties' willingness to cooperate:

Incentive mechanism: If both parties in the Greater bay Area cross-border land choose to share information at a certain stage, it increases the utility of both parties, i.e., a certain incentive value  $G$  is attached to each party.

Penalty mechanism: If one party chooses not to share information, reduce its utility in the next stage as a penalty value  $P$ .

Utility functions of both sides:

$$U_{gd} = \sum_{t=1}^T (E_{gd} - C_{gd} + G) - \sum_{t=1}^T P \quad U_{hk} = \sum_{t=1}^T (E_{hk} - C_{hk} + G) - \sum_{t=1}^T P$$

In the multi-stage game, in order to maintain a stable cooperative relationship, the incentive value  $G$  must be greater than the penalty value  $P$ . As derived from the model, the equilibrium solution for both parties is a cooperative strategy when  $G > P$ , i.e., each stage chooses to share information.

### 3.3.2 Analysis of costs and benefits

With the introduction of incentives and penalties, this model can be further refined to analyze the costs and benefits under the cooperation model. It is assumed that both sides of Greater bay Area cross-border places each have 50% cost reduction benefits in terms of sharing information and resource optimization:

Total cost of Greater bay Area cooperation: Assuming that the original cost of customs clearance is  $C_0$ , after cooperation the cost for each party becomes  $0.5C_0$ .

Efficiency gains: Assuming that the "cooperative inspection" model reduces clearance time by 30% on average, this gain is quantified as additional utility for each party.

By substituting the above variables into the utility function in the game model, it can be verified that the gain when cooperating is significantly larger than the gain when not cooperating.

### 3.4 Model feasibility assessment

The results of the game model show that the "Cooperative Inspection, One-time Release" model is theoretically feasible. The equilibrium solution of the cooperative strategy shows that when both sides of the Greater bay Area choose to share information and optimize resources, the efficiency of customs clearance is maximized and the cost of customs clearance is effectively reduced. However, the model also shows that in the absence of a reasonable incentive mechanism and an information sharing platform, both parties are likely to reduce their willingness to cooperate due to the high cost of cooperation.

## 4. Research Conclusion and Countermeasure Suggestion

### 4.1 Optimize the Customs Clearance Mode in Greater bay Area

To enhance the efficiency of cross-border customs clearance in Greater bay Area, we need to focus on the two-dimensional optimization of "information sharing + incentive mechanism": on the one hand, to build a unified data sharing platform between Guangdong and Hong Kong, to integrate the data of immigration and customs, and to realize real-time interoperability and compliance sharing through standardized interfaces and security encryption technology, and to promote the agreement on mutual recognition of information, to reduce the duplication of inspection by mutual recognition of credit and results, and to establish a dynamic expansion of the mutual recognition list mechanism. On the one hand, a unified data-sharing platform for Guangdong and Hong Kong will be established to integrate immigration and customs data to achieve real-time interoperability and compliance sharing through standardized interfaces and secure encryption technology.

### 4.2 Strengthening cooperation and communication between the two sides of the Greater bay Area

Both sides of the cross-border area need to establish a regular communication mechanism among immigration, customs and port management departments, and ensure seamless law enforcement collaboration by holding regular joint meetings on customs clearance and forming interdepartmental collaboration groups. At the same time, they should eliminate differences in systems and enhance the transparency of customs clearance through the unification of inspection standards, risk strategies and enforcement procedures; establish a standardized data release mechanism, and enhance the stability of collaboration through institutionalized information sharing and mutual recognition of standards, so as to inject credibility and predictability into cross-border governance.

### 4.3 Enhance the efficiency of cross-border two-way customs clearance in the Greater bay Area

Greater bay Area cross-border customs clearance mode optimization needs to be promoted on two fronts: on the one hand, relying on the "Single Window" system to integrate the entry and exit process, realizing "one declaration for passengers and multiple sharing for goods". One declaration, multi-sharing", combined with face recognition, AI data analysis and other intelligent equipment to optimize automatic in-

spection and baggage scanning links, reduce artificial dependence and improve processing efficiency; on the other hand, through the addition of temporary inspection channels to divert the peak flow of passengers, and comprehensively upgrade the old facilities, the deployment of fast lanes and new intelligent equipment, the formation of a "Technology Enabling + Hardware Strengthening" synergistic system to support the sustainable operation of the 'cooperative inspection' model.

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