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Modeling and Simulation of Regulating Process in International Trade

Master Thesis

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Summary

In today's complex and dynamic trade environment where actors rely more and more on the core competences of other actors along the value chain, the transparency of business process to governments and business actors is required. Regulative mechanisms integrating with well-defined and well-enforced laws and legal guidelines need to be built to enable the business transparency. The traditional regulative mechanism, direct control by governments, however, is insufficient for the complex and dynamic business environment. Self-regulation can be viewed as a new regulative mechanism to adapt to today's complex and dynamic business environment. The shift of tasks from direct control to self-regulation results in the change of relations and dependencies among multi-actors, particularly the relation between governments and companies.

In order to study the differences between different regulatory mechanisms, especially self-regulation and direct control in regulative interactions between governments and companies, I firstly use the OperA+ organization modeling approach to analyze different regulative and interactive structures in international trade by case study, and then simulate corresponding regulating processes in order to compare between two regulating approaches, i.e., direct control and self-regulation. The main research question is:

> *How to analyze the regulating process under self-regulation and direct control by OperA+ and what are the differences between the two regulatory mechanisms?*

To be able to answer the main question, there are some sub-questions which should be answered.

a. *What are the roles involved in international business trades?*
b. *What are the types of relations and dependencies between the actors in international business process?*
c. *How to design collaborative models among multi-actors in business trades and simulate them?*
d. *How to analyze the results of the simulation of the multi-organization model?*

The main methodologies in this project are case study and simulation. Six cases are selected and analyzed by OperA+, a framework based on a multi-agent approach. The organization models are established according to the roles and dependencies identification by using OperA+. Then the simulation model is set up based on the organization model. During simulation, indicators are set to measure the performance of the business trades under different regulatory mechanisms.

To better understand the project, literature review is done at the beginning of the project. Firstly, the advantages and deficiencies of self-regulation are presented according to our literature research. Secondly, multi-agent systems are introduced as a basis for our proposal.

Finally, the OperA+ organization modeling approach is presented, which will be used to guide how to define roles and dependencies to develop multi organization models in case analysis.

After literature review, six cases are selected: apple export from China to the EU, grape export from South Africa to the EU, clothes export from China to Canada, dairy export from Denmark, paper export from Finland to Asian countries and shipment between US and Mexico. All the cases are related to international business trades with regulations. The organization models of all the cases are specified based on the identification of roles and role dependencies. Through comparisons between the different organization models, several factors influencing regulation are identified. At first, the similarities and differences between two regulatory mechanisms are presented in the apple export cases. Moreover, the influences of different aspects of regulation in international business trade are shown based on the comparison between the case of apple export from China to the EU and the case of grape export from South Africa to the EU. Furthermore, comparison between food business trade and non-food business trade shows the influences of different types of products on the regulations in international business trade.

Then the organization model of the apple export case is developed into a simulation model to analyze how business actors and regulators perform in the international business trades under two regulatory mechanisms. The simulation model is setup according to the agent interaction model (see the *figure0-1* below). Based on the data obtained from simulation, the differences of performance of international business trades between the two regulatory mechanisms are presented.

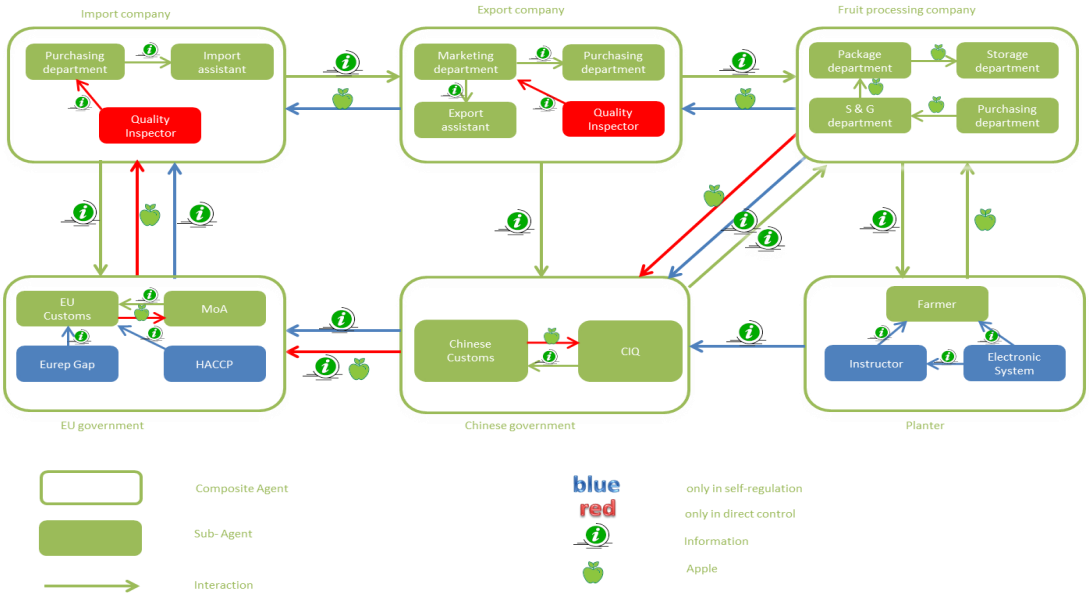

Figure 0-1: Interactions structure of agents

At last, I conclude this thesis with several implications, based on organization models and data analysis after simulation.

1. The change of regulatory mechanism results in the change of dependencies between regulators and business actors, and the change of regulators' activities. To enable the

effectiveness of self-regulation, the explicit and strict sanctions have to be set up.

2. Because different areas or different standards influence the regulative relationship between regulators and business actors, unified standards or codes for the same product in the world are able to simplify the regulative relationships.

3. Main actors' interests should be considered in setting up new regulatory mechanism – self-regulation.

4. In order to measure the performance of self-regulation, time, costs, risks and other factors should be taken into consideration.

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1. Introduction

Since international business processes involve multiple cross-border actors and business activities are performed in different countries, it is impossible to regulate and monitor cross-border activities simply by direct control. Self-regulation can be viewed as a new regulative mechanism to adapt to today's complex and dynamic business environment. In this project, I will analyze the interactions between multiple organizations and various regulators under self-regulation and direct control to investigate the differences between them. In this chapter, I will introduce the problem orientation, research objectives and questions, and research methodology to present an overview of this project.

1.1 Problem Orientation

With the dramatic development of economy and the advent of new information technology, business globalization has been realized in many fields for resources optimization and profit maximization. Driven by this trend, increasingly more strategic alliances, collaborative commerce and virtual corporation (Chea and Bui 2004) are established to complete business processes in an integrated way. Multi-actors from various locations are involved in the business value chain to accomplish their cooperative goals. Under today's complex and dynamic environment where actors rely more and more on the core competences of other actors along the value chain, the transparency of business process to governments and relative actors is required.

Regulative mechanism integrating well-defined and well-enforced laws and legal guidelines needs to be built to enable the transparency of business (Overbeek, Virginia and Yao-Hua 2010). The traditional regulative mechanism, direct control by government, however, is insufficient for the complex and dynamic business environment. Since international business activities along the value chain are achieved in various actors in different locations, it is impossible to monitor and inspect specific activities directly by inspectors in supervision department. Furthermore, conflicts among multi actors resulting from the differences of law, norms, values and culture (Sorsa 2010) are very normal in international businesses. Such conflicts are the barriers to direct control by regulators in international business trade.

Moreover, direct control imposes too many limitations on the specific activities of multi actors, influencing the progress of the business process. In addition to the cooperative goal, each actor involved in the business process has its own objectives. Although actors are interdependent on resources or competences of their partners to fulfill expectations, they have their own capabilities and resources. Each individual organization has right to decide how to achieve its own business activities and maximize its profits (Jennings, et al. 1998). The business activities in value chain should not be seen as a rigidly defined set of actions, bus as relationships among semi-autonomous actors (Cysneiros and Yu 2003). Moreover,

dynamic environments bring about changes in the relations or dependencies among actors. Therefore, autonomy enables actors to have flexibility to deal with the inconstant relations with other actors. To both fulfill the compliance and agility, the direct control by government seems to be insufficient to the requirements in today's business environment. Frequent interruptions from government impact the progress of the business process, resulting in the delay of some activities.

Furthermore, the monitoring and inspecting costs of direct control are increasingly high in modern business trade. Actors are physically distributed, resulting in a large amount of traffic for inspectors involved in the regulative process. Additionally, in very specialized fields, regulative organization might need to hire external professionals to help them monitor and inspect, leading to the increase of costs.

Obviously, based on the previous reasons the traditional regulative mechanism - direct control cannot adapt to the complex and dynamic business environment, bringing about unnecessary interventions and inefficiency. Therefore, self-regulation as a control approach in the international business trade to certify corporate social and environmental performance (Sorsa 2010) has been introduced to complement direct control in the regulation of modern international business trades.

Thanks to the development of information technology, the exchange and tracking of information can be realized via internet, which is the precondition for application of self-regulation. In self-regulation, the government will set the boundaries of the business activities; while the enforcement mechanism is carried out by company itself without regulatory supervisor (Overbeek, Virginia and Yao-Hua 2010). The information exchange and data monitoring are mainly realized via internet. From the regulators' perspective, self-regulation might be an effective instrument to ensure complacence with legislation instead of public enforcement (Ayres and Braithwaite 1992); from company's perspective, self-regulation gives them enough space to operate its activities freely within the legal scope and therefore reduce the continuous interventions by direct control. So far, the certification mechanisms as one of method of self-regulation are widely used in many types of industries in the world. The governments or institutions related to the certain industry set up the codes of practice for the economic actors in this industry. The economic actors design their enforcement mechanisms in order to comply with the codes of practice. If they are up to the standards, they will get certifications, meaning that those economic actors are trustworthy. The activities of them or their products do not need to be inspected or monitored directly by supervision department, simplifying the regulatory procedures. Authorized Economic Operator (AEO) program (European Commission 2007)is a good example of certification mechanisms. However, being a new regulative mechanism, self-regulation will need to prove itself before fully-fledge introduction as regulatory mechanism.

To achieve effectiveness and efficiency of self-regulation, many issues must be taken into account. Self-regulation will redistribute or delegate the control tasks among the actors (Brugemeestre, Hulstijn and Tan 2010). The shift of tasks will result in the change of relation

and dependency among multi-actors, particularly the relation between governments and companies. Obliviously, the traditional interaction types have become obsolete. Therefore the new type of regulative interactions between governments and companies has been one of crucial issues to influence the degree of effectiveness of self-regulation.

1.2 Research Objectives

Under direct control, the interactions between companies and regulators are relatively simple and direct. Regulators not only set the norms or standards for the business processes and products, but also specific requirements of each business activity along the value chain. Then regulators will inspect the business activities of different actors directly and ask for the relative data and information regularly to control the specific activities. The actors who are involved in the business process have to accept inspections from governments or other regulatory organizations and provide the specific data and information to them in order to get approval of the regulators.

In contrary to direct control, in the self-regulation control mechanism, regulators liberate the actors from the limitations of specific activities. The enforcement mechanisms are carried out by the actors themselves according to the norms or standards set by regulators. The shift of the control tasks leads to the changes of the behaviors of both actors and regulators, and therefore the interactions between actors and regulators. Instead of specific activities, regulators inspect and monitor the enforcement mechanisms designed by actors under self-regulation. Companies apply information technology to make the regulatory activities transparent and regulators can check the relative information via internet in real-time.

In order to research the differences between self-regulation and direct control, particularly in the regulative interactions between governments and companies, I will use OperA+ modeling language to analyze the regulating process and interactions, and then simulate the regulating process to see the results. In this project, there are two main objectives:

1. *To test whether the OperA+ organization modeling approach is an effective approach to analyze the international business trades with multi-actors.*

2. *To contribute to a better understanding of the differences between self-regulation and direct control mechanisms.*

1.3 Research Questions

Based on the objectives, the main research question in this project will be:

How to analyze the regulating process under self-regulation and direct control by OperA+ and what are the differences between the two regulatory mechanisms?

To be able to answer the main question, there are some sub-questions which should be answered. Firstly, multiple actors are involved in the international business trade and are expected to complete various business activities along the business value chain. Each actor will perform different activities in the value chain and coordinate with other actors to achieve the collective goals. Therefore, to study the interactions, I should define the roles played by the actors in the regulative process. The first sub-question is therefore:

a. *What are the roles involved in international business trades?*

However, identification of roles is not enough to understand how the roles behave in the business process. The relations and dependencies between the actors in the business process have to be defined as well. With the analysis of roles dependencies, we can know their interaction patterns and understand the changes of dependencies among actors from direct control to self-regulation. The second sub-question is:

b. *What are the types of relations and dependencies between the actors in international business process?*

Based on the identification of roles and their dependencies, OperA+ is used to develop an organization model. However, this model just delineates the differences between two regulatory mechanisms from the perspective on the relations between actors and the structure of organizations. In order to analyze the performance of business trade under the two regulatory mechanisms, a simulation will be conducted. The third sub-question is:

c. *How to design collaborative models among multi-actors in business trades and simulate them?*

Through this simulation, the results will be analyzed to investigate the differences between the two regulatory mechanisms. The fourth sub-question is:

d. *How to analyze the results of the simulation of the multi-organization model?*

1.4 Methodology

In this section, I introduce the research strategies used in this project. The whole project will be divided into four phases: roles identification, interaction identification, simulation model design and result analysis. In the following, I will introduce four phases separately.

Phase I: Roles identification

At the beginning of the project, roles will be defined. After the literature review in the domains of self-regulation, multi-agent system and the current situation of regulation in Netherlands, I get better overview and understanding of this topic. Case study is one of the main research strategies through this project.

The cases are chosen according to several conditions. Firstly, they should involve business processes or transactions. Secondly, the business activities should be taken place in the dynamic and open environment, involving multi-actors in multi locations. Thirdly, the interactions among the multi-actors are considered as a necessity to achieve the various activities. Finally, the description of regulation mechanism in the business processes or transactions is required.

To analyze the cases, we use the OperA+ organization modeling approach. At first, the collaboration structure of the cases will be identified. Moreover, the norms and objectives, including social objectives and sub-objectives will be collected by desk research to define the roles. Based on the information collection, I will interpret norms into specific compliant behaviors of the business process. Then according to the objectives and specific behaviors, roles will be determined in the whole process by using the concepts in OperA+ modeling approach. Simultaneously, the objectives, capabilities and activities of each role will be specified.

Furthermore, according to the OperA+ modeling approach, roles are divided into two groups: atomic and composite. For composite roles, the internal organization structures of the second layer of role will also be determined. The same methods are used to define roles on the top layer.

Phase II: Interaction identification

After identifying roles, I will determine the types of interactions and dependencies between them. According to the objectives and capabilities of roles, I will establish the scenarios which describe how actors interact with each other to achieve the objectives. In these scenarios, I will define the types of dependencies between actors based on the identified roles. One point to notice is that dependencies between roles and the activities of roles might differ in different scenarios. On the basis of the roles and interaction identification, the organization model is developed using OperA+ modeling approach.

Since each case has its own properties, I will compare their organization models to analyze the differences and similarities. The models of business trades under direct control and self-regulation mechanism will also be compared in this phase.

Phase III: Simulation

This phase will be divided into two steps: model design and implementation. The NetLogo simulation language will be employed as the main instrument to design and simulate the model which will conduct the business process with multi-agents, representing the dependencies between the agents and involving the regulation requirements and normative values.

I will start by translating the organization model into to represent the whole business processes according to the regulatory mechanisms. At the same time, indicators are set to measure the performance of the business trade. After development of the conceptual model,

it will be implemented using Netlogo.

Phase IV: Result analysis

During the simulation phase, we have already identified some performance indicators, such as time, costs. The data of each indicator will be collected through simulation of model in last phase. SPSS is used for analyzing the results. Based on the data analysis, I will look for differences of business trade between two regulatory models. Finally, according to the result analysis, I will give some conclusions and recommendations for improving the current regulatory mechanisms.

2. Scientific Background

In this chapter, I will introduce theories and approaches that will be employed in this project, and some scholar's viewpoints of such theories.

2.1 Self-regulation

Regulations are carried out in most of the industries in order to standardize production, final products to reduce the risks and crimes in the international business trade.

Compliance enforcement covers all activities and strategies to ensure that a company follows all guidance and implements all measures required by an external or internal regulation (Kharbili, et al. 2008). Traditional enforcement mechanisms often require external supervisors or regulative organizations to monitor the behavior of the companies and impose sanctions in case of norm violations. This mechanism is called *direct control*. *Self-regulation* refers to a firm's adoption of performance standards or management systems beyond or replacing the requirements of government regulations (Christmann and Taylor, Globaliztion and the Enviornment Determinants of Firm Self-Regulation in China 2001). It can be viewed as a complementary regulative instrument which can avoid complexity and delays of regulatory process.

Under direct governmental regulation, regulators not only set the norms for the business processes and products, but also specify and enforce rules on each business activity along the value chain. In order to correctly shape the involving actors' behavior, regulators have to specify the business activities in length to cover the complexity of different activities (Braithwaite 1982). While under self-regulation, each company can design its own regulatory mechanism according to the company's situation within the boundary of the regulation set by governments and relative organizations. The regulatory organizations would inspect the regulatory mechanisms set by companies instead of specific business activities (Braithwaite 1982).

International business trades across many countries bring about the complexity of the transactions because of the different customs and traditions (Dwarka 2009). As mentioned above, the deficiencies of direct control in today's economic environment show the need for a new regulative approach. Compared to the direct control, self-regulation has several advantages in today's complex and dynamic business environment.

At first, from financial point of view, direct governmental control will cost more money to do an adequate job on its own (Braithwaite 1982). Sometimes governments cannot afford a large amount of monitoring and inspection costs to check every workplace for compliance (Braithwaite 1982). Under self-regulation mechanisms, cooperative organizations will regulate the business activities by themselves; while government just needs to monitor

companies' control mechanism, instead of specific activities. It will decrease the costs of monitoring and inspections for governments.

Secondly, the self-regulation is able to deepen the inspection and enlarge the regulating coverage. There are two main reasons. One is that employees in the companies have more expertise and are more familiar with the business process (Ogus 1995), compared to the governmental inspection officers. The employees in companies are the persons who are really executing the business processes and know the details of all business activities. They know to which part of the business process they should pay more attention. The governmental regulators are more likely to follow the formal specification closely; ignoring the potential risks inside. Companies are more capable than external inspectors to regulate its activities since no other organization is more familiar with the business activities than the companies themselves. Another reason is that external regulators usually cannot enter a plant to monitor the activities at any time or cannot get complete and firsthand data timely (Braithwaite 1982). The external regulators usually do not have opportunities or legal authority to track all activities deeply. By contrast, the power of companies' inspectors is greater than the external regulators because they are inside the companies.

Furthermore, the efficiency of the regulatory process will be increased by self-regulation. In the traditional regulatory mechanisms, the phenomenon of repeats of tasks and overlaps of information are usual. Additionally, frequent interruptions due to inspection impact the progress of the business process. Self-regulation optimizes the regulatory process by using the information technology. The information sharing and electronic flow is able to let each actor, including governments, share their own data easily, as well as access other actors information in time, despite the geographically distance (Jennings, et al. 1998). Once information is shared in the system, actors can gather them simultaneously. It reduces greatly the works of information duplication for different actors.

On the other hand, self-regulation has some weak points. Firstly, the self-regulation mechanism set up by individual enterprise or industry may lack the quality required by government (Palzer and Scheuer 2003). The builders of self-regulation mechanism just only focus on their own specific interests which can bring about tangible and intangible benefits, usually ignoring the global interests. This can result in damage of part of public or other actors' interests. Secondly, the voluntary nature of most self-regulation does not force every company to join in (Lenox and Nash 2003). Some small companies with little capital may prefer to stick with the traditional regulatory mechanism since they are not able to invest much money on self-regulation mechanism. Therefore self-regulatory mechanism does not have influence on such companies.

Last but not least, cheating behaviors of companies and ineffective self-regulatory mechanisms may lead to the violations of codes of practice, which may bring about serious loss or harm for both business stakeholders and customers when they are discovered too late. Unsafe food without inspection will result in the harms of health of human if they are thrown into the market (Barendsz 1998). Hazardous substance is dumped during production by some companies because of the incomplete inspection mechanisms, causing

environmental pollution (Christmann and Glen 2005). Generally speaking, violations of standards or codes result from two main reasons. One is that some companies intend to exploit an advantage from the vague rules or trust under self-regulation mechanisms, deceiving the customers and other stakeholders. Since self-regulation is set up based on the context of trust, companies' honesty and consciousness of complying with laws are crucial to influence the effectiveness of self-regulation mechanism. If a food company who has certification enabling product exemption mingles unhealthy food with eligible food to launch on the market for great profit, consumers will have the risks of food poisoning. The other one is that companies do not want to cheat deliberately, but the faulty self-regulatory mechanisms may bring about the violations which are not discovered by companies themselves.

As a result, effective self-regulation mechanism should be set up based on the explicit laws or codes and tough sanctions. The explicit laws or codes enable companies to set up complete self-regulatory mechanisms and minimize the risks of opportunistic behaviors of companies from the loophole of laws. The items of tough sanctions should be published accompanying the codes of practice in order to push companies comply with the laws or codes. If the violations are discovered, the supervision department will impose tough sanctions on the perpetrators so that companies do not dare to make mistakes.

2.2 Multi-agent System

Understanding self-regulation in the complex and dynamic economic environment efficiently and effectively is challenging to regulators and social scholars.

Since compliance covers many aspects of business and ranges from financial laws to quality standards (Kharbili, et al. 2008), self-regulation should integrate different laws, standards, and values into the regulative process to regulate the business process involving multi actors. Generally speaking, compliance requirements come from a) international business trade rules; b) national's laws; c) industrial standards; d) individual company's guidelines; e) cultures. Such variety of the norms may result in some conflicts and inconvenience (Sorsa 2010) in the regulatory process. In order to decrease the conflicts and facilitate the self-regulatory process, not only the uniformity of the values and standards (Gorton and Reiff-Marganiec 2007) are required, but the normalized interaction framework among the multi-actors are needed (Weber, Barth and Hasselmann 2004).

Organizations involved in the supply chain are autonomous as well as interdependent (Vulkan and Jennings 2000). On one hand, although multiple organizations achieve the business process together, each organization has its own objectives, capabilities and resources. The organization has the right to decide how to achieve the business activities and try to maximize their own profits (Jennings, et al. 1998). On the other hand, multiple organizations have to interact with each other frequently to enable the consistency of the business process. They are not the single units, but interdependent with each other.
To analyze the business process involving multi actors, Jennings (1998) proposed to look at

the business process as a collection of autonomous, problem solving agents which interact when they have interdependencies. Multi-agent system (MAS) is a structural environment within which a set of artificial agents act together and interact with each other to realize their collective goals (Ferrand 1996). With more and more interdependencies between real life and computer science, new technologies and mindset are developing on the basis of the computer science to satisfy various demands. MAS is one of them, which is developed in 90's to resolve the problems encountered in the environment where distributed units with their own type of knowledge or expertise (Gilbert and Terna 1999)complete the collective goals together through interacting with each other (Conte, Nigel and Jaime Simao Sichman 1998).

Wooldridge and Jennings (Wooldridge and Jennings 1995) described the following the properties of MAS:

- *Autonomy* - agents operate without the direct intervention of humans or others, and have some kind of control over their actions and internal state;
- *Social ability* - agents interact with other agents (and possibly humans) via some kind of agent-communication language;
- *Reactivity*: agents perceive their environment and respond in a timely fashion to changes that occur in it;
- *Pro-activeness*: agents do not simply act in response to their environment, they are able to exhibit goal-directed behavior by taking initiative."

MAS are used to define a virtual environment, within which a number of software objects, the 'agents', representing individual or organizational actors interact with each other (N. Gilbert 2004). The interactions between the agents in the virtual environment can be modeled to correspond to similar interactions between actors in the real world. Besides the collective goals of the multi-agent system, each agent has its own autonomous and objectives. It can perceive the environment and make decision to behave individually on the basis of the established rules (Bonabeau 2002). In addition to the known behaviors in the real-world, multi-agent system is able to develop unanticipated behaviors (Bonabeau 2002). Since the complexity of behaviors of actors and the dynamical change of environments can be described naturally by MAS approach, the applications of MAS are very extensive, from biology to social science.

In previous research, several approaches or models based on multi-agent system have been studied to manage dependencies, deal with cooperative decision makings or integrate with heterogeneous units in the process management involving multi actors. The advanced Decision Environment for Process Tasks (ADEPT) system approach focuses on the negotiation in the service providing process (Jennings, et al. 1998). The architecture of ADEPT involves a responsible agent who interacts with peers and the subsidiary agencies and tasks within its agency. Order Fulfillment Process (OFP) is applied in supply chain networks based on multi-agent system, starting with receiving orders from customers and ending with delivery of the finished goods (Lin, Tan and Shaw 1995). The organization-Centered Multi Agents

System (OCMAS) builds the agents from an organizational point of view (Ferber, Gutknecht and Michel 2002). In designing this framework, the activities on organizational level will be specified, but the methods to conduct the activities will not be described. This approach is used in the complex programs, in which agents may create, enter and leave at any time during the lifetime. OperA+ is similar to this approach.

2.3 Conception of OperA+

As far as we know, there are a number of organization modeling approaches based on MAS, which are capable of solving problems in complex and dynamic environment with multi-actors. However, the agents in most of approaches are considered as atomic entities which cannot be further decomposed (Cossentino, et al. 2012). Additionally, such agents are usually described on the same conceptual level, leading to an extremely large model consisting of a mass of fragmentary information (Jiang, Dignum and Tan 2011). This may lead to an unnecessarily complex model since it is not easy to organize and describe multiple agents at the same aggregation level. Also the relatively large model at the same level does not have enough flexibility to adapt to change (Jiang, Dignum and Tan 2011).

Because of its ability to describe MAS at different levels of abstraction, I will use the OperA+ organization modeling approach to analyze the interactions between actors in the international business trade. OperA+ is a new approach based on MAS, which can make up the deficiencies mentioned above. Firstly, the model contains not only atomic entities, but also composite ones which enable to analyze the process with multi-actors at different levels of abstraction (Jiang, Dignum and Tan 2011). The overall systems with main actors are modeled at the higher levels to provide a holistic picture of the whole process; while the components are specified according to specific requirements at the lower levels (Jiang, Dignum and Tan 2011). It is easy for actors to understand their positions in the process clearly and the models can be adjusted flexibly for changes.

Moreover, unlike some of the multi-agent system approaches, OperA+ inherits the characteristic of OperA mdoel, distinguishing the roles from agents. It provides two representation dimensions: *specification* dimension and *enactment* dimension. The *specification* dimension presents the regulating structures in terms of connected roles and organizations while the *enactment* dimension presents the acting components in terms of agents enacting the roles (Dignum and Aldewereld 2010). The meta model of the OperA+ framework in *Figure 2-1* shows the main concepts and their relationships.

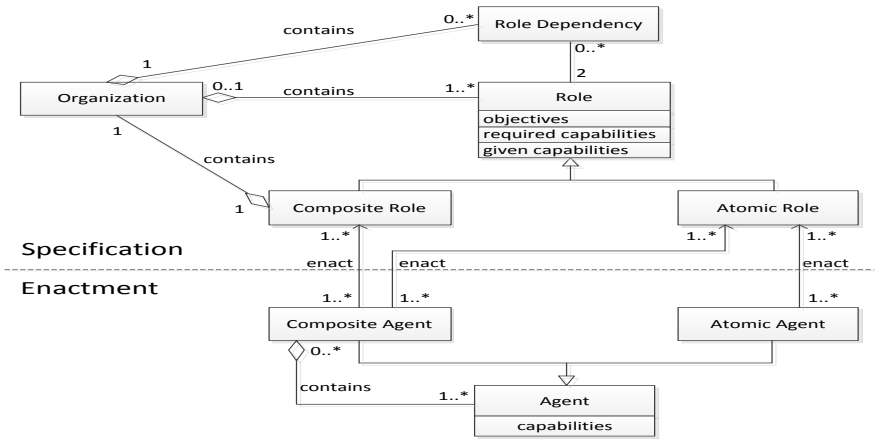

Figure 2-1: Meta-model of the OperA+ framework Source: (Jiang, Dignum and Tan 2011)

Some concepts of OperA+ that will be used in this project are described below (Jiang, Dignum and Tan 2011).

Definition 1. (*role*). A role *r* is a tuple (Obj_r, $RCap_r$, $GCap_r$, org_r) such that:

- Obj_r is a set of atomic objectives,
- $RCap_r$ is a set of atomic capabilities required by the role to accomplish the objectives,
- $GCap_r$ is a set of atomic capabilities given by the role to accomplish the objectives,
- $org_r = (R, Dep)$ is an organization which contains a set of roles $R = \{r_1, r_2, \cdots, r_n\}$ and a set of role dependencies $Dep = \{dep_1, dep_2, \cdots, dep_m\}$ where $dep = (r_i, r_j, obj)$, $r_i, r_j \in R$, $obj \in Obj_{r_i} \bigcup Obj_{r_j}$,

When $org = \phi$, *r* is an atomic role. When $org \neq \phi$, *r* is a composite role. Objectives and capabilities are expressed as predicates.

Definition 2. (*agent*) An agent *a* is a tuple (Cap_a, A_a) such that:

- Cap_a is a set of atomic capabilities,
- $A_a = \{a_1, a_2, \cdots, a_k\}$ is a set of agents,

When $A_a = \phi$, *a* is an atomic agent. When $A_a \neq \phi$, *a* is a composite agent.

A particular instance of specification and enactment is illustrated in *Figure 2-1*.

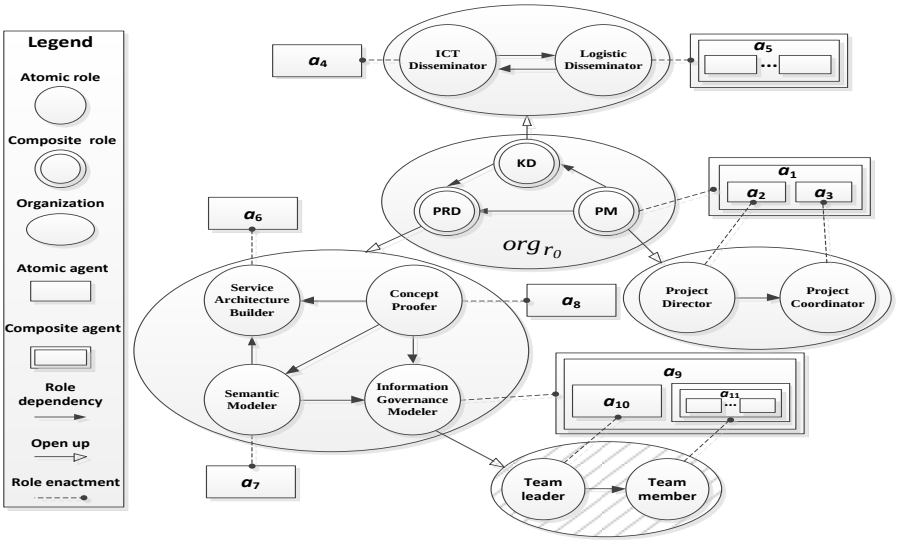

Figure 2-2: The specification and enactment of the project Source: (Jiang, Dignum and Tan 2011)

In the first layer, three composite roles are presented: the *Project Manager* (PM), *Knowledge Disseminator* (KD) and the *Project R&D* (PRD). PM is specified into the sub-roles: *Project Director* and *Project Coordinator*; KD is specified into the sub-roles: *ICT disseminator* and *Logistic disseminator*; PRD is specified into four sub-roles. One of the sub-roles on the second layer of PRD – *Information Governance Modeler* is further specified into two sub-roles on the third layer: *Team leader* and *Team member* shown in the shadow area. The rectangles represent the enactment of roles. PM is enacted by a research institute a_1 in which two employees a_2 and a_3 enact the sub-roles. The KD is enacted through two independent agents a_4, and a_5. The PRD is enacted through four independent agents a_6, a_7, a_8, and a_9 which is a university that further elaborates it into a_{10} (a person) and a_{11} (a group of researchers) in order to enact the two sub-roles on the third layer. All the role enacting agents in this project are selected by the project owner through comparing the obtained capabilities of the candidate agents with the required capabilities of the roles. In addition, if a new role *Norm modeler* is added in the organization of *Project R&D*, it will only influence the related roles and their enacting agents within this organization, which makes the whole model more stable (Jiang, Dignum and Tan 2011).

In addition, OperA+ model has another advantage for analyzing international business trade with regulations: context-aware. Since the environment of international business trades is dynamic and complex, a large number of factors affect the regulative relationships between regulators and business organizations, such as: diversity of transaction goods, diversity of regulation policies and diversity of partnerships (Jiang, Dignum, et al. 2011). As a result, the regulatory processes are diversified in different international business trades. Therefore the relations or dependencies between governmental organizations and business organizations are different due to the different regulatory processes. In order to deal with this difference, OperA+ develops the context-aware applications for modeling different interactive environments.

The context-aware of international business trades is specified in three layers in the OperA+ model (Jiang, Dignum, et al. 2011). They are:

- General specification: to express the common objectives of inter-organizational collaborations
- Contextual specification: describe the interactive relationships and present sub-roles in the lower level
- Operational specification: depict complete pictures of the collaboration model in different executive situations.

The *Figure 2-2* gives the example to present how to analyze the case with context-aware by OperA+ model. It shows the differences of operationalization level between two contexts: ctx_1 and ctx_2. Each operational specification contains a complete description of organizational interactions in its own context. For example, a beer company with an AEO certification in the Netherlands exports beer to another country in the EU and the Dutch Customs has to perform regulations on it. In this case, the company and the Dutch Customs fit in with the interactive environment of ctx_2, which indicates that each of them has to perform as the specifications of the lower level organizations in es_2 (Jiang, Dignum, et al., A Context-aware Inter-organizational Collaboration Model Applied to International Trade 2011).

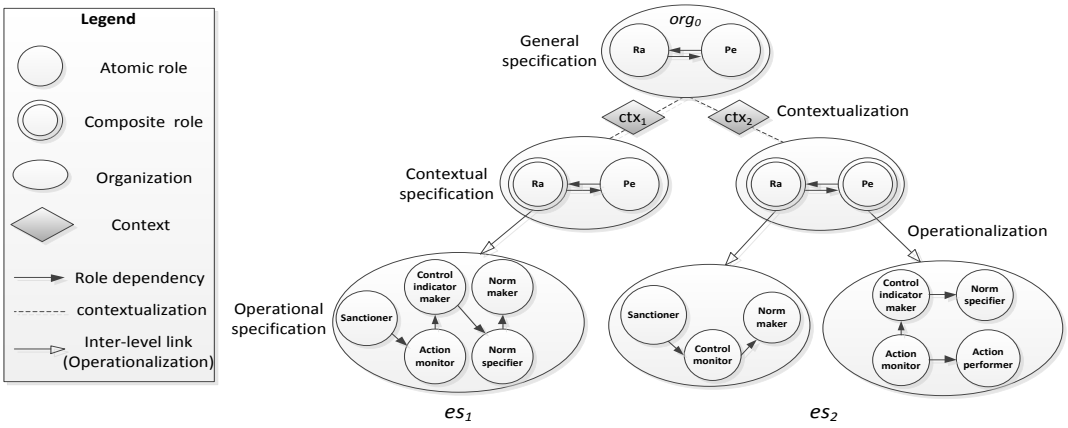

Figure 2-3: Modeling process of the example Source: (Jiang, Dignum, et al. 2011)

3. Case Analysis

In this chapter, I will apply the OperA+ modeling language to analyze cases related to the international business trade. In each case, I will identify the roles and dependencies between roles by OperA+ approach and design the collaboration structures to represent the roles and their dependencies. The two main cases are the apple export from China to Europe and the grape export from South Africa to Europe. After the analysis of each case, I will make cross case comparisons between cases and give a conclusion of the overall case analysis.

3.1 Apple Export Case

China's apple exports volume took up 13.5 percent in the global apple exports in 2007 (UNcomtrade 2007). In order to export more apples for great profits, China made the policy to standardize the quality and safety of the export apples, and provided large amount of money in subsidies for producing high quality apples that can meet the requirements of international regulations (Zhang, Qiu and Huang 2009). In the following, I will analyze the case of apple export chains from Qixia, the leading apple export region in Shandong, China to the EU, involving many business activities from planting apples trees to exporting apples. The case is selected from the Zhang, et al. article (Zhang, Qiu and Huang 2009). I will analyze the regulatory process in the apple export-import process under direct control mechanisms adopting OperA+ modeling language. After that, I will set up the self-regulatory mechanisms according to the current policies and analyze the self-regulatory process in the apple export-import process, adopting OperA+ modeling language.

3.1.1 Regulation background

1. Relative regulations and institutions:

In 1984, Qixia, the most famous apple growing region in China, was defined as a Quality Apple Production Base by the Chines Ministry of Agriculture (MoA). In 2001, China planned to set up a sound food quality and safety standard system to satisfy both domestic and international consumers' demands. The pollution-free Food Action Plan is introduced to promote the use of organic fertilizers and minimize the use of chemical pesticides. Qixia was certified as 'Pollution-free Apple Demonstration Base' by MoA in 2001. In the next year, because of achievements in environmental protection, Qixia was certified as a National Ecological Demonstration Zone by the National Bureau of Environmental Protection (NBEP). By 2008, most apple exporters in Qixia had gotten EurepGAP certifications, which facilitate Qixia's apple export to the EU (Zhang, Qiu and Huang 2009).

In addition to the regulations of the orchard, both exporters and importers have specific regulations to standardize the quality of apples, packages, storage and transport to ensure the quality and safety of the apples. *Table 3-1* introduces the regulative points and relative public institutions along the apple export chain. The exporting apples and their packages

should meet not only Chinese apple export standards, but the standards set by the EU for importing apples quality. Besides the public institutions in the table, there are some private institutions to regulate the quality and other aspects of apples, such as: Eurep GAP, HACCP. Most of them have public credibility so that many business actors intend to get certifications provided by such institutions to promote their exporting volume.

	Inspecting Items	Chinese Institution	EU Institution
Production	Orchards; Pesticide residue;	CIQ[1]	
Quality	Appearance; Size; Ripeness degree; Flaw; Tolerance	CIQ	Eurep GAP
Health	Phytosanitary inspection	CIQ	Psychopathological Department of MoA
Package	Label; Wood boxes; Sealing method	CIQ	HACCP
Storage	Grade & Variety of the apples; Temperature & Humidity	CIQ	

Table 3-1: Regulations and institutions (apple export)

2. Business activities with regulation

We can see that there are various regulations through the apple export business from plant apples to export them. The activities from planting apples to purchasing apples are all regulated by relative organizations. The *figure 3-1* describes the business activities which are involved regulations and relative actor.

[1] CHINA ENTRY-EXIT INSPECTION AND QUARANTINE BUREAU (CIQ) is a ministerial-level department under the State Council of the People's Republic of China that is in charge of national quality, metrology, entry-exit commodity inspection, entry-exit health quarantine, entry-exit animal and plant quarantine, import-export food safety, certification and accreditation, standardization, as well as administrative law enforcement.

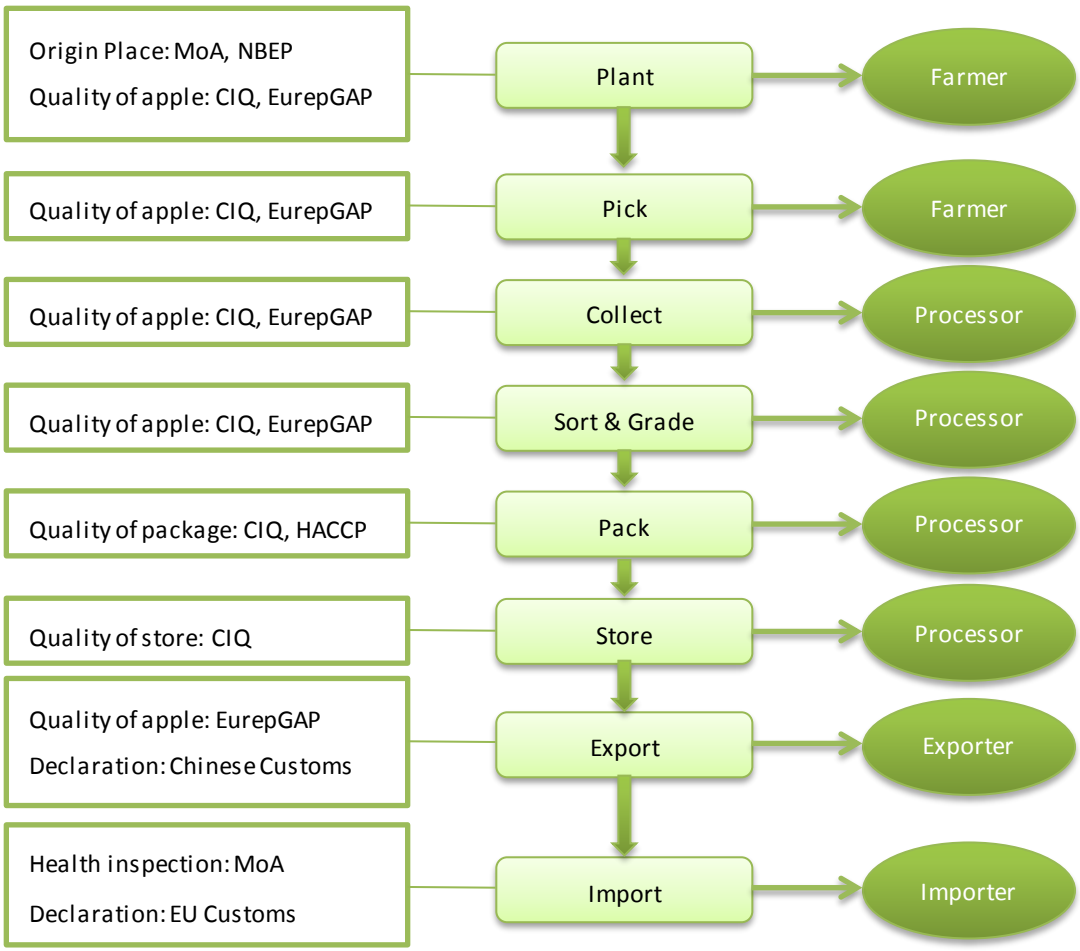

Figure 3-1: Regulative activities (apple export)

3.1.2 Organization model under direct control

In this part, I will analyze the apple export process under direct control and design the organization model using the OperA+ modeling approach. The regulators in China (CIQ) should monitor the apple's production and processing processes directly and inspect the apples directly before they are exported. Customs will let the export apples pass the customs after they get the quality and other aspects approval from regulators. On EU side, when the apples arrive at the EU, they will be inspected by EU regulators. EU customs only allow the apples which are approved by quarantine and quality organizations of the EU to go to the EU market. The figure 3-2 describes the organization model under with direct control mechanisms using OperA+ modeling language. The specification of roles and dependencies are given in Appendix A.1.1, A.1.2 and A.1.3.

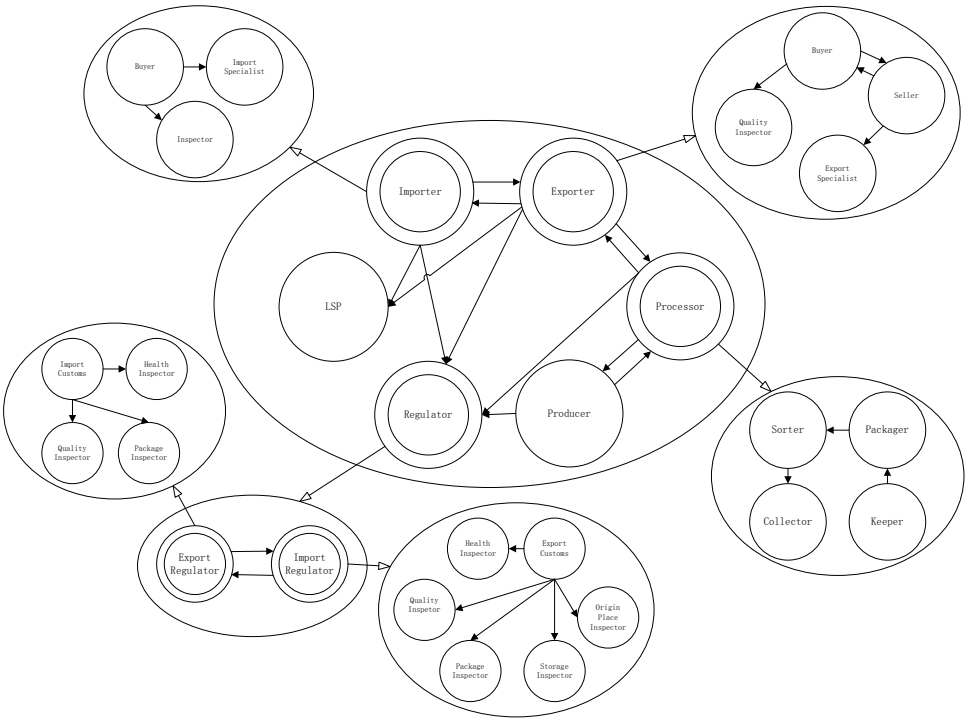

Figure 3-2: Organization model for apple case (direct control)

3.1.3 Organization model under Self-regulation

To reduce the time and costs of regulative process, a certification mechanism has adopted to regulate the quality of apples, enabling self-regulation. The orchards in Qixia which plant the apples have been certified by MoA and NBEP and many producers in that area get EurepGAP certifications. Packagers also can ensure the quality of the packing to meet the standards from both China and the EU through HACCP certification for packing quality. Those certifications can reduce the physical inspection procedure when the apples pass customs.

To realize self-regulation, not only a certification mechanism should be adopted by regulators but also the electronic technology is needed to support both actors and regulators monitor information in real-time. In addition to the certifications mentioned above, the apple exports chain with self-regulation should include the China GAP certification of the quality of apples, the certification of health both from China and the EU, the certification of storage. All the eligible business actors need to register on the official website of China's customs and MoA to let other The export customs provide the lists of eligible exporter to the import customs. Therefore the importers can find out the eligible exporters via import customs website and contact with them.

Additionally, the regulators have begun to adopt the information technology to refine the regulative activity and share information. For example, in order to meet the EU wooden package regulation: all wooden pallets have to be steamed for more than 45 minutes at a

temperature higher than 60 degrees Celsius, the CIQ require packagers should install the video cameras in their pack house to monitor the steam process (Zhang, Qiu and Huang 2009).

To enable the transparency and better monitor regulators and stakeholders, several electronic monitor systems need to be set up. Firstly, the monitor system in apple production bases should be establish to monitor the level of fertilizer, pesticide and the parameters of growing apples. The information is not only used by technical consultants to instruct the farmers grow apples better, but can be checked via internet by relative stakeholders and regulators to inspect. Secondly, in the packing process, the video cameras are installed in the packages to monitor the internal environment. Moreover, the RFID tags are labeled on the box to store the information of the apples in the box, including the variety, grade, origin place, and other relative information of apples. Depending on the RFID tag, the apples can be tracked in transportation process. Thirdly, the monitor system is set up in the keeping area to control the temperature and humidity of the storage environment. The information can be checked via internet in real-time.

Under self-regulation mechanism, the relations between regulators and other actors change from the relations between them under direct control. The regulators have to be dependent on the actors who are regulated for monitoring their self-regulatory mechanisms and inspecting the real-time data via internet. The information exchange between regulators and other actors are more frequent than in the traditional regulatory mechanisms. *Figure 3-3* describes the apple export process with self-regulation, analyzed by operA+ modeling language. The specification of roles and dependencies are given in Appendix A.1.4, A.1.4 and A.1.5.

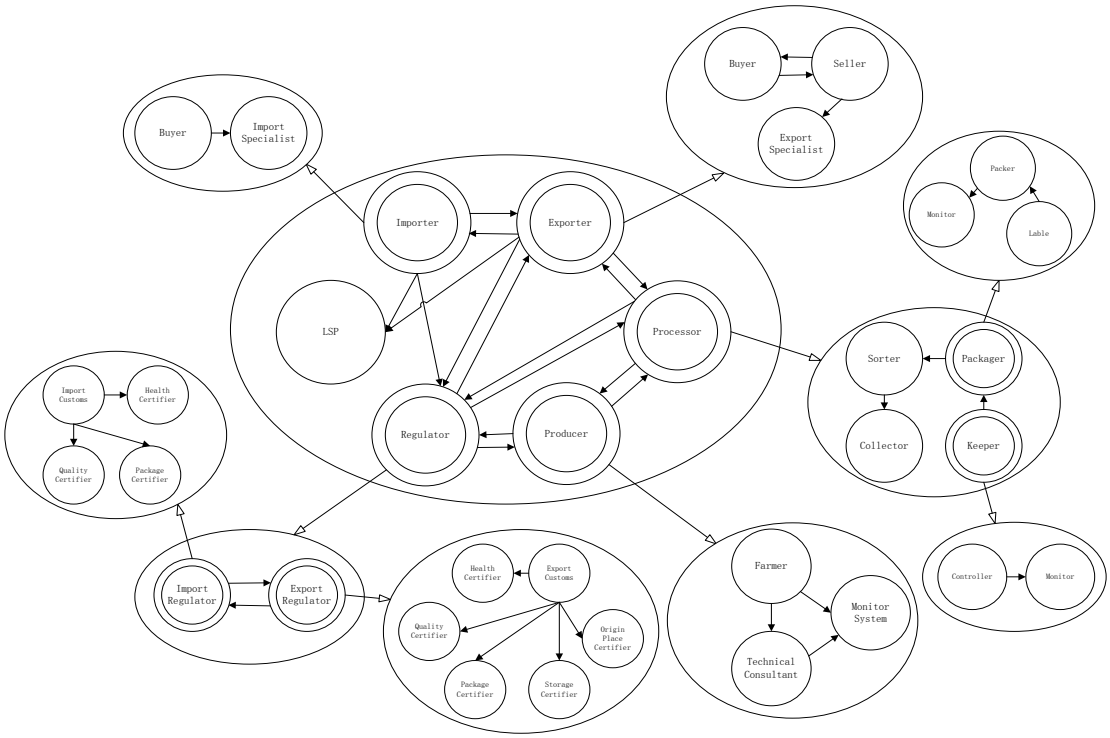

Figure 3-3: Organization model for apple case (self-regulation)

3.1.4 Comparison of two organization models

I will compare two organizational structures with the different regulation mechanisms. Different regulatory mechanism can be viewed as different context that will influence the collaboration structures. *Figure 3-4* shows the organization model that integrates the two collaboration structures under different regulative mechanisms based on the contextual layer of OperA+.

1. The integrated organization models:

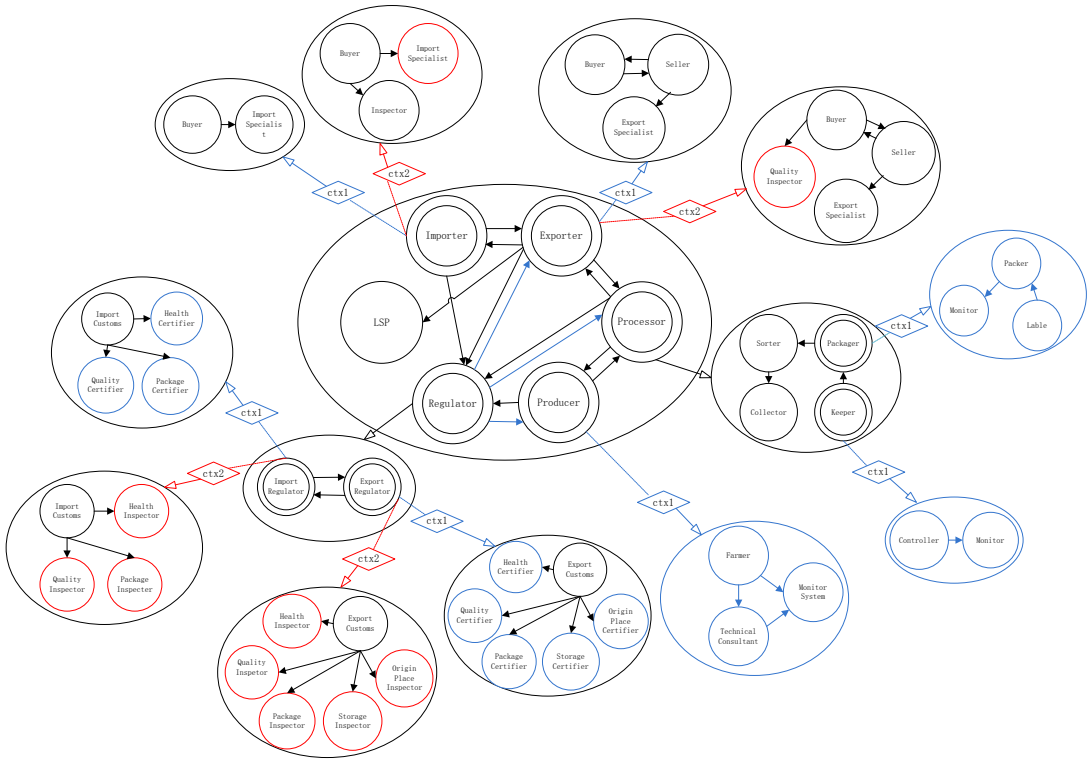

Figure 3-4: Integrated organization model for apple export case

In the integrated organization model, two colors represent the particular organizational structures under the each regulatory mechanism. Red represents ctx2: direct control, and blue represents ctx1: self-regulation. The analysis of similarities and differences from the organization model are the following.

2. Similarities:

Since the case is same, there are certainly many similarities between the two organization models. I will only look at the similarities relating to the regulations.

a. The involved regulators and their objectives are the same.

Based on the same case, the regulative aspects and regulations are identical between two mechanisms. The norms and standards of the quality of export apple and the boundary of the regulations do not change with the transformation of the regulatory mechanism.

Correspondingly, the regulators involved in two mechanisms are also the same. Even though the regulators do not need to inspect the activities personally under self-regulation, they are still required to set policies and provide certifications to the eligible companies. Furthermore, whether the regulators directly control the actors' business activities or release the regulative power to actors, their objectives are in both cases to ensure legislative activities along the whole business process.

b. The dependencies among various regulators are the same.

The transformations of the regulative activities of regulators do not change the dependencies among the multiple regulators under the parent organizations of the regulators. In direct control mechanism, the export apple must be inspected directly by the regulators to get approval of the export qualification. Customs depend on the approvals from institutions for different inspection aspects (such as health, quality, environment and so on) to discharge the export apples. In the self-regulation mechanism, the regulators substitute certification mechanism for direct inspection and monitor business activities by means of information technology. But customs are still dependent on the relative institutions for the quality certificates of export apples to approve the legislative declaration.

3. Differences:

Some roles and dependencies of them are varied with the change of the context. The transformation of the regulatory mechanisms results in the changes of the organization model.

a. Changed relations between regulators and other actors.

In both of the organization models, roles which need to be regulated are dependent on the regulators for approval. However, under self-regulation, regulators are also dependent on exporter, processor and producers to inspect their self-regulatory mechanisms. When regulators certify the actors, they do not participate in the self-regulating activities of actors any more. Therefore, if regulators want to get firsthand data of production process or look over the performance of self-regulation mechanisms set by actors, they are dependent on actors to provide them relative information.

b. Changed objectives of dependencies between regulators and other roles that need to be regulated.

As mentioned above, in both of the organization models, roles which need to be regulated are dependent on the regulators for approval. However, in the current regulative mechanism (direct control), the roles that depend on the regulators must accept the inspection and monitor by regulators to make sure that the quality of the apples meet the requirement of the regulations. While in the self-regulative mechanism, such roles depend on the regulators for two other main reasons. The one is to get clear codes and standards of the quality of apple and processes from regulators to standardize their business activities and products themselves. The other is to get certifications from regulators to let them have apple export qualifications.

c. The regulator' activities are different.

Since the regulators release their power of monitoring and inspecting to other roles in the self-regulation situation, the regulators' activities are different from the direct control situation. In the apple export case, under direct control mechanism, the regulator should inspect and monitor the specific business activities directly to ensure the high quality; the main activities of regulators in self-regulation mechanism are setting up the certification mechanisms, providing the certifications to the legible actors to let them regulate themselves and also some random inspections.

We will illustrate this difference using the health regulator on the export side as an example. In the direct-control regulative process, the health regulator should inspect the apples before they leave China. Each batch of the exporting apples has to go through the Phytosanitary inspection by health regulators before they pass the customs. In contrast, in the self-regulative process, the health regulators will give the certifications to the trustful actors and do not need to inspect each batch of exporting apples with phytosanitary certification at customs. The export apples with complete certifications are able to pass the customs without physical inspections.

d. Sub-roles under same parent organizations are different due to the different regulatory mechanisms.

Based on the different regulatory mechanisms, sub-roles under same parent organizations are different. In self-regulatory mechanism, controllers and monitors are required in the internal organizational structure of the parent organizations to realize self-regulation. Therefore, the sub-roles of quality controller or monitors under composite roles which are authorized as the trustful actors in the self-regulatory process are required. On the contrary, in direct control mechanism, sub-roles for quality controller or monitors are not required in the production process.

Moreover, the sub-role of inspectors under role of exporter and importer are designed in direct control regulatory process to ensure the quality of products due to the lack of the transparency of the business activities. Both exporter and importer assign specialists to inspect the sample of apples before they send orders. By contrast, in the self-regulative process, exporter and importer do not need the inspector any more since they can find the trustful companies along the apple exports chain via internet, provided by either public or private institutions.

3.2 Table Grape Export Case

The beginning of South African table grape export can be traced back to 1886, when South Africa exported table grapes to the UK for the first time (Burger 2002). Since then, the table grape exports in South Africa have gradually increased. In the last two decades, around 75% of total export table grapes in South Africa have flowed into the market of UK and Continental Europe (Ntombela 2010). The Trade, Development and Co-operation Agreement (TDCA), set together by South Africa and the EU, facilitating the export-import business trade

between South Africa and the EU. In the following, I will analyze the table grapes export-import process from South Africa to the EU involving various regulations.

3.2.1 Regulation background

1. Relative regulations and institutions:

In the whole export process, there are various regulations to standardize the quality of the table grapes and the package to enable safety and health. The South African table grapes exporting to the EU should comply both with the regulations of South Africa and those of the EU. However, since the EU has certified South Africa as having an Approved Inspection Service, meaning that the EU accepts the South African Conformity Certificates, the EU does not need to regulate the quality of export grapes itself (DAFF 2010). The EU releases its power of inspection to the Perishable Products Export Control Board (PPECB), the assignee of the Department of Agriculture, Forestry and Fisheries (DAFF) in South Africa, to carry out conformity checks (DAFF 2010).

From the South African perspective, all the actors that are involved in the table grape export value chain in South Africa have to register their businesses to get relative codes enabling to export eligible grapes, including: Production Unit Code (PUC), Pack-House Code (PHC), Commercial Cold Store Code (CCS), Processing Plant Code (PPOCES), Container Depot Code (CD), and Transport Operator Code (TRANS) (DAFF 2010). All the registrations are required and managed by Department of Agriculture Forestry and Fisheries (DAFF), Directorate Food Safety and Quality Assurance (D:FSQA). The DAFF issues a phytosanitary certificate to relative actors and PPECB ensure the certification qualifications of the actors (Vermeulen, et al. 2006). In addition to the public institutions, there are many private institutions such as EurepGAP to control the quality of food in international markets. The *table 3-2* introduces the main regulative activities and relative institutions along the table grape export chain.

	Inspecting Items	SA Institution	Private Institution
Production	Orchards; Production facilities	PPECB	
Quality	PUC	PPECB	EurepGAP, SA GAP
Health	Phytosanitary inspection	PPECB	EurepGAP, SA GAP
Package	Traceability; Wood boxes; Marking and labeling; PHC	PPECB	HACCP
Storage	Temperature	PPECB	GMP

Table 3-2: Regulations and institutions (grape export)

2. Business activities with regulations:

There are many activities in the value chain are related to the regulations. The figure describes main business activities which are involved regulations and their actors.

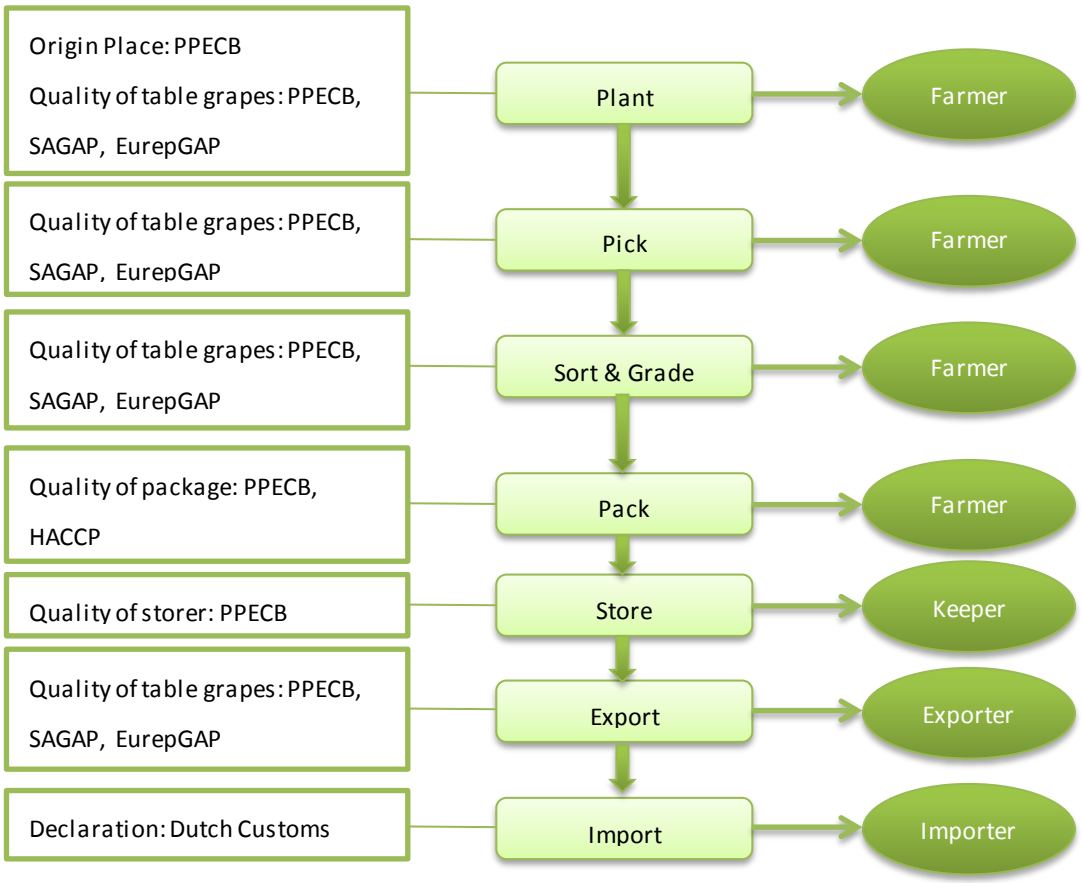

Figure3-5: Regulative activities (grape export)

3.2.2 Organization model of self-regulation

From the EU point of view, the table grape export from South Africa has been operated by self-regulation. The EU authorized the PPECB as the designated assignee of the DAFF to control and inspect the quality of fruit destined for EU. The exporting table grapes meeting the requirements of the South African regulations are able to be exported to the EU. From the South Africa point of view, the involving actors in table grape export to the EU should comply with various codes and therefore get relative certifications from DAFF for safety, quality, package, storage and so forth. Actors who get certifications provided by DAFF are capable of exporting table grapes to the EU.

In order to enable the transparency of the business process from planting grapes to exporting grapes to the EU, many self-regulation systems and monitor systems are designed. Due to such self-regulation systems, the relative data or information from production to transport is publicized on internet, via which business operators and regulators can check. *Figure 3-5* describes the table grapes export process with self-regulation, analyzed using the OperA+ modeling language. The specifications of roles and dependencies in this case are given in Appendix A.2.1, A.2.2, A.2.3.

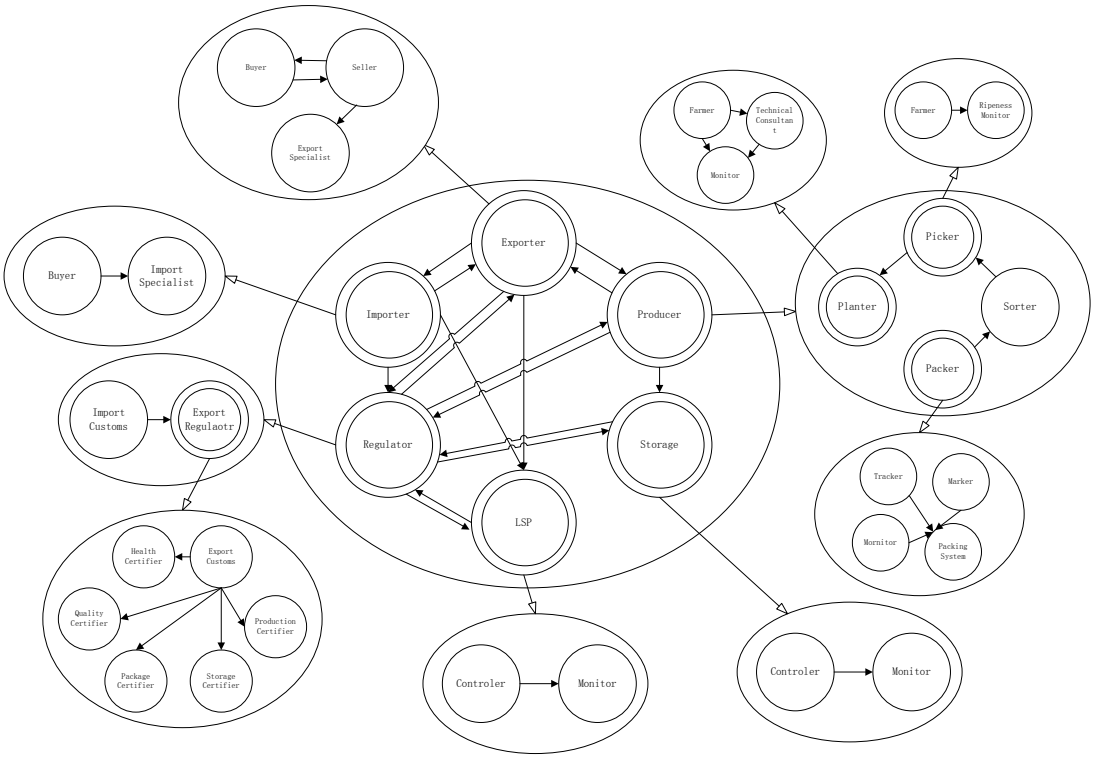

Figure 3-5: Organization model of grape export

3.2.3 Comparison between the cases of apple export from China and table grape export from South Africa

Given the same type of export products and the same destination, I would like to compare the case of the apple export from China (under self-regulation) with the case of the table grape export from South Africa. Based on the analyses described in the previous section, I will give both similarities and differences between these two cases.

1. Similarities:

Since that fresh fruit is the export product in both of the cases, the business activities along the business value chain are similar in some aspects.

a. Some roles are same in two cases.

Both fresh fruit export processes include similar activities: plant, harvest, grading, packing, storing and transporting, all of which require appropriate roles to perform along the fruit export chains. Therefore same roles such as: planter, picker, packer and so on are designed in both cases to achieve same objectives.

b. Regulators on exporter side are similar.

Fresh fruit is one of the largest components of high-value exports, with US$ 21 billion in 2001 in the whole world (FAO 2003). As we know, China and South Africa both have large output of fresh fruits every year, while the EU is one of the largest importers of fresh fruit. In

order to enable the fresh fruit to access to European market, both China and South Africa set strict standards and other relative regulations to control the quality of their fresh fruit. Due to the particularities of fresh fruit, aspects involved in regulations are more than those relating to commodities. In addition to the common quality regulation, there are also some special other regulations to ensure safety and health of the fruit, such as: phytosanitary inspection, restriction of temperature of the storage environment and so on. Aspects that need to be regulated in fruit export process are the same no matter which country exports or which type of fruit. Therefore in both of cases, the types of regulators for inspection are the same.

c. Self-regulation mechanisms are similar.

Since some activities and the emphases for regulation are similar in both cases, the self-regulation mechanisms are also similar between the two cases. In both of cases, regulators provide certificates to the actors who are considered as trustful companies meeting the requirements of the regulations. To enable transparency of the regulative business activities, relative actors introduce information technology and electronical monitor, realizing self-regulation. Therefore sub-roles are similar for the same regulative activities between the two cases. For example, in order to control the certain temperature in storing environment, the temperature control system is applied to monitor and adjust the temperature. The data of the temperature is published via internet in real-time to the regulators and relative stakeholders. As a result, sub-roles under the role of storage are similar in the two cases.

2. Differences:

Although the export type of products and destinations are the same, there are still some differences between the two cases because of the different contexts between China and South Africa.

a. Norms and standards are different in two countries.

Different backgrounds, norms, cultures between different countries result in the different regulations and standards of the same product or process. China and South Africa set their policy or codes for export fruit according to their practical situations. Therefore, the standards of the export fruit should be different between the two cases. The regulations of production, package, storage and the quality of the fruit and the procedures of the regulations are different between China and South Africa. For example, PPECB in South Africa gives explicit packing standards. It regulates the specific materials of bagging fruit for different kinds of fruit (Vries 2009). On the contrary, CIQ in China do not regulate the specific materials of bagging fruit in that level. It only says that the bagging materials should be clean, soft and ductile (foods1.com 2007).

b. Regulators on EU side are different.

Since the EU has certified South Africa as having an Approved Inspection Service, which means that the EU accepts the South African Conformity Certificates, the EU does not need to regulate the quality of export grapes from South Africa itself (DAFF 2010). South African

fruit entering the EU markets therefore do not need quality control by the EU governmental bodies. By contrast, China does not have the Approved Inspection Service certified by the EU. The export fruit should be regulated or certified by the EU organizations directly. This reflection of the differences is showed in figure 3-3 and figure 3-5 of the organization models between two cases. Under the role of importer regulators, only import customs is set in the grape export case to deal with the declaration things. But in the apple export case, there are some other regulators under the role of importer regulators to control the quality of the export fruit.

c. Operating system in China and South Africa are different.

Because of different conditions, the business actors between two cases are different. In China, farmers normally have several acres of land and plant their fruit individually. After harvest, regional collector will collect all fruit from farmers to process, including: sorting and grading, package, storage and so on. While in South Africa, the owners of orchards have several hundred acres land and many farmers. The owner of orchard organizes farmers to plant fruit together. Table grapes are packed in the orchard's pack house, instead of the regional pack house. Therefore the collecting activity is not required in the table grapes export. The sub-role of sorter and packer are under the role of producer in the table grape export.

3.3 Other Case Analyses

3.3.1 Clothes export from China to Canada

The negotiation between Canadian buyers and Chinese sellers are involved in export. The business process of clothing exporting from China to Canada includes: exporter, importer, banks on two sides, supplier, manufacture, logistics service provider, regulators and other roles. The case is from (MBAlib.com 2010). Due to the complicated regulative export process in China and various governmental organizations, the exporter and other relative actors will spend more time and energy on getting approval and declaration at customs. Through this case, we can see the relatively complex regulatory processes and various regulators in China.

The organization model is presented in *figure 3-6* and the specifications of roles and dependencies are given in Appendix A.3.1 and A.3.2.

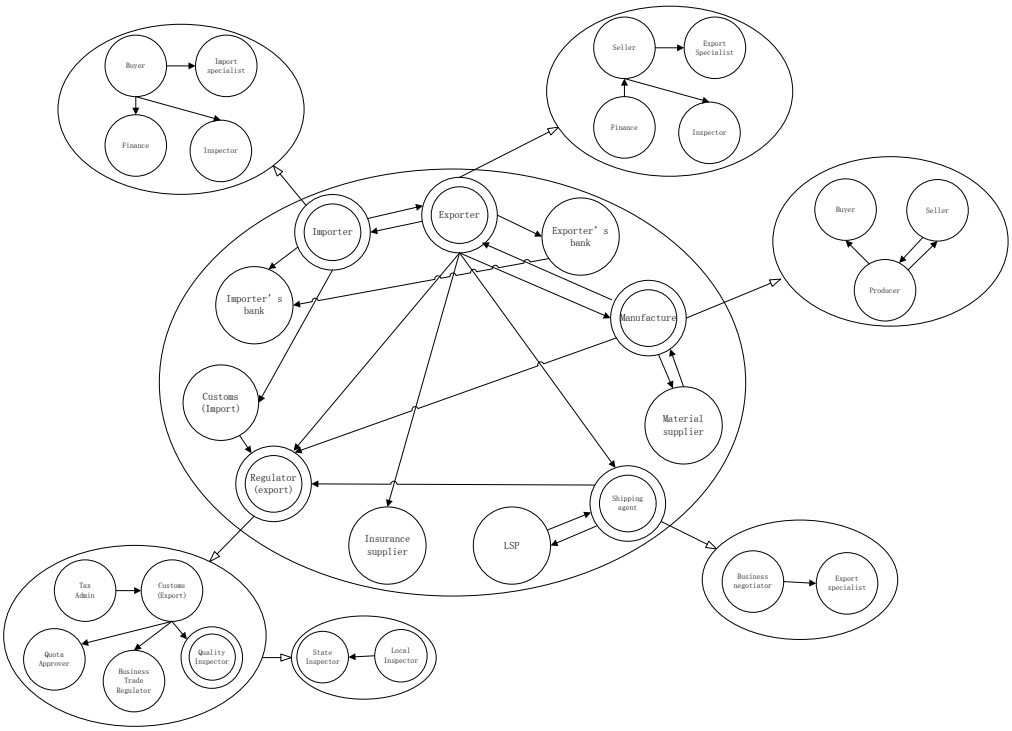

Figure 3-6: Organization model for clothes export

3.3.2 Dairy products export from Denmark to the Non-EU countries

Denmark dairy company export dairy products to the Non-EU countries. Dairy products export is more difficult and complicated than other products export. There are two main problems in the export process. One is that delay will spoil diary products; the other are the contagious diseases that may be contained in the export food. The latter problem often forces both export and import customs to pay more attention to the diary products, requiring many documents and certifications. However, errors on the documents or delay in inspection will bring about the first problem. To solve this issue, electronic regulative process is used to reduce the time and avoid the error of the documents. This case is from (Tan, Bjorn-Andersen, et al. 2011). *Figure 3-7* shows the organization model for dairy products export under new regulatory process. The specifications of roles and dependencies are given in the Appendix A.4.1, A.4.2 and A.4.3.

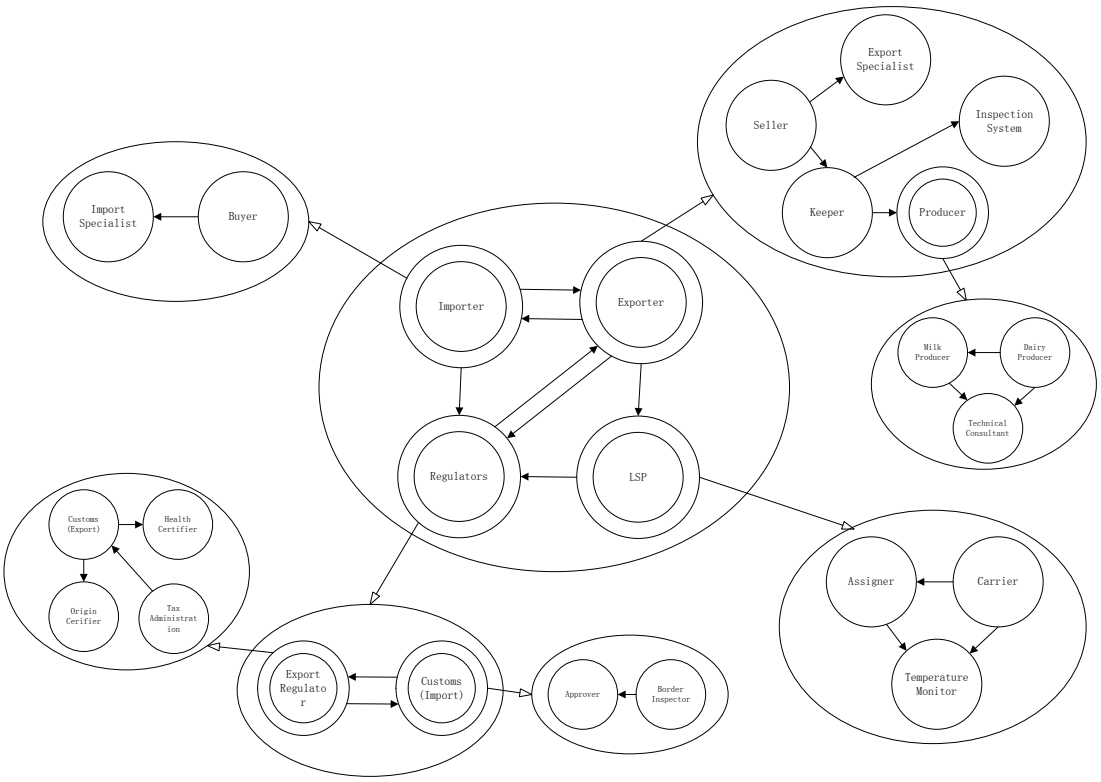

Figure 3-7: Organization model for dairy products export

3.3.3 Paper export from Finland to the Asian countries

The Finished paper and board industry takes up a large proportion of the global paper exports. With the growth of exports to Asia, Russia plays an important role as the railroad route across Russian to China is an alternative to marine transports. However, the separate declaration of Finland and Russia causes the lack of information sharing between Finish and Russian customs. This is the causes of fraud about declarations to pay less import tax. To solve this problem, ICT platform is applied, on which all the information of the whole process will be showed. The AEO (Authorized Economic operator) certification mechanism is employed to set up a green corridor through which information exchange between customs and trusted companies are convenient and swift. This case is from (Tan, Niels, et al. 2011). *Figure 3-8* shows the organization model for paper export under new regulatory process. The specifications of roles and dependencies are given in the Appendix A.5.1, A.5.2 and A.5.3.

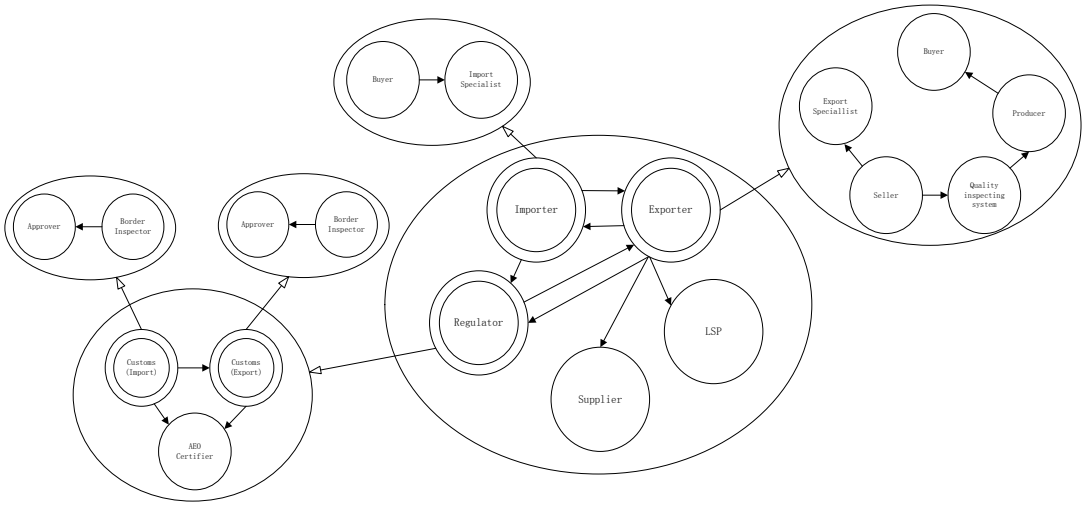

Figure 3-8: Organization model for paper export

3.3.4 Shipment between US and Mexico

The large number of commercial transactions between US and Mexico lead to several thousand commercial trucks crossing the US-Mexico border every day. The truck drivers often bring incomplete or incorrect documents, which results in expensive inspection costs and delays at ports of entry. Delays increase the costs of both transport providers and manufactures. To reduce the inspection time at ports as well as ensure reliability of carrying goods, the Border Trade Facilitation System (BTFS) applies the highly-accessible electronic documentation scheme to make the regulative process efficient. This case is from (Goldsmith, Phillips and Spires, A Multi-Agent System for Coordinating International Shipping 1998) *Figure 3-9* shows the organization model for paper export under new regulatory process. The specifications of roles and dependencies are given in the Appendix A.6.1, A.6.2 and A.6.3.

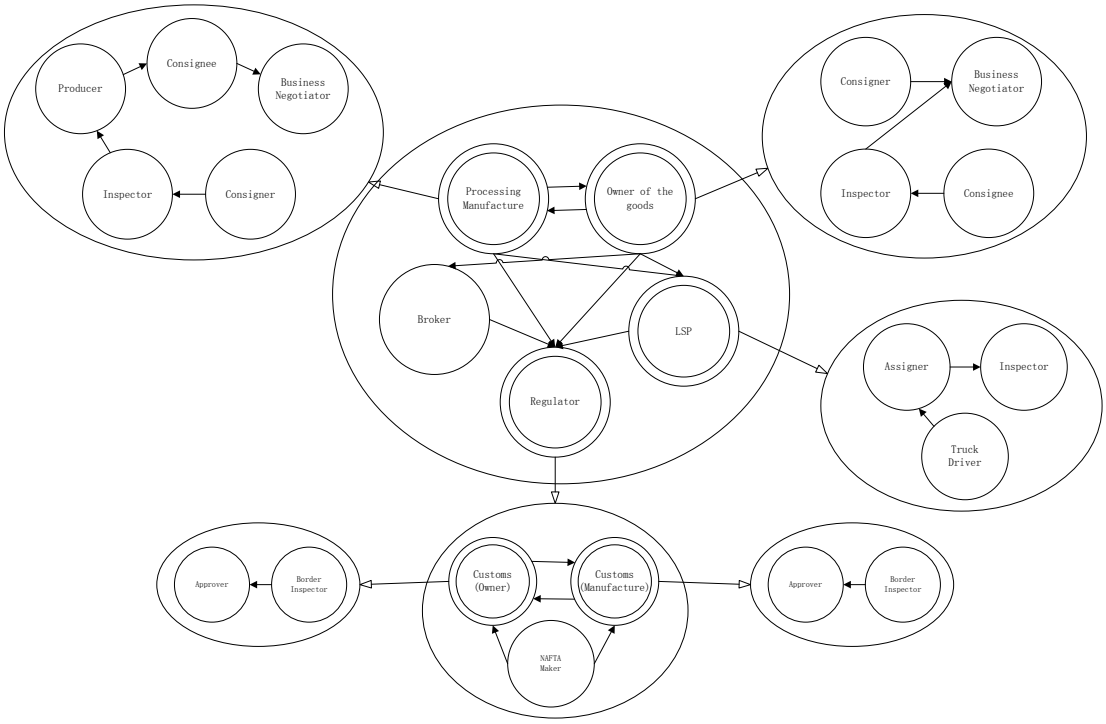

Figure 3-9: Organization model for shipment between US and Mexico

3.4 Cross Case Analysis

Based on the specification of different cases in the OperA+ modeling language, I will conduct cross case analysis in order to identify similarities and differences in the various international business trades with self-regulation.

3.4.1 Similarities

Since this research focuses on self-regulation in the international business trade, the cases I choose are all related to the international business trades involving exporters, importers and various regulators. Many actors, their objectives and business activities in the business processes are similar to some extent. Therefore there should be some common grounds in collaboration structures. Based on the case analyses using OperA+ modeling language, we can see some similarities of the collaboration structures. *Figure 3-10* shows the common organization model, including the similarities identified in the previous cases analyses. The specific analyses for similarities are in the following.

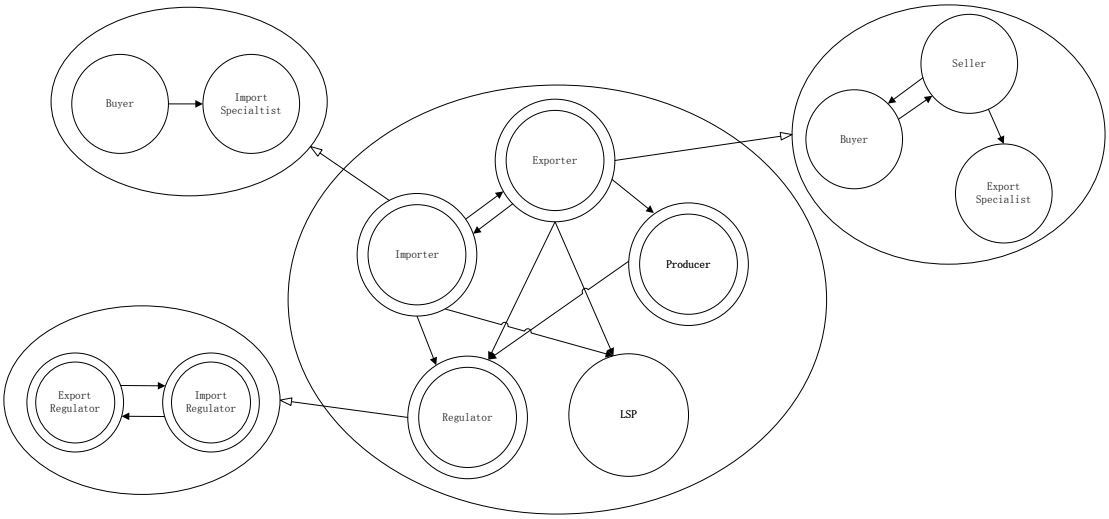

Figure 3-10: Organization model for business trade

1. The first layer of collaboration structure is similar in all cases.

Since the international business trade generally involves the export-import process, it is not difficult to imagine that roles in top-level organization are similar. Some roles, such as exporter, importer, logistic service provider and so on, are required in the top layer to achieve the collective goals.

Through the pictures of organization models of the cases, several necessary roles are involved in the first layer. They are: exporter, importer, regulators on both sides, logistics service provider (LSP). Exporter and importer are the main actors in the international business trade, who collectively initiate the business trade and expect to complete the trade successfully to get profits. Exporters intend to sell their goods or other vendors' goods out of the port of the country; while importers want to buy the goods from foreign countries to meet local demands. Regulators are the organizations who regulate and monitor the business trade to enable the transparency of the whole process, reducing the risks of fraud and opportunism. In the self-regulative process, regulators are mainly responsible for formulating policies, inspecting the self-regulative process, imposing sanctions on the illegal actors or activities. Other actors should set the self-regulation mechanism according to the policies or norms to regulate themselves. LSP is responsible for transporting the products from exporting area to the importing area, always crossing the boarders. To achieve the complete international business trades, these roles are normally indispensable, no matter what product is expected to be exported.

Not only are the roles similar in the top layer, but also the types of dependencies between them are same to some extent in the collaboration structure of international business trade. Because of the similar objectives in the export-import process, the dependencies are same to achieve such objectives. First of all, the exporter and importer interdepend on each other for the business trade. Exporter who wants to sell products will depend on importer to give more orders; importer who wants to get more desired products will depend on provision from exporter. Moreover, to ensure the legal export-import process and the quality of the

transaction goods, the importer and exporter will both depend on regulators to approve the business trade. Furthermore, the LSP is depended by the exporter for transporting the products to the destination in general. These several dependencies are existed in most of the international business trades. The common organization model shows such dependencies.

2. **There are some similar sub-roles under the parent organizations in the second layer to achieve some similar sub-objectives.**

Even though the sub-roles are more specific in the lower level of collaboration structure, there are also some similarities of roles and dependencies because of the same objectivities and perceived activities. For example, since the international trade involves transportation crossing the border, the customs on both exporter and importer sides are essential sub-roles to approve the export and import under the regulator organization. The role of seller and buyer often appear individually under the exporter and importer organizations, being seen as the role to sell or buy the eligible products to achieve the business trades. Furthermore, in self-regulatory process, the inspector or monitor is usually considered as a sub-role under the role that produces the products to control the quality of products and the whole production to meet the requirements of regulations.

Of course, due to the same sub-objectives and similar sub-roles in different international businesses, sometimes the types of dependencies are similar under the parent organizations. There is no doubt that the import regulators depend on the export regulators to provide the list of approved companies for international business trade. The buyer is dependent on the import specialist under the importer organization to complete the importing procedures with importing regulators. Such kinds of dependencies will be involved under the parent organizations if there are similar sub-roles existing.

3. **Some composite roles which need to be specified in the top level organization are the same in different cases.**

In the OperA+ model, main roles are normally set as composite roles which need to be specified further into sub-roles to show the inner collaboration structures in lower level. The specification can open up the sub-roles and their dependencies in lower level to enable the transparency of the business activities of company in the business trade.

In the illustrations of organization model of cases, importers, exporters, producers (when the exporter is not the producer) and regulators are all specified into lower level organizations.

3.4.2 Differences

Although there are some similarities among the cases, each case somewhat has its own characteristics in the organization models because of the different contexts. There are several following differences through the cases analysis.

1. **Different type of products for transaction leads to the differences in the organization**

models.

The type of products for transaction determines which regulators should be involved in the business process and therefore which kind of regulations should be complied with by the different actors. Some special type of products needs more regulations and inspections than others in international business trade, such as: agricultural commodities or food, flammable and explosive materials, or medicines. Dutch VGEM (safety, health, economy and environment) legislation which guarantees that the products passing Dutch customs are sound divide goods into several varieties based on their own characteristics and list relative regulators for each variety of goods (DutchCustoms 2011).

Take the agricultural commodity business trade as an example, in order to avoid disease and pesticide, health, pesticide, regulators relating to the food safety are involved in the regulative process. Therefore the regulations which regulate the health, pesticide, origin place of exporting food are taken into account in the international business trades with self-regulation. In the case of dairy exports from Denmark, the place of origin has to be certified and the safety needs to be approved by health agency. The similar situation occurs in the case of apple exports from China and grape export from South Africa. All the production and collection procedures, from the planting base to package, need to get certification from either national or international regulators. By contrast, the international business trade with other products, such as paper, clothes do not need to require such regulators as the food business trades. *Figure 3-11* shows the differences of regulators between food and normal commodity business trades. Ctx1 represents food business trade; Ctx2 represents normal commodity business trade.

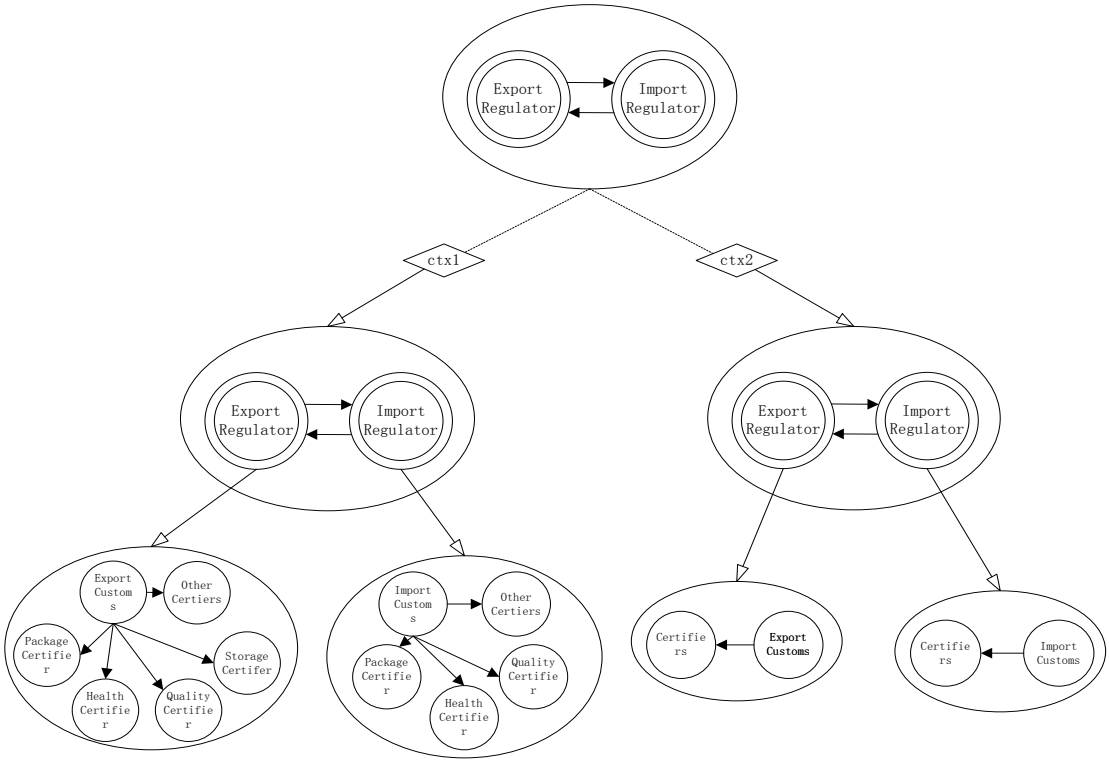

Figure 3-11: Differences of regulators between food and normal commodity business trade

The type of products also affects the differences of lower level organization structures under the parent organizations. Different sub-roles with different objectives are assigned under the similar parent organizations. First of all, In order to get approvals or certifications of the regulators, sometimes the producers of goods include some special sub-roles. Since food export needs more regulations for health and safety, the sub-role of inspector or quality controller for self-regulation will have more objectives and more activities to ensure eligible quality. In the case of apple export, under the producer role, there are not only farmers who plant apples, but technical consultants who provide the instruction on the planting technique, fertilizing and using pesticide to help farmers acquire the apples meeting the exporting standards. Compared to the apple case, the inspector under the role of manufacture in the case of clothes export has relatively simple objective, ensuring the quality of the material, workmanship and standard size. *Figure 3-12* shows the differences of sub-roles of producers between food and normal commodity business trades. Ctx1 represents food business trade; Ctx2 represents normal commodity business trades.

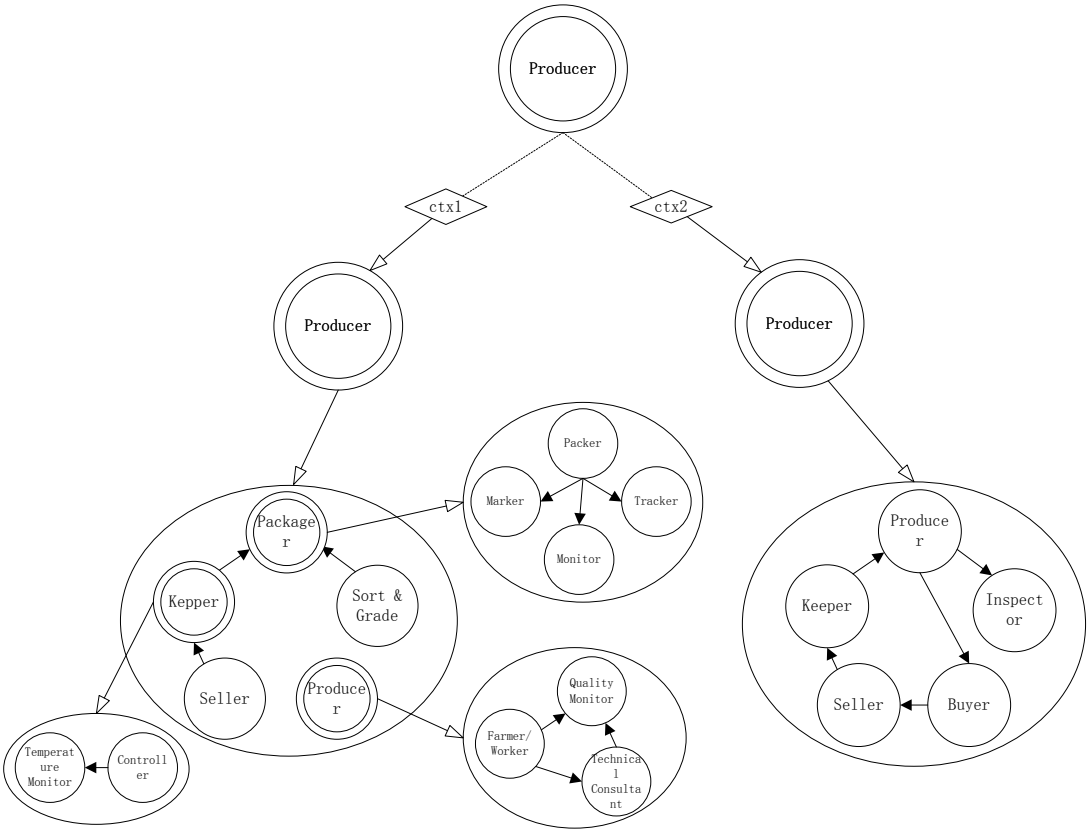

Figure 3-12: Differences of producers between food and normal commodity business trade

Secondly, some types of products need special attention, influencing the degree of the importance of the roles. Usually LSP is viewed as the atomic role to transport goods to the destination. However, the LSP needs more attention when the goods are special. LSP carrying fruit or dairy products should control the internal temperature to prevent food from deterioration. If they carry frangible goods, they will pay attention to the package. Under these conditions, we have to specify the LSP into sub-roles to enable the transparency of the

transportation process. In the case of dairy products export from Denmark, we can see that there is the temperature system as a sub-role under the role of LSP to make sure that the internal temperature during transportation is appropriate for the dairy products. In the contrast, in the case of paper export from Finland, the LSP is not specified because the goods are not easy to destroy.

Thirdly, the different processes of different types of products in the practical situation determine the differences of the sub-roles. In South Africa, the table grapes are packed in the farmer's own pack-houses while other fruit is transported to the communal pack-houses to pack (Ortmann, van Vuuren and van Dvk 2006). In analyzing case of grape export from South Africa, I set the sub-role of packer under the role of producer since the pack activity is followed by harvest closely and they are all operated by farms. In any other fruit export processes, the role of packer should be set as the role in the top level structure as the practical situation in South Africa.

2. **Different involved areas in the business trade results in the differences of the collaboration structures**.

The regulative environments in different counties influence the organization model. There are different kinds of regulators and interactions based on the different regulations among the cases. Since different countries have different values, norms and regulations, the regulators who regulate the whole business process are diversified according to the different governmental environment. Furthermore, some special agreements or protocols between two countries or in a certain regions are able to reduce the regulators and formalities to enable the efficiency. For example, the North American Free Trade Agreement (NAFTA) decreases the regulative rounds and therefore results in more trades between US and Mexico (Goldsmith, Philips and Spires, A multi-agent system for coodinating international shipping 1999). The US and Mexico governments employ highly-accessible electronic documentation scheme to make the regulatory process efficient. Companies who are in the list of NAFTA can join in the electronic declaration systems to make the business trade smooth and easy. Therefore, US companies prefer to look for the Mexican processing manufactures in the list of NAFTA as the partner to let the international trades be reliable and simple.

The comparison between the case of apple export from China and the table grape export from South Africa present the differences of fruit export to the EU between China and South Africa.

3. **The roles who are supposed to achieve similar objectivities are assigned in the different layers depending on the real intra-level structures of the parent organizations.**

In some cases, the exporter and the manufacture are enacted by the same agent, meaning that a company acts two roles in the business processes, for example in the dairy product export case. Under this context, we can either combine the two roles together or separate them in the first layer.

The similar thing is also presented in the shipment case between US and Mexico. Both the export and import companies do not have the specialist for exporting and importing process, but delegate the brokers to achieve that. Therefore, in the model of this case, the brokers on both sides are included in the first layer to assist the companies to complete the regulative process in exporting and importing business. However, in other cases, the specialists for such things are designed in the second layer under the companies.

3.4.3 Some implications from case analyses:

1. Role identification:

In OperA+ model, roles are identified to enact activities and services that will enable social objectives. According to the OperA+ model, a role is described as a set of objectives and a set of capabilities. To identify roles in the case analysis, three following factors need to be considered.

a. Objectives and desires

Undoubtedly, under the joint goals of the whole process, there are various objectives and desires. The achievements of the objectives and desires will contribute to the joint goals. In order to achieve such the objectives or desires, the roles are required to assume the appointed responsibilities and perform the corresponding activities. According to the objectives, the set of appropriate roles with corresponding capabilities will be identified to achieve the objectives.

b. Obligations and norms

In addition to the goals or objectives, obligations and norms are the other important issues taken into account in identifying the roles. In the self-regulative process of international business trade, the norms and obligations are needful to restrict the behaviors and performances and therefore restrict the roles identification. The roles and their capabilities will be set up comply with the norms and obligations.

c. Realistic actors

Since every case has its own characteristics, different cases involve different actors. Although there are similar objectives between two cases, the roles might be different according to the realistic situations. In some cases different roles will assume different responsibilities individually, while in some cases, the one role will assume various responsibilities. The roles will be set up according to the real actors in the case.

2. Criteria of specification of the lower level structure:

In the OperA+ model, roles are defined as either atomic or composite roles. The composite role refers to a unique organization at a lower level in the hierarchy and forms the inner nodes of the hierarchy. Atomic roles do not have internal level structures, forming the leaves of the tree-like structure (Jiang, Dignum and Tan, An Agent Based Inter-organizational Collaboration Framework: OperA+ 2011). How to determine whether roles in the case analysis are composite or atomic is a challenge in role identification. Based on the previous

case analysis I summarize the following criteria:

a. Importance of the international business trade

In international business trade, there are various roles involved in the value chain. Some of them should be paid more attention than others due to their importance in the value chain of the business trade. For example, the exporters and importers are the main roles in the business trade from the initiation phase to the close of the trade. Such kind of roles generally needs to be specified in the lower level for clearness of the organization of roles. While the LSP who provides the logistics service for transporting normal goods from the port to the destination, is usually considered as the supporting role to help exporters achieve the objectives. These kinds of roles usually do not need to be specified in most of the cases. Also the role of regulator is viewed as the main role in the self-regulative business process. Therefore, role of regulator is specified based on the context of the international business trade, such as products, involved areas and so on.

We can see the organization models of the case I analyzed, the importer and exporter roles in each case are individually specified in lower level. The roles in lower level organization are specified according to the sub-objectives which are particularized from the objective of the parent organizations.

b. Importance in the regulative process

Since this research focuses on regulations, the roles related to important entities in the regulative process usually need to be designed as the composite roles. Normally, the important entities in the regulative process are the roles that have direct interactions with regulators, who are dependent on regulators to give them approval for their activities. By implementation of the self-regulation, such roles will use more information and communication technology to realize the automatic information share with regulators and other stakeholders.

Different from other cases, in the case of the dairy export, LSP is specified in lower level, including the inspector who controls the degree of the internal transporting environment, since there are the detailed regulations on the temperature limit in transporting in case of rot of the dairy products.

c. Capabilities

The capabilities required for the roles is another criterion of specification of the roles. In the collaboration structure of the cases analyzed by OperA+, the roles require the capabilities to achieve the multiple objectives. If the capabilities of roles are unitary or are related to only one field, the roles usually do not need specification. However, if the capabilities of roles are quite complicated and related to many fields, we need to specify the roles into lower level to assign capabilities to sub-roles.

In the case of paper export, the capabilities of multiple suppliers possess enough appointed materials. The required capabilities of those roles are very clear and single so that they do

not need to specify into sub-roles. By contrast, the exporter in the same case is responsible for buying the materials, producing the paper, selling and exporting them. To make clear of the business activities of exporter, the tasks are divided and assigned to the sub-roles, such as: buyer, producer, seller and export specialist.

4. Simulation

In the previous chapter, I have analyzed six cases of international business trade using OperA+. The differences between direct control and self-regulation in the organization models have been presented. According to the different regulatory mechanisms, the sub-roles under the parent organizations conduct different behaviors. Under the self-regulation mechanism, sub-roles are designed under the producer or exporter to fulfill the requirements of self-regulation. It means that in the real international business trades, the company of exporter or producer should assign the specific departments or employees to complete tasks for self-regulation. However, we cannot directly see the influences of the two regulatory mechanisms on the processes of practical international business trades from the model.

In this chapter, therefore, I will conduct simulation based on the organization models to see the influences of direct control and self-regulation mechanisms on the international business trade. I will simulate the international business trade under both regulatory mechanisms to show the differences, using the case of apple export from China to the EU as an example.

4.1 Simulation Goal

The goal in this simulation is to show how international business trades perform under the two regulatory mechanisms. Based on the data obtained from simulation, we are able to evaluate the consequences of international business trades under different regulatory mechanisms.

4.2 Simulation Boundary

In this simulation, we will simulate the complete apple export process from sending order to exporters to receiving apples for importers. Due to the extreme complexity of the actual international business trade, some business activities have to be simplified or limited in the simulation. Since we focus on the comparison between the two regulatory mechanisms, the regulating activities are accentuated in this simulation and other activities are relatively reduced. There are some assumptions to set the boundary of this simulation.

- Assumption 1: negotiations between actors have been done before the start of the simulation

Because the negotiations between actors are different in every business trade, the term of the negotiations cannot be fixed in a range and the process of negotiations are quite complicated. If it is the first time for importers to import apples from China, it will take them long time to look for trustful exporters to cooperate with. If the importers have long cooperation with apple exporters in China, the term for negotiation is relatively short. In this simulation, therefore, the activities of negotiations between actors are not considered.

- Assumption 2: farmers are capable of providing enough apples as the requirements when they get orders.

The process of planting apples is not included in the simulation. I assume farmers have already harvested the apples and they have enough apples to supply to the processors.

- Assumption 3: before apples pass the customs, regulators inspect apples physically under direct control, but only inspect specific documents and certificates under self-regulation.

Under self-regulation, the exporting apples are certified by relative organizations so that they do not need to be inspected physically at customs except random check. Inspectors on both export and import side only check the validity of the certificates and documents for apples with certificates. While under direct control, apples have to be inspected physically before passing the customs.

- Assumption 4: the fees of apple storage for inspection term (including waiting time) are charged by exporter and importer respectively on export and import side.

Regulators need time to inspect either apples or documents, so apples should be sent to the appointed warehouse during the inspection term. The physical inspection of apples might be continued for 4-6 days. The time will be longer if they need to wait. The fees of storage for this term are not charged to regulators, but to exporters and importers.

- Assumption 5: there are not obvious differences for apples transportation between the two regulatory mechanisms in this simulation.

Since in the case analysis the regulations of apple transportation are not considered, I assume that the activities of LSP are the same in each apple export process.

- Assumption 6: Time and cost of obtaining the capability of self-regulation are not considered.

I do not consider the initial investments and time of setting-up self-regulation for each business actor. I assume that the self-regulatory mechanisms of business actors under self-regulation have been set up before the business trades start in the simulation.

- Assumption 7: Violations exist under self-regulation.

I assume there are violations under self-regulation during the business trade. If the violations are discovered by random check, the exporter will be punished and fined five times of the value of the exporting apples. Besides, the business trade will be stopped by the inspectors. If the violations are not selected to check the apples will be received by the importers at last.

According to such assumptions, the framework of the main activities in the simulation is showed in *figure 4-1.*

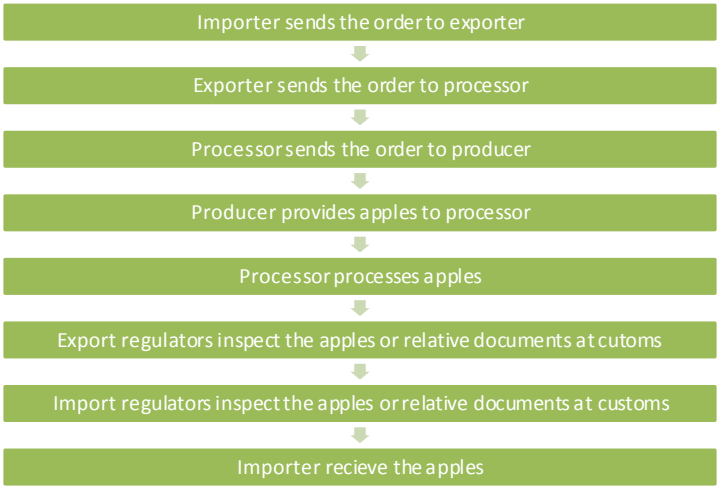

Figure 4-1: Main business activities in simulation

4.3 Agent Identification

4.3.1 Role enactment

Agents involved in the case of apple export from China to the EU are identified based on the roles analysis by OperA+ model in last chapter. Each role should be enacted by agents with certain capabilities to perform the perceived activities. For simplicity, the simulation model in this project only includes agents which enact roles in the top two layers. Because of the importance of the regulatory mechanisms, the roles of regulators in the third layer will be enacted. The complete simulation within multiple layers of roles will be researched in further study. In the *table 4-1*, the agents are introduced according to the roles in the OperA+ model.

Composite Agents/Roles	Sub-Agents/Sub-Roles	Main Activities
Import companies in the EU countries/ Importer	Purchasing department/ Buyer	Contact the exporters and conduct the business trades
	Import assistant/ Import specialist	Prepare relevant documents and declare at customs
	Quality department/ Quality inspector (direct control)	Inspect the import apples before import
Export companies in China/ Exporter	Marketing department/ Seller	Sell the apples to the EU countries
	Export assistant/ Export specialist	Prepare relevant documents and declare at customs
	Purchasing department/ Buyer	Buy the apples from local processors
	Quality department/ Quality inspector (direct control)	Inspect the apples before purchasing from processors
Fruit processing companies in China/ Processor	Purchasing department/ Collector	Buy the apples from farmers
	Sorting & Grading department/ Sorter	Sort and grade apples into different types

	Package department/ Packager	Pack the apples according to requirements
	Storage department/ Keeper	Store the apples in a good condition before selling
Planters/ Producers	Farmers/ Farmers	Plant apples
	Instructor/ Technical specialist (self-regulation)	Instruct farmers to plant apples
	Electronic System/ Monitor (self-regulation)	Monitoring the changes of indicator of apples in real-time
Logistic companies/ LSP		Transport apples from China to the EU
Chinese government/ Export regulators	Chinese customs/ Export customs	Decide which batches of apples can be exported
	CIQ/ regulators	Provide the laws of export apples and decide whether the exporting apples are eligible enough for export
EU government/ Import regulators	Customs in one of the EU countries/ Import customs	Decide which batches of apples can be imported
	Psychopathological Department of MoA/ Health regulators	Test whether the harmful bacteria are brought by apples
	Eurep GAP/ Quality regulators	Regulate the quality of apples
	HACCP/ Package regulators	Regulate the package of apples

Table 4-1: List of agents in apple export case

4.3.2 Interactions of agents

In international business trade, agents collaborate with each other to realize their collective goals. Information exchange and apple transaction between agents happen throughout the whole business process. The dependencies between roles have been presented in the OperA+ model in last chapter. This leads to the model structure depicted in the *figure 4-2*.

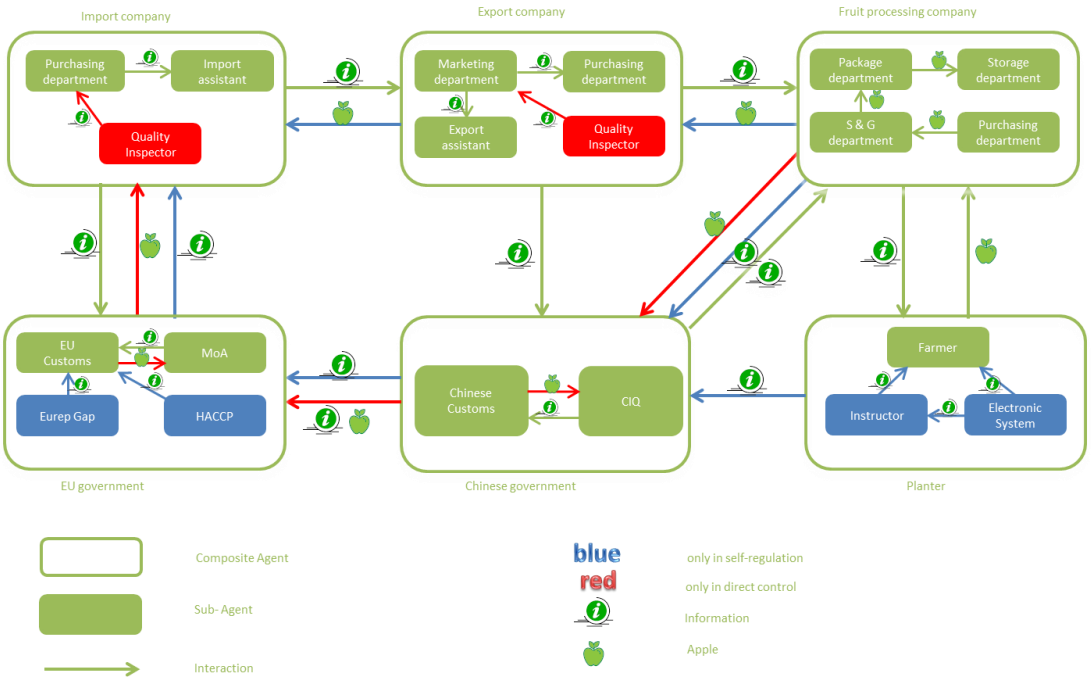

Figure 4-2: Interactions of agents

4.4 Identifying Inputs of the Simulation

Based on the interactions of the agents, the tasks and behaviors that agents perform in the simulation are explicit. The input will be defined in this section to trigger those tasks and behaviors.

4.4.1 Flowchart

The flowchart (*figure 4-3*) which formalizes the detailed simulation system delineates the possible task execution sequences in the simulation.

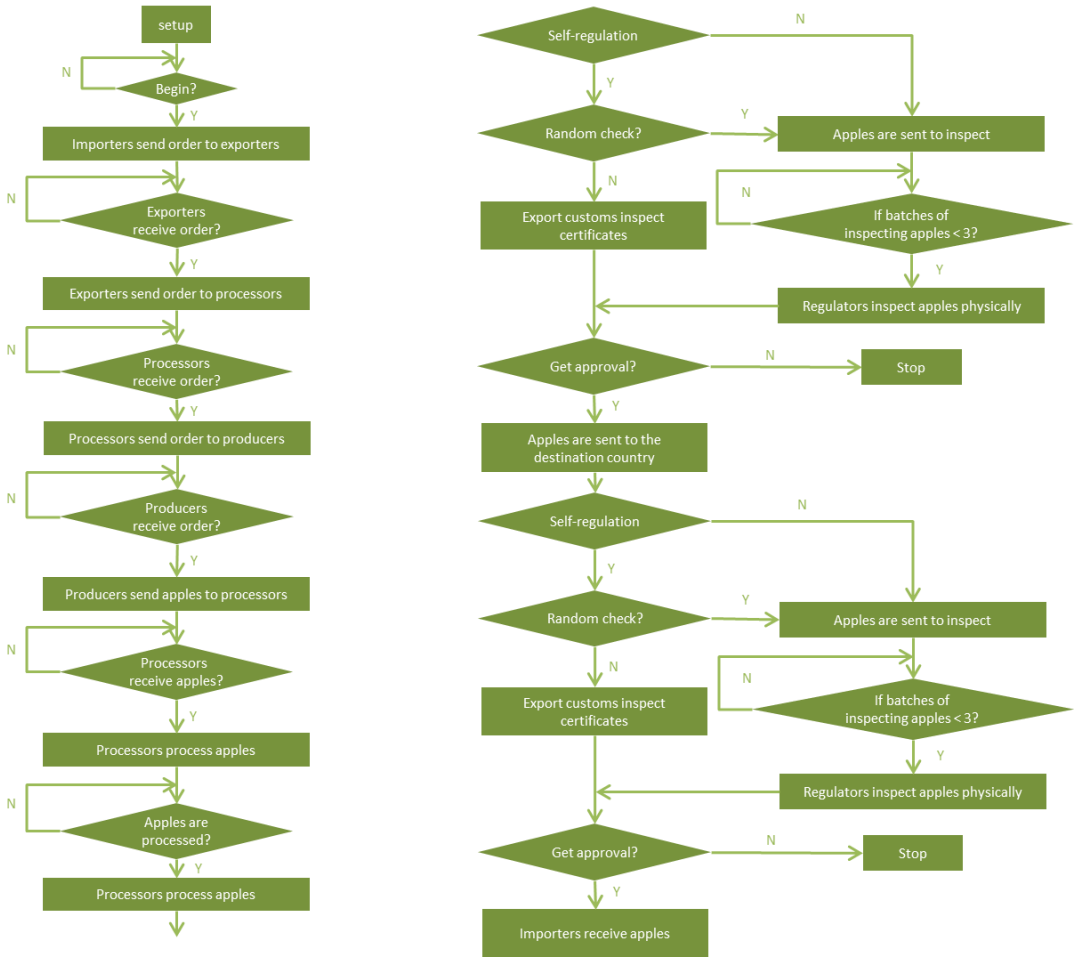

Figure 4-3: Flowchart of simulation

4.4.2 Default initial conditions

At the beginning of the simulation, a series of default initial conditions are set.

- The time of each business trade is not influenced by the quantity of apples.
- The type of apples in each business trade is the same.
- Timescale in the model is one day per tick.
- All the business trades start within three months.
- The transport means of inland transportation is truck, the transport means of international transportation is airplane.
- Under direct control, the customs can inspect a maximum of three business trades at the same time. It means that apples may be delayed while waiting for inspection.
- Under self-regulation, the probability of random check for physical inspection is 5%.

4.4.3 Input data

In order to simulate the business process, input data has to be obtained. Because of time and sources constraints, some requisite data could not be found in real case. We have

estimated such data based on literature research. However, this simulation approach can be used in real cases if sufficient data is available. Since the time is difficult to fix in days or hours, we set a reasonable range of time and the data will be selected randomly in the range during the simulation. Because the costs under different regulatory mechanisms are diversified, the data of costs are showed in self-regulation and direct control separately. Costs in business trades are not the same, so we also set a range of costs just as what we do on the time. The data is determined by referencing the report from (Zhang, Qiu and Huang 2009), (Orden, et al. 2007) and a Chinese apple transaction website (CFMA n.d.). *Table 4-2* shows the data we use in the simulation. The explanation of the symbols is showed in Appendix B.

Costs	**Self-regulation (euros/kg)**	**Direct control (euros/kg)**	**Time**	**Days/batch**
C_f	0.18-0.23	0.12-0.16	T_{ie}	1-2
C_{ia}	0.55-0.65	0.45-0.50	T_{ep}	1-2
C_{ea}	0.42-0.48	0.30-0.36	T_{pf}	1-2
C_a	0.28-0.32	0.21-0.25	T_{fp}	1-3
$C_{s/d}$	0.002-0.003	0.002-0.003	T_p	2-4
$C_{p/d}$	0.02-0.04	0.013-0.016	T_{et}	2-3
$C_{ei/d}$	0.0005	0.0005	T_{ei}	1/4-6 (self-regulation/direct control)
$C_{ii/d}$	0.0005	0.0005	T_t	2-4
			T_{ii}	1/4-6 (self-regulation/direct control)
			T_{it}	2-3

Table 4-2: Input data in simulation

4.5 Identifying Outputs of the Simulation

In order to measure the performance of the apple export process under the two regulatory mechanisms, we need to define the key indicators before the simulation. In this simulation, time, costs and the rate of undiscovered violations are chosen as the three types of performance indicators.

The economic profit is one of the most crucial factors that influence the decision making by multi-actors in international business trades. All actors involved desire to maximize their value they get from the business trade. Therefore the costs can be seen as one indicator to measure the performance of the business trades under the two regulatory mechanisms. In addition, time is another important factor that actors consider in decision making. If time increases, the costs for human labor and transportation or storage will be certainly increased. By contrast, relative short period of business process can not only decrease the costs for actors, but reduce the cash conversion cycle of actors. The risk is another factor that needs to be considered by business actors, especially the governments. If the undiscovered violations under self-regulation are excessive, the unqualified apples will be sold in the market, endangering the health and safety of consumers.

Since there are many actors involved in one business trade, we have to analyze the influence between self-regulation and direct control on costs and time of each actor individually. The *table 4-3* lists all the indicators and the explanations that will be used in the simulation. The explanation of the symbols is showed in Appendix B.

Costs	Explanation
Costs-Import company ($C_I = C_{IS} + C_{IA}$)	• Storage fees for inspection (including waiting) ($C_{IS} = T_{II} \times C_{s/d} \times n$) • Costs of purchase of apples from exporters ($C_{IA} = C_{ia} \times n$)
Costs-Export company ($C_E = C_{ES} + C_{EA}$)	• Storage fees for inspection (including waiting) ($C_{ES} = T_{EI} \times C_{s/d} \times n$) • Costs of purchase of apples from processors ($C_{EA} = C_{ea} \times n$)
Costs-Processing company ($C_P = C_{PC} + C_{PA}$)	• Costs of processing ($C_{PC} = T_p \times C_{p/d}$) • Costs of purchase of apples from producers ($C_{PA} = C_{pa} \times n$)
Costs-Farmers (C_F)	• Costs of planting apples ($C_F = C_f \times n$)
Costs-Chinese regulators (C_{ER})	• Costs of regulating and inspecting($C_{ER} = T_{ei} \times C_{ei/d} \times n$)
Costs-EU regulators (C_{IR})	• Costs of regulating and inspecting($C_{IR} = T_{II} \times C_{ii/d} \times n$)
Time	**Explanation**
Time-Total ($T = T_{ie} + T_{ep} + T_{pf} + T_{fp} + T_p + T_{IE} + T_t + T_{II} + T_{it}$)	• Time from the beginning to the end of the business trade
Time-Inspection-export ($T_{IE} = T_{ei} + T_{ew}$)	• Time for export inspection (including waiting time)
Time-Inspection-import ($T_{II} = T_{ii} + T_{iw}$)	• Time for import inspection (including waiting time)

Table 4-3: Indicators in simulation

As can be seen from the indicator table, the costs of each actor do not contain every item of the costs in the real world. The costs for transportation, human labor and other aspects are not included in consideration because it is difficult to collect and estimate related data. For the costs of import company and export company, two parts are included in the costs. One part is the storage fees for inspection (including waiting time). Through the equation, we know that the storage fees are decided by the inspection time which is decided by the regulatory mechanisms. Therefore, the storage fees can reflect the differences between the regulatory mechanisms to some extent. The other part is the costs of apples. Since farmers and processors invest more money for the establishment of self-control system, the costs of apples under self-regulation are normally higher than that of the direct control. We can see under which regulatory mechanism the costs containing these two parts are lower after simulation.

4.6 Implementation in Netlogo

Netlogo is used as the software to implement the simulation. In order to present the agents' activities clearly and get enough data, I develop two models for simulation. The first one is used to simulate single business trade to show not only the activities of parent agents but also how sub-agents under parent agents behave in the business process. The second one is used to simulate multiple business trades to get data for analysis. In the second model, the activities of the business trades are limited to the first layer. The behaviors of sub-agents cannot be shown in the simulation due to the complexity.

4.6.1 Single business trade simulation

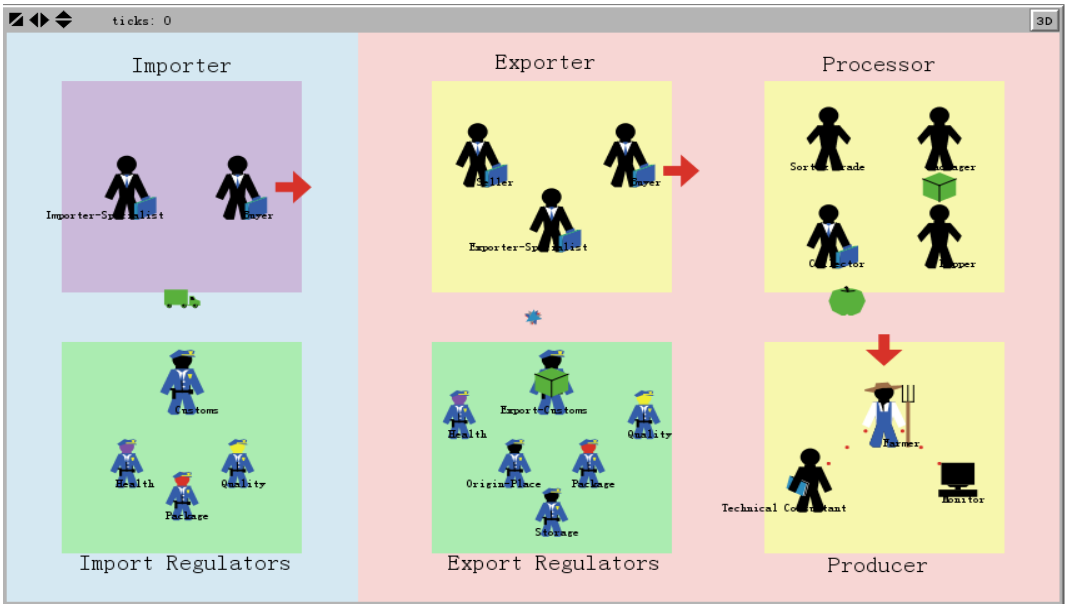

Figure 4-3: Model representation in Netlogo (single business trade)

The agents and sub-agents of the second layer are shown in *figure 4-3.* In the simulation, the business trade is considered as an object whose shape and location can be changed to reflect the different activities at different phases of business trade. The arrow between the importer and exporter means that a buyer or an importer is sending an order to a seller or an exporter. According to this implementation, the apple between producer and processor means that a producer is sending apples to a processor according to the order. The box on the processor means that the processor are packaging apples and the box on the export regulators means that they are sending the apples to the regulators for inspection. In this single business trade simulation, all of the states of business trade cannot be popped up at the same time. The state of the business trade will change during the simulation progress.

4.6.2 Multiple business trades simulation

In the multiple business trades simulation, the model shows a number of business trades with different characteristics. The visual model representation is shown as below (*figure 4-4*).

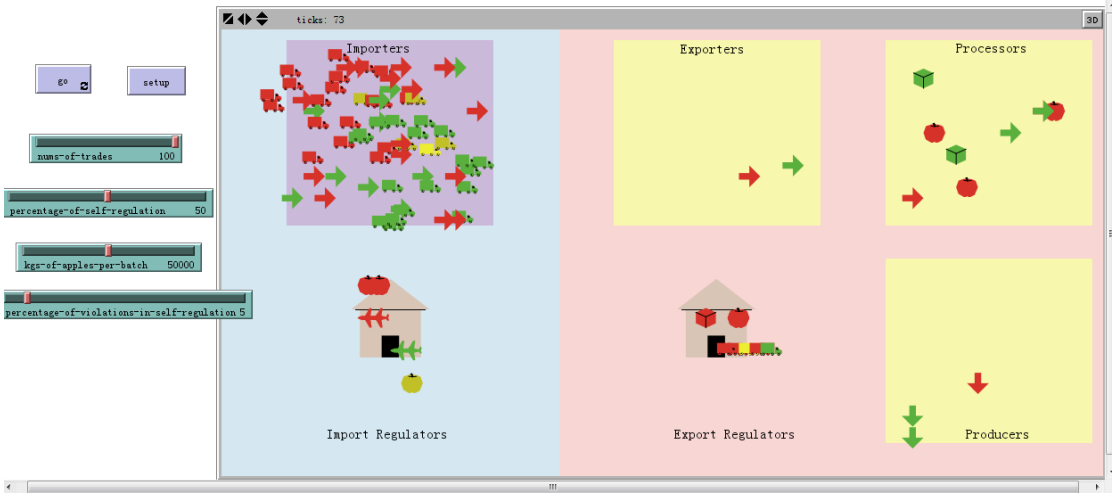

Figure 4-4: Model representation in Netlogo (multiple business trades)

The representations of the shape of the objects are the same as that of the single business trade simulation. The red colored objects represent apples under direct control while the green colored represent self-regulation. The yellow colored objects indicate that apples under the self-regulation mechanism are selected for physical inspection. On the left side of the interface, there are four sliders. The first one is the slider for choosing the numbers of business trades; the second one is for choosing the percentage of the business trade under self-regulations; the third one is for choosing the quantity of apples in each business trade; the fourth one is for setting the percentage of violations in self-regulation.

4.7 Verification and Validation

Before verification and validation of the simulation model, the purpose of this simulation has to be re-emphasized. The purpose is to see the influences of two regulatory mechanisms on the international business trades by comparing the data obtained from the simulation. Before model establishment, the system boundary and model assumptions have been built. Then I will analyze the verification and validation separately.

4.7.1 Verification

1. Testing the state transition of the object

The activities of the agents in the business trades are represented by the change of the shape and location of corresponding objects. Therefore, we have to test whether the state transition of the objects are in accordance with the progress of the business trade. Netlogo provides the function for watching and monitoring the objects, which can be used to test the

state transition of the objects. In each run, we select several objects to monitor and follow their state transition. The results demonstrate that the objects can perform correctly during the business trade. The *figure 4-5* shows how to test this state transition in simulation. The highlighted arrow is the object being monitored and the table of its attributes and parameters is shown on the left.

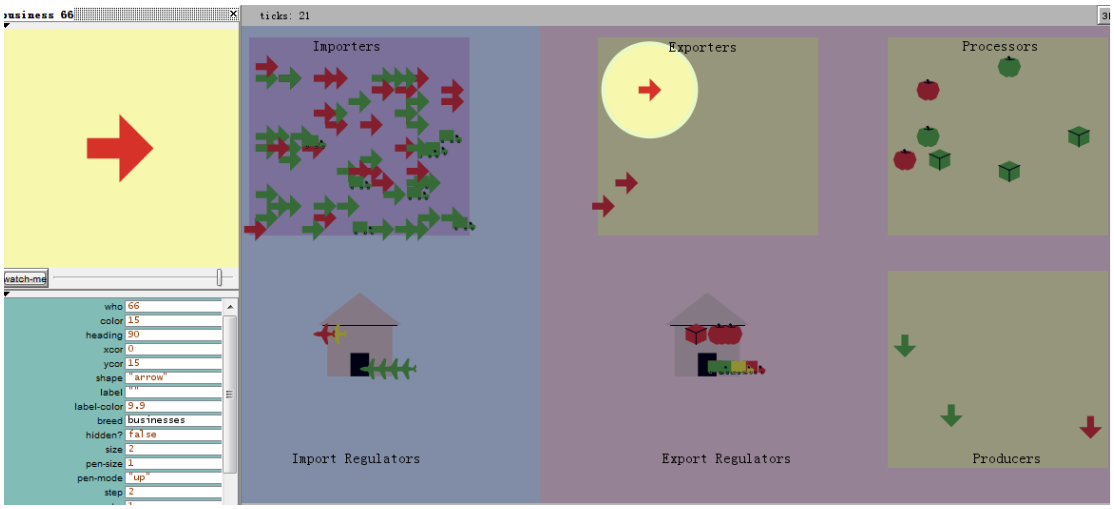

Figure 4-5: Testing change of states of objects

2. Testing the output of data

In order to test the output of the simulation, the percentage of self-regulation is set to 10%, 20%, 30%...100% to see the changes of the indicators of the business trades under self-regulation. Since inspection time of most business trades is 1 day under self-regulation, we assume the total time of business trades under self-regulation are similar. If there is not much variability of days of each run at different percentages, the output can be viewed as reasonable data. Std. deviation and mean are applied to measure the variability of time. The *table 4-4* shows the results. The means of total time of business trades under self-regulation are similar, meaning that the percentage do not influence the time of business trades under self-regulation. The std. deviation of each run is relatively small, meaning that there is not much variability of total times of every business trade under self-regulation. Therefore, the output is reasonable.

	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Mean	15.50	15.43	15.96	15.88	16.52	15.88	15.83	15.97	15.69	15.54
Std. deviation	.850	.992	1.895	1.742	3.121	1.672	1.630	1.288	1.288	1.080

Table 4-4: Means and Std.deviation of total days of business trades under self-regulation

4.7.2 Validation

So far, with the current model, the general apples export process with main activities is simulated and the simple indicators are obtained from simulation. The differences of inspection by regulators between direct control and self-regulation can be seen directly from the simulation. This simulation approach can be applied in other cases based on the organization model.

However, the simulation just provides an overview of international business trade because of the time and sources. The model needs to be improved for further validation. The model can be extended to the second layer of the agents in multiple business trade simulation. More variables can be added to measure the performance of the business trades and the data for input can be more precise and detailed. Additionally, the input data is not precise enough so that the results of the simulation might have errors influencing result analysis.

5. Result Analysis

This chapter is dedicated to the comparison of the influences of the two regulatory mechanisms on international business trades through data analysis. Notice that the goal of the simulation is not to analyze a large amount of data in the real world, but to find out how the different regulatory mechanisms influence the actors in international business trades.

The analysis includes four aspects: time, costs for each actor, the influence of the percentage of self-regulation and the violations of self-regulation in business trade. For the first two aspects, simulation is run ten times. The number of business trades is set to 100; the percentage of self-regulation is set to 50%; the quantity of apples per business trade is set to 50,000kg; and the percentage of violations in self-regulation is set to 5% . In each run, the data of 50 business trades under self-regulation and 50 business trades under direct control are obtained. Such data will be inputted in SPSS for analysis. For the third part, simulation should be run for several times to know how business trades perform under different percentage of self-regulation in 100 business trades. The simulation is run 11 times with different percentage of business trade under self-regulation. The number of business trades in each run is set to 100 and the quantity of apples per business trade is set to 50,000kg. For the last part, I run the simulation 100 times to see how many times the violations under self-regulation are discovered.

5.1 Time

In this part, time-inspection-export, time-inspection-import and the total-time of international business trade will be analyzed. The data of business trades under the two regulatory mechanisms are shown individually and compared in the analysis.

1. Time-inspection-export (T_{IE})

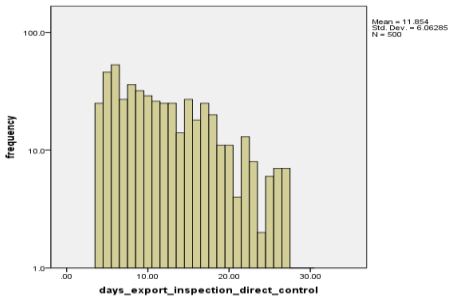

Figure 5-1: T_{IE} (Direct control)

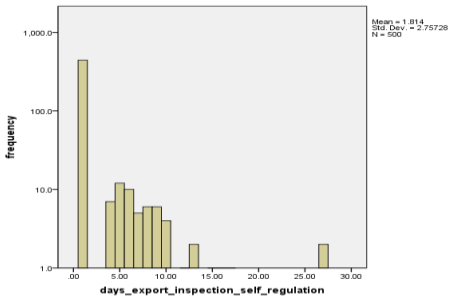

Figure 5-2: T_{IE} (Self-regulation)

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
Days of export inspection	500	26.00	4.00	30.00	11.8878	6.097511	37.180

Table 5-1: T_{IE} Descriptive statistics (Direct control)

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
Days of export inspection	500	26.00	1.00	27.00	1.8061	2.73678	7.490

Table 5-2: T_{IE} Descriptive statistics (Self-regulation)

Figure 5-1 and *figure 5-2* show the frequency distribution of T_{IE} of business trades under direct control and self-regulation. Most T_{IE} is 1 day under self-regulation, while T_{IE} is distributed between 4 days and more than 26 days under direct control. In table 5-1 and table 5-2, we can see the mean of T_{IE} under self-regulation is significantly shorter than that under direct control. There are two main reasons leading to these results. One is that the actual inspection time is different between self-regulation and direct control. Export regulators need 4-6 days to inspect apples under direct control. But they only spend 1 day on inspecting export apples with enough certificates since they do not need to make physical inspection of such apples.

The other reason is that waiting time for inspection of apples increases T_{IE} under direct control. Owing to the shortage of the resources, the export regulators can only inspect three batches of apples in maximum at the same time. Apples under direct control are more likely to be delayed for waiting for the physical inspection. Waiting time depends on the numbers of batches of anterior waiting apples. The more apples are waiting, the longer the waiting time is. In contrast, apples under self-regulation do not need to wait since inspections of documents and certificates save time and labor. In *table 5-1*, *Std. Deviation* of T_{IE} of business trades under direct control are relative high, showing the uncertainty and volatility of waiting time under direct control

Seen from figure 5-2, several business trades go through 6 days or even longer for inspection, deviating from others. It means that the export apples in those business trades are selected for physical inspection although they have enough certificates. Therefore the inspection time are increased.

2. Time of inspection for import (T_{II})

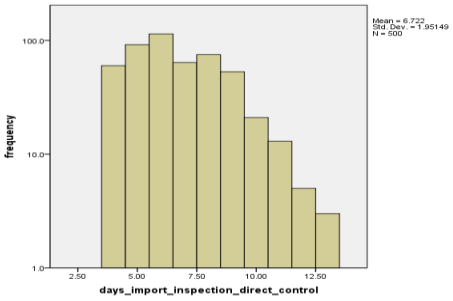

Figure 5-3: T_{II} (Direct control)

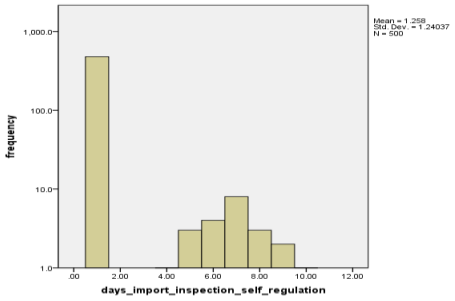

Figure 5-4: T_{II} (Self-regulation)

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
Days of import inspection	500	9.00	4.00	13.00	6.7184	1.96031	3.843

Table 5-3: T_{II} Descriptive statistics (Direct control

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
Days of import inspection	500	9.00	1.00	10.00	1.2633	1.25243	1.569

Table 5-4: T_{II} Descriptive statistics (Self-regulation)

Figure 5-3 and *figure 5-4* clearly show that inspection time of business trades under self-regulation is shorter than that under direct control. The reasons are the same as I explain in T_{IE}. Compared the *figure 5-3* with *figure 5-1,* we find that the inspection time of most business trades under direct control on export side is longer than that on import side. The mean of inspection time on import side is 6.2 days (see *table 5-3*), while it is 11.9 days (see *table 5-1*) on export side. This is because business trades are inspected physically by export regulators firstly. The business trades under direct control are forced to wait for inspection when the regulators are inspecting the three batches of export apples. So when the apples are sent to the destination countries for inspection, the possibility of arrival of apples at the same time is smaller than that on export side.

3. Total time (T)

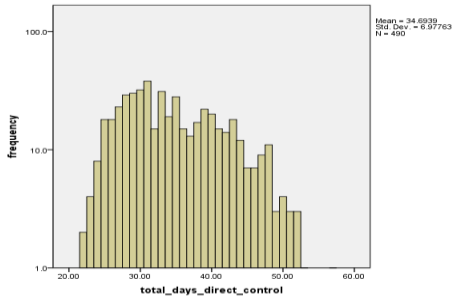

Figure: 5-5 T (Direct control)

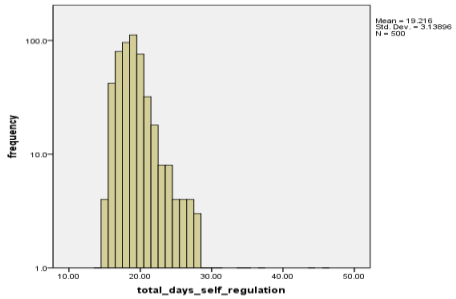

Figure 5-6: T (Self-regulation)

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
Total days	500	35.00	22.00	57.00	34.69	6.97763	44.687

Table 5-5: T Descriptive statistics (Direct control)

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
Total days	500	32.00	14.00	46.00	19.21	3.137	9.842

Table 5-6: T Descriptive statistics (Self-regulation)

From the results, we can see that the days of business trade under self-regulation are less than that under direct control. The mean of T under self-regulation (19.21 days) is significantly lower than the mean of T under direct control (34.69). Additionally, we can also see that the difference of T of each business trade under self-regulation is small. Most of the business trades under self-regulation have approximate 18 days, except the business trades in which apples are selected for inspection. In contrast, the difference of T of each business

trade under direct control is relatively big. The min of T is 22, while the max is 57. Both the frequency distribution of T in *figure 5-5* and the Std. Deviation of T demonstrate that the T under direct control is not stable. Because the days of other business activities do not have marked differences, the big difference of T under direct control results from the big difference of inspection time.

5.2 Costs

In this part, costs for the main actors under the two regulatory mechanisms are analyzed. The data of the two regulatory mechanisms will be showed separately.

1. **Producers (Farmers)**

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
Costs of farmer	500	1967.26	6000.49	7967.76	6986.66	589.25	347212.165

Table 5-7: C_F Descriptive statistics (Direct control)

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
Costs of farmer	500	2495.58	9004.13	11499.71	10232.77	748.40	560107.244

Table 5-8: C_F Descriptive statistics (Self-regulation)

The costs of farmers under self-regulation are more than that under direct control. To plant 50,000kgs apples, farmers under self-regulation spend around 10230 euros; while farmers under direct control only spend about 7000 euros. Several factors contribute to the bigger expenditure for farmers under self-regulation. Firstly, in order to reach the standards set by the regulators for getting certificates, farmers need agricultural consultants to instruct them. Furthermore, since the requirements of certificating are comprehensive and strict, the fertilizers, pesticides and other materials for planting apples have clear provisions. Farmer might spend more money on buying the high quality materials for planting apples. Moreover, the maintenance of self-regulation system is charged by farmers, like the maintenance of apple monitoring equipment. Compared to farmers with certificates, farmers under direct control do not need to invest in the aspects that mentioned above. Therefore the costs are relatively low.

2. Processors

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
Costs of farmer	500	3794.67	11810.72	15605.39	13675.67	845.06	714120.776

Table 5-9: C_P Descriptive statistics (Direct control)

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
Costs of farmer	500	7316.99	16100.15	23417.14	19484.13	1633.46	26682.6.60

Table 5-10: C_P Descriptive statistics (Self-regulation)

The costs of processors under self-regulation are also more than that under direct control. Reasons that lead to this result are similar as the reasons for the costs of farmers. In addition, processors under self-regulation only purchase apples with certificates, which are more expensive than the apples without certificates. Therefore, the expenditure of purchasing for processors under self-regulation is more than the processors under direct control.

3. Exporters

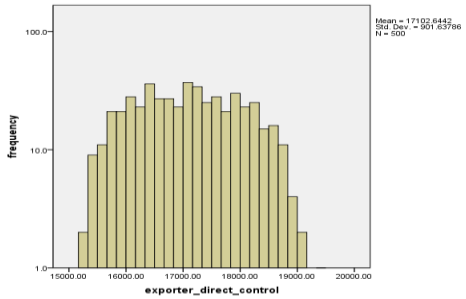

Figure 5-7: C_E boxplot (Direct control)

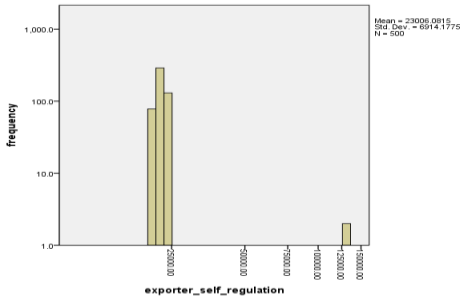

Figure 5-8: C_E boxplot (Self-regulation)

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
Costs of exporters	500	4071.38	15321.30	19392.68	17095.00	902.43	814381.93

Table 5-11: C_E Descriptive statistics (Direct control)

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
Costs of exporters	500	113195.28	21054.66	134249.93	22979.1640	6693.85	44807689.03

Table 5-12: C_E Descriptive statistics (Self-regulation)

The costs of exporter normally include two parts. One part is the costs of apples buying from the processors. Undoubtedly, the costs of apples with certificates under self-regulation are more than the normal apples without certificates. The other part is the costs of storing apples during export inspection term, including waiting time. In the analysis of time, we have known that the time for export inspection (T_{IE}) under self-regulation are significant shorter than that of direct control. Therefore, the storage fees of exporter under self-regulation are less than that under direct control. However, the mean of costs of exporter under direct control (17095.00) is less than that under self-regulation (22979.164), showing that less costs of storing apples cannot cover more expenditure of buying apples with certificates.

Furthermore, in *figure 5-8,* there are two points that deviate from the area that most points

locate. The costs of exporters at these two points are quite higher than others under self-regulation. This is because exporters at these two points are fined by regulators. There are violations in the business trades at these two points and they are discovered by random check. Because of these two points, the range is very large and the std. deviation is high in *table 5-12*.

4. Importers

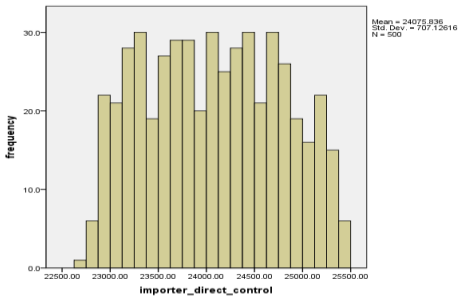

Figure 5-9: C_I (Direct control)

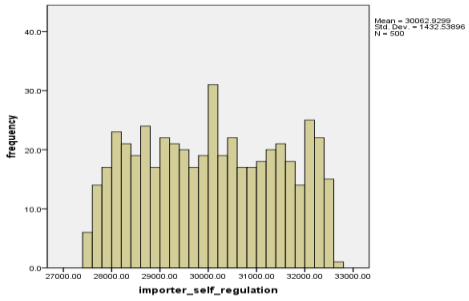

Figure 5-10: C_I (Self-regulation)

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
Costs of importers	500	4071.38	22719.35	25491.01	24076.65.00	712.23	507268.823

Table 5-13: C_I Descriptive statistics (Direct control)

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
Costs of importers	500	5137.60	27552.75	32690.35	30056.99	1428.18	2039693.826

Table 5-14: C_I Descriptive statistics (Self-regulation)

The situation for the costs of importers is similar as the situation for the costs of exporters. The average costs of importer under direct control is about 24000, while under self-regulation is 30000. Although the importer under direct control needs to pay for the storing fees during inspection time, the costs of importer under direct control are lower than that under self-regulation. The Std. Deviation of costs of importer under self-regulation is relatively high and the volatility of C_I is considerable. It is because the price of the apples for importer has large variability.

5. Regulators

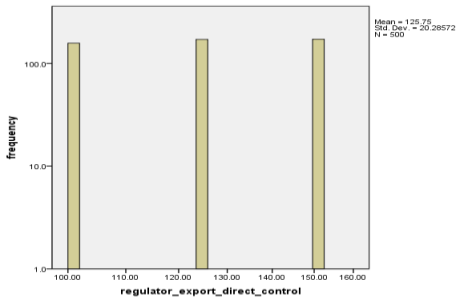

Figure 5-11: C_{ER} (Direct control)

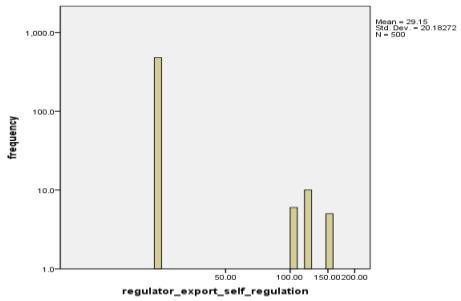

Figure 5-12: C_{ER} (Self-regulation)

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
Costs of regulators	500	50.00	100.00	150.00	125.59	20.24	409.597

Table 5-15: C_{ER} Descriptive statistics (Direct control)

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
Costs of regulators	500	125	25.00	150.00	29.30	20.62	425.089

Table 5-16: C_{ER} Descriptive statistics (Self-regulation)

Since the situation of regulators on export side and import side are the same, I just analyze the costs of export regulators. It is not difficult to see that the costs of regulators under self-regulation (mean is 29.30) are much less than the costs under direct control (mean is 125.59). Seen from *figure 5-12,* inspectors spend 25 euros on most of the business trades under self-regulation. Only several business trades costs more than 100 euros because of random check by inspectors. On the contrary, inspectors should spend at least 100 euros under direct control for the physical inspection. The inspection of documents and certificates can save much time for regulators. Therefore, from regulators' perspective, self-regulation mechanism should be encouraged.

5.3 Percentage of Self-regulation in Business Trades

In this part, I will run the simulation 11 times. The percentage of self-regulation will be set to 0, 10, 20…100 in each run. I will compare the total time of business trades among the 11 runs. Table 5-17 shows the minimum, maximum, mean, std. deviation and variance of the total time in each run. Figure 5-17 and 5-18 show the trends of means of total time under direct control and self-regulation in each run separately.

percentage		Minimum	Maximum	Mean	Std.Deviation	Variance
0 %	Self-regulation	-	-	-	-	-
	Direct control	20	118	66.15	28.194	194.876
10 %	Self-regulation	14	17	15.50	.850	.722
	Direct control	22	99	59.84	22.387	501.193
20 %	Self-regulation	14	17	15.43	.992	.984
	Direct control	22	75	49.29	14.171	200.829
30%	Self-regulation	14	24	15.96	1.895	3.591
	Direct control	22	81	55.53	16.718	279.477
40%	Self-regulation	14	22	15.88	1.742	3.305
	Direct control	21	56	36.80	10.113	102.264
50%	Self-regulation	14	32	16.52	3.121	9.744
	Direct control	21	44	33.54	5.702	32.517
60%	Self-regulation	14	23	15.88	1.672	2.796
	Direct control	21	27	23.43	1.335	1.782
70%	Self-regulation	14	23	15.83	1.563	2.443
	Direct control	20	32	24.28	2.963	8.778
80%	Self-regulation	14	22	15.97	1.630	2.657
	Direct control	21	27	23.22	1.594	2.542
90%	Self-regulation	14	20	15.69	1.288	1.658
	Direct control	21	28	23.00	1.758	3.901
100%	Self-regulation	14	20	15.54	1.080	1.166
	Direct control	-	-	-	-	-

Table 5-17: Descriptive Statistics of percentage of self-regulation

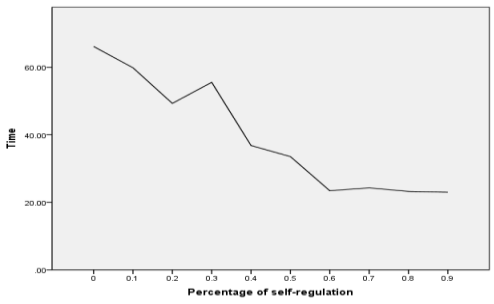

Figure 5-13: Means of T (Direct control)

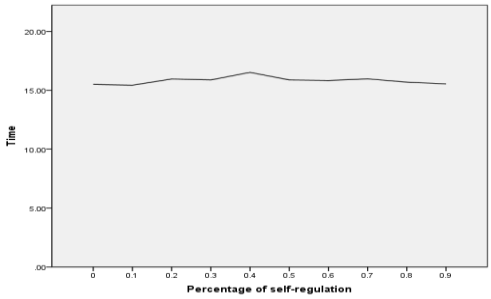

Figure 5-14: Means of T (Self-regulation)

From *figure 5-13* and *table 5-14*, we can see that different percentages of self-regulation in business trades have little influence on the total time of business trades under self-regulation. The means of total time under self-regulation is very stable at different percentages. On the contrary, the influence on the business trades under direct control is considerable. Seen from *figure 5-13*, the means of total time of business trades under direct control decreases dramatically as the percentage of self-regulation in all the business trades increases. However, the means of T begins to remain stable when the percentage of

self-regulation reaches to 60%. It means that if the percentage of self-regulation is more than 60%, the influence of the percentage is little on the total time of business trades under direct control.

Additionally, *table 5-17* shows that the Std. Deviation of T under direct control becomes relatively low when the percentage equals to 60%, which means that the variability of total time becomes small from that point. Total time of business trades is influenced greatly by the waiting time for inspection. The relative stability of T means that the waiting time for inspection under direct control does not have large variability when the business trades under direct control occupy less than 40% of the total number of the business trades.

5.4 Violations in self-regulation

In this part, I set the percentage of self-regulation to 10, 20…100 and run the simulation 100 times at each percentage in order to see the percentage of omission at different percentages of self-regulation. In each run, the percentage of violations in self-regulation is set to 5%, the number of business trades is set to 100. The equation is:

Omission rate= the number of business trades with undetected violations / the total number of business trades

In order to improve the accuracy, I run the simulation 100 times at each percentage of self-regulation and calculate the mean of the omission rate of the 100 runs. If there is no business trade with violation in a run, this run is eliminated. Table 5-18 shows the mean of omission rate at each percentage of self-regulation. Figure 5-15 shows the trends of means of omission rate with the increase of the percentage of self-regulation.

Percentage of self-regulation	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Mean of percentage of omission	0.98%	1.46%	1.70%	2.21%	2.72%	3.33%	3.87%	4.38%	4.66%	4.92%

Table 5-18: Descriptive Statistics of percentage of omission

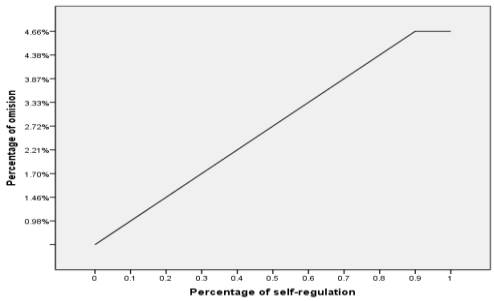

Figure 5-15: Means of percentage of omission

The omission rate rises with the increases of percentage of self-regulation, as seen from *table 5-18* and *figure 5-15.* Since the percentage of violations in self-regulation is invariable,

the increase of numbers of business trades under self-regulation leads to the rise of number of business trades with violations in all the business trades. The percentage of random check is invariable, so the possibility of undiscovered violations increases with the rise of percentage of self-regulation.

5.5 Conclusion

In this chapter, we compare the time and cost of the business trades in the two regulatory mechanisms based on the data obtained from the simulation. There are some conclusions we can get from data analysis.

1. Self-regulatory mechanism can shorten the time span of business trades.

Undoubtedly, self-regulatory mechanism has absolute advantages on the total time of business trades, compared to direct control mechanism. Both the inspection time and waiting time for inspection are decreased by self-regulatory mechanism, which benefit exporters, importers and regulators. The relatively short period of apple export process can speed up the capital turnover of exporters as well as importers, enabling them to run more business trades. Regulators are able to deal with more batches of export apples at the same time.

In addition, the total time of business trades under self-regulation is stable around 16 days, which enables exporters and importers to anticipate the progress of the apple export process and make better preparation. In direct control, however, the total time of business trades is more sensitive to the numbers of batches of export apples during the inspection term. Business actors cannot forecast how much time they will spend on one business trade. The uncertainty and randomicity might lead to risks.

2. For most of the business actors, the costs under self-regulation are more than that under direct control.

From previous data analysis, we can clearly know that the costs of importers, exporters, processors and farmers under self-regulation are more than the costs under direct control to various extents. The reasons have been presented in the data analysis. However, the high input may bring high output. Apples with certification are more competitive in exporting markets. Taking farmers as an example, although the costs of planting apples are much higher than that under direct control, farmers under self-regulation can also make more profit from selling apples since the apples with certification have high unit price. Moreover, the reputation of certification attracts more apple business transactions, resulting in more profit. Increasingly more importers intend to choose the actors with certifications to ensure good quality and safe of apples. Furthermore, the business actors with certification along apple value chain are more likely to establish the long term relationship, benefiting themselves.

However, large investments on electronical equipment or automatic production line are needed to realize self-regulation. For the small and medium enterprises, large investments

for self-regulation at the beginning are not realistic. The relatively low costs are more suited to their situation under which they are shortage of money for investment.

3. Regulators save costs in self-regulation.

It is not difficult to see that the costs of regulators under self-regulation are significantly less than the costs under direct control because of short inspection time. The self-regulation mechanisms should be encouraged by regulators. However, self-regulation mechanism brings some risks and opportunisms inevitability. In apple export process, so many business actors are involved to achieve their collective goals. We cannot guarantee that every actor involved in the business trade complies with the rules or regulations, even though they are trusted companies with certifications. If they are not inspected physically at customs on both export and import side, the apples will enter into the EU market, which may lead to the danger of health and safe for people. The costs of possible damage are much more than the costs of regulators for physical inspections.

Therefore, regulators should set up strict and explicit laws in the new regulatory mechanisms. Spot-check is necessary to avoid the risks that I mentioned. And sanctions are another approach for regulators to regulate the apple export process.

4. The percentage of business trades under self-regulation influences the total time of business trades under direct control.

With the decrease of the number of business trade under direct control, the total time of business trades under direct control are being shortened due to the reduction of inspection waiting time. In this simulation, the total time of business trades under direct control are stable at about 30 days when the percentage reaches to 60%。The total time will not decrease with the increase of percentage when it exceeds to 60%. It is a base for government to decide which percentage of business trades under self-regulation mechanism is better for actors both with and without certifications in the real world. The percentage of self-regulation in the simulation gives a reference to officers to balance the numbers of business trades under self-regulation and direct control.

5. The risk of undetected violations increases with the rise of the number of business trades under self-regulation.

With the increase of number of business trades under self-regulation, the number of business trades with violations goes up. The business trades under self-regulation are selected to check in very limited amounts, so most of business trades with violations are not discovered by regulators, leading to potential dangers of consumers.

6. Conclusion

This chapter is dedicated to summarize all the insights that we obtained from the research of this project. It is divided into three subsections: conclusion of the project, limitations of the project and future work.

6.1 Conclusion of the Project

In this project, regulatory mechanisms in international business trades are studied. From literature study it was understood that as business environment becomes complex and dynamic, self-regulation mechanism is proposed to fit to today's business environment. In order to see the differences of international businesses between direct control and self-regulation, I use OperA+, an agent based organization modeling approach to analyze several cases of international business trades with regulations. The roles and their objectives, capabilities, dependencies in each case are analyzed. Then the organization model of each case is built up according to the roles and dependencies by using OperA+. The comparisons are conducted based on the organization models. Firstly, I compare the two regulatory mechanisms in the apple export process to understand the similarities and differences of the organization models under the two regulatory mechanisms. Secondly, I compare the case of apple export with the case of grape export and conclude the influence of different regions to understand the differences and similarities of regulations concerning different export products.

Then according to the organization models, the simulation model is built up to simulate how international business trades perform under the two regulatory mechanisms. The apple export case is selected as an example to present the simulation approach. The agent interactions model, flowchart, input and output are defined before simulation. Based on the data obtained from the simulation, the differences of performance of international business trades under the two regulatory mechanisms are presented. Viewed as a whole, the self-regulation has some advantages over direct control in international business trades.

Based on the result of this research, I will give some conclusions as following.

1. **The change of regulatory mechanism results in the change of dependencies between regulators and business actors, and the change of regulators' activities. To enable the effectiveness of self-regulation, the explicit and strict sanctions have to be set up.**

From the comparison of the organization model of the case of apples export between direct control and self-regulation, we can see that different regulatory mechanisms influence the dependencies between regulators and business actors. In direct control, business actors depend on regulators for regular inspection and approval. However, in self-regulation, not only business actors depend on regulators, but also regulators depend on business actors for

inspecting their self-regulatory mechanisms and getting firsthand data from business actors. The regulators' activities under self-regulation are also different from direct control. Under direct control, main activities of regulator are inspecting and monitoring the specific business activities to ensure high quality; while under self-regulation, main activities of regulators are setting up certification mechanisms, providing the certification to legible actors, random inspections and sanctions. Setting up good and complete certification mechanisms with explicit standards and strict punishment mechanisms are very import in self-regulation. In the violations analysis in chapter 5, we can see that self-regulatory mechanism might bring about risks since some violations are not discovered due to omission. In order to minimize this kind of risk, regulators should make explicit standards of certification and strict sanctions for violation of regulations. If business actors are found to deceive customers or manipulate some business activities for self-interest, the strict sanctions will be imposed on them.

2. **Because different involved areas or different standards influence the regulative relationship between regulators and business actors, unified standards or codes for the same product in the world are able to simplify the regulative relationships.**

In the comparison between the case of apple export from China to EU and the case of grape export from South Africa to EU under self-regulation mechanism, we can see that different countries have different standards, regulations which influence the regulative relationship between regulators and business actors. Such differences bring about complications of regulatory activities for both regulators and business actors. Since China and the EU have two kinds of standards for apples, the business actors have to comply with both Chinese and the European standards. If the Chinese exporters who intend to export apples to both EU and USA, they have to comply with three different standards and apply for three kinds of certificates since the standards of apples in China, EU and USA are different.

If all the countries accept the same standard of the transaction product, business actors can comply with only one kind of rules and apply one kind of certificates, which can reduce the costs and energy for business actors. Regulators on import side can discharge the products with export approval directly without physical inspections if regulators on export side have the same standards and regulations as regulators on import side. The case of grape export from South Africa to the EU demonstrates the advantages of the unified standards between import and export countries. AEO certificate in the EU is another example of unified standards.

3. **Main actors' interests should be considered in setting up new regulatory mechanism – self-regulation.**

The change of regulatory mechanism influences all the involved actors in international business trade. Therefore all the actors, especially the main actors' interests should be considered in setting up self-regulation mechanism. From costs analysis of different actors in chapter 5, we can see that from regulators' perspective, self-regulation is an economical way to regulate actors. However, for business actors, the costs increase with the change of regulatory mechanism, which means that companies should invest more in business trade under self-regulation.

The small and medium enterprises (SME) cannot afford the increase of costs in international business trades under self-regulation. The decision makers should consider this situation and retain direct control mechanism to support the development of SME. To balance the number of business trades under self-regulation and direct control, the regulator can reference the percentage of business trades under self-regulation in the simulation to decide a reasonable ratio of business trades under self-regulation to direct control.

4. **In order to measure the performance of self-regulation, time, costs, risks and other factors should be taken into consideration.**

To measure whether self-regulation mechanism should be encouraged in complex and dynamic business environment, we cannot simply consider one or two factors. In terms of time, self-regulation has absolute advantage compared with direct control. Time analysis in chapter 5 demonstrates that the total time of business trades under self-regulation is greatly shorter than that under direct control. For the regulators, self-regulation reduces the inspection time effectively and therefore reduces the inspection costs. For business actors, the period of business trade is shortened by self-regulation, leading to the acceleration of capital turnover of exporters as well as importers. In terms of costs, the costs of regulators decrease because they do not need to inspect physically, but inspect the regulatory mechanism of the business actors. However, the costs of business actors are increased under self-regulation mechanisms and not all actors can afford such big investment on the business trades as I mentioned. In terms of risk, the violations are not easy to discover by random check under self-regulation. In violations analysis in chapter 5, we can see that the more business trades under self-regulation, the more risk for undetected violations launching on market.

Therefore, although self-regulation has the advantage of saving time compared with direct control, we cannot easily say that self-regulation is better than direct control because it will bring about problems, like increasing the costs of business actors, increasing risks. If regulators want to encourage self-regulation mechanism, they should also consider other factors and resolve the problems that self-regulation brings.

6.2 Limitations of the Project

One of the main limitations is that the OperA+ model is a developing MAS approach. So I just analyze the cases of international business trades in the first step, building up the organization model based on the identification of roles and dependencies. The concrete activities and protocols of interactions between multi-actors cannot be analyzed until the OperA+ model is further developed.

The second limitation is that the simulation of multiple business trades can just only show the behaviors of the roles on the first layer of organization models. The operating performance of inter organizational structures cannot be realized in the simulation of multiple business trades in this project. Only the simulation for single business trade can show the behaviors of sub-roles on the second layer in the international business trade.

The third limitation is that the input data are not precise, leading to the low validity of the results. Because of time limitation and difficult access to the real data that we need for analysis, the results may be a little weak. However, in this project, we do not focus on analyzing a large amount of data in the real world, but finding out a method to show how the different regulatory mechanisms influence the actors in international business trades. The simulation approach can be developed to apply in the case with sufficient data.

6.3 Future Work

The simulation model can be developed into a mature approach fitting to simulating various cases. The multiple layers in the organization model can be presented in the simulation model and therefore the behaviors and activities of the roles in multiple layers can be performed during simulation.

In self-regulation mechanism, there are a large number of approaches that can realize self-regulation. Business actors and regulators may negotiate with each other to decide which approach is better for everyone based on several factors. We can compare such approaches during simulation to see the differences of performances between those approaches for decision making.

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Appendix

Appendix A.1.1: Role table for top level organization of apples export case (direct control)

Role	Objective	Capability	Dependency
Exporter	Export eligible apples as the requirements of importer	Have export license; Be able to get apples with requirements	Importer, Processor, LSP, Regulator
Importer	Import eligible apples	Have import license; Be able to contact the exporters in other locations	Exporter, Regulator, LSP
Processor	Process apples with requirements of exporters	Have processing regulation knowledge; Have equipment for packaging; Have appropriate storehouse to keep apples	Exporter, Regulator, Producer
Producer	Plant eligible apples	Have apple plant technique and resources for planting	Processor, Regulator
LSP	Organize the apples transport and provide transport services	Have resources for transporting; Be able to transport crossing the border	
Regulator	Ensure the whole process is legitimate	Have specialists to regulate the process; Have official authorization to inspect the business process	

Appendix A.1.2: Role table for second level organization of apples export case (direct control)

Role	Sub-role	Objective	Capability	Dependency
Exporter	Export Specialist	Deal with the export procedures to let the apples be exported	Understand the export procedures of apples; Be able to declare at customs	
	Seller	Get the orders abroad	Have good relationship with the importers in the EU;	Export Specialist, Buyer
	Buyer	Get the eligible apples	Be able to get apples as requirements of importer	Quality Inspector, Seller
	Quality Inspector	Ensure the quality of the apples and their package before buying	Understand the international and national regulations; Be professional in inspecting the quality of apples and their packages	
Importer	Import Specialist	Deal with the import procedures to let the apples be imported	Understand the import procedures of apples; Be able to declare at customs	
	Buyer	Buy the eligible apples abroad	Be able to buy eligible apples meeting the requirements of regulations	Import Specialist, Inspector
	Quality Inspector	Ensure the quality of the apples and their package before buying	Understand the international and national regulations; Be professional in inspecting the quality of apples and their packages	
Processor	Collector	Get the eligible apples from farmers	Be able to get apples with requirements	
	Sorter	Sort and grade the apples into different grades	Understand the standards of apples grades in regulations; Be able to sort apples	Collector
	Keeper	Keep the apples in good condition	Store apples in appropriate environment	Packager
	Packager	Pack the apples as the requirements of regulations	Know the regulations of packages; Be able to package apples meeting the requirements of regulations	Sorter
Regulator	Export Regulator	Regulate the export process; Make sure the export apples meet the requirements of regulations	Be able to inspect the export process and quality of the export goods	Import Regulator
	Import Regulator	Regulate the import process; Make sure the import apples meet the requirements of regulations	Be able to inspect the import process and quality of the import goods	Export Regulator

Appendix A.1.3: Role table for third level organization of apples export case (direct control)

Role	Sub-role	Sub-sub-role	Objective	Capability	Dependency
Regulator	Export Regulator	Customs(Export)	Regulate the export process	Be able to inspect the export procedures and approve the legal export process	All the inspector
		Inspectors	Ensure the quality of export apples	Be able to make standards of the quality and inspect the relative actors	
	Import Regulator	Customs(import)	Regulate the import process	Be able to inspect the import procedures and approve the legal import process	All the inspector
		Inspectors	Ensure the quality of export apples	Have specialist for inspections	

Appendix A.1.4: Role table for top level organization of apples export case (self-regulation)

Role	Objective	Capability	Dependency
Exporter	Export eligible apples as the requirements of importer	Have export license; Be able to get apples with requirements	Importer, Processor, LSP, Regulator
Importer	Import eligible apples	Have import license; Be able to contact the exporters in other locations	Exporter, Regulator, LSP
Processor	Process apples with requirements of exporters	Have processing regulation knowledge; Have equipment for packaging; Have appropriate storehouse to keep apples; Have self-regulatory mechanisms	Exporter, Regulator, Producer
Producer	Plant eligible apples	Have apple plant technique and resources for planting	Processor, Regulator
LSP	Organize the apples transport and provide transport services	Have resources for transporting; Be able to transport crossing the border	
Regulator	Ensure the whole process is legitimate	Have specialists to regulate the process; Be able to certify actors who can self-regulate themselves	Exporter, Importer, Processor, Producer

Appendix A.1.5: Role table for second level organization of apples export case (self-regulation)

Role	Sub-role	Objective	Capability	Dependency
Exporter	Export Specialist	Deal with the export procedures to let the apples be exported	Understand the export procedures of apples; Be able to declare at customs	
	Seller	Get the orders abroad	Have good relationship with importers in the EU; Register the company in the relative organizations	Export Specialist, Buyer
	Buyer	Get the eligible apples	Be able to get apples from the processor with certifications	Seller
Importer	Import Specialist	Deal with the import procedures to let the apples be imported	Understand the import procedures of apples; Be able to declare at customs	
	Buyer	Buy the eligible apples abroad	Be able to buy eligible apples meeting the requirements of regulations; Inspect the certifications before buying	Import Specialist, Inspector
Processor	Collector	Get the eligible apples from farmers	Be able to get apples from the quality of apple bases with certification	
	Sorter	Sort and grade the apples into different grades	Understand the standards of apples grades in regulations; Be able to sort apples	Collector
	Keeper	Keep the apples in good condition	Get the certification of the storage of apples; Have monitor system to monitor the temperature and humidity in real-time	Packager
	Packager	Pack the apples as the requirements of regulations	Know the regulations of packages; Be able to package apples meeting the requirements of regulations	Sorter
Producer	Farmer	Plant the eligible apples and sell them	Have necessary resources and technique to plant apples	Technical Consultant, Monitor System
	Technical Consultant	Guide farmer to plant eligible apples meeting requirements of regulators and apply the technical monitor system in production	Be familiar with the regulations; Have enough planting knowledge and experience	Monitor System
	Monitor System	Make farmers control level of fertilizer and pesticide; Let the regulator check the level of fertilizer and pesticide via internet	Be able to monitor parameters of apples in real-time	Technical Consultant
Regulator	Export Regulator	Regulate the export process; Make sure the export goods meet	Be able to inspect the export process and quality of the export goods	Import Regulator

		the requirements of regulations		
	Import Regulator	Regulate the import process; Make sure the import goods meet the requirements of regulations	Be able to inspect the import process and quality of the import goods	Export Regulator

Appendix A.1.6: Role table for third level organization of apples export case (self-regulation)

Role	Sub-role	Sub-sub-role	Objective	Capability	Dependency
Processor	Packager	Packer	Pack the apples as requirements of regulation	Have facilities to pack apples	Monitor
		Monitor	Ensure high quality of package process	Be able to monitor packing process	
		Marker	Make the mark on the package as the requirements of regulations	Be able to mark information as the requirements of regulations	Packer
	Keeper	Controller	Keep the certain temperature in the storing environment	Control the temperature automatically	Monitor
		Monitor	Show the certain temperature in the storing environment	Monitor the temperature in real-time	
Regulator	Export Regulator	Customs(Export)	Regulate the export process	Be able to inspect the export procedures and approve the legal export process	All the certifiers
		Certifiers	Provide the certifications and Inspect relative actors	Be able to make standards of the quality and inspect the relative actors	
	Import Regulator	Customs(import)	Regulate the import process	Be able to inspect the import procedures and approve the legal import process	All the certifiers
		Certifiers	Provide the certifications and Inspect relative actors	Be able to make standards of the quality and inspect the relative actors	

Appendix A.2.1: Role table for top level organization of table grape export case

Role	Objective	Capability	Dependency
Exporter	Export eligible table grapes as the requirements of importer	Have export license; Be able to get table grapes with requirements	Importer, Producer, LSP, Regulator
Importer	Import eligible table grapes	Have import license; Be able to get eligible exporters	Exporter, Regulator, LSP
Storage	Keep the table grapes in good condition before export	Have storage certification; Be able to install the temperature control system to keep the certain temperature	Regulator
Producer	Plant and pack eligible table grapes	Have grape plant and package technology and resources for planting and packing; Have certifications for planting and packing	Exporter, Regulator, Storage
Logistics service provider (LSP)	Organize the table grapes transport and provide transport services	Have resources for transporting; Be able to transport crossing the border; Be able to keep the certain temperature in the internal environment during the transport	Regulator
Regulator	Ensure the whole process is legitimate	Have specialists to regulate the process; Be able to certify the relative actors	Exporter, Importer, Storage, Producer

Appendix A.2.2: Role table for second level organization of table grape export case

Role	Sub-role	Objective	Capability	Dependency
Exporter	Export Specialist	Deal with the export procedures to let the table grapes be exported	Understand the export procedures of table grapes; Be able to declare at customs	
	Seller	Get the orders abroad	Be able to register the exporter on the relative organizations	Export Specialist, Buyer
	Buyer	Get the eligible table grapes	Be able to get table grapes from the producers with certifications	Seller
Importer	Import Specialist	Deal with the import procedures to let the table grapes be imported	Understand the import procedures of table grapes; Be able to declare at customs	
	Buyer	Buy the eligible table grapes abroad	Be able to buy eligible table grapes meeting the requirements of regulations; Inspect the certifications before buying	Import Specialist, Inspector
Producer	Planter	Plant the eligible table grapes	Have necessary resources and technique to plant table grapes	
	Picker	Pick the ripe fruit	Be able to recognize the degree of ripeness	Planter
	Sorter	Sort and grade the table grapes into different grades	Understand the standards of table grapes grades of regulations; Be able to sort table grapes	Picker
	Packer	Pack the table grapes according to the regulations	Be able to package table grapes meeting the requirements of regulations	Sorter
Storage	Controller	Ensure that the grapes keep good condition	Control the internal environment of storage to meet the requirement of regulations	Monitor
	Monitor	Monitor the internal environment of Storage	Be able to monitor the internal environment and record the data	
LSP	Controller	Ensure that the grapes keep good condition during the transportation	Control the internal environment during transportation to meet the requirement of regulations	Monitor
	Monitor	Monitor the internal environment during the transportation	Be able to monitor the internal environment and record the data	
Regulator	Export Regulator	Regulate the export process; Make sure the export goods meet the requirements of regulations	Be able to inspect the export process and quality of the export goods	Import Customs

	Import Customs	Regulate the import process; Make sure the import goods meet the requirements of regulations	Be able to inspect the import process	Export Regulator

Appendix A.2.3: Role table for third level organization of table grape export case

Role	Sub-role	Sub-sub-role	Objective	Capability	Dependency
Processor	Planter	Farmer	Plant the eligible grapes	Have necessary resources and technique to plant grapes	Technical Consultant, Monitor System
		Technical Consultant	Guide farmer to plant eligible grapes meeting requirements of regulators and apply the technical monitor system in production	Be familiar with the regulations; Have enough planting knowledge	Monitor System
		Monitor System	Make farmers control level of fertilizer and pesticide; Let the regulator check the level of fertilizer and pesticide via internet	Be able to monitor the fertilizer, pesticide in real-time	Technical Consultant
	Picker	Farmer	Pick enough ripe grapes	Have experience to recognize ripe grapes	Ripeness Monitor
		Ripeness Monitor	To let farmer pick enough ripe grapes	Be able to detect the ripeness of grapes	
	Packer	Packing system	Pack the table grapes according to the requirements	Have facilities to pack apples	
		Monitor	Ensure high quality of package process	Be able to monitor the package process	Packing system
		Tracker	Install a tag on the package to track the grapes	Be able to track the grapes in real-time	Packing system
		Marker	Make the mark on the package as the requirements of regulations	Be able to mark information as the requirements of regulations	Packing system
Regulator	Export Regulator	Customs(Export)	Regulate the export process	Be able to inspect the export procedures and approve the legal export process	All the certifiers
		Certifiers	Provide the certifications and Inspect relative actors	Be able to make standards of the quality and inspect the relative actors	

Appendix A.3.1: Role table for top level organization of clothes export case

Role	Objective	Capability	Dependency
Exporter	Export required clothes to other countries	Have the export license; Be able to get clothes	Importer, Manufacture, Shipping Agent, Regulator, Bank, Insurance Provider
Importer	Get required clothes from other countries	Have the import license: Be able to contact with company with certification	Exporter, Regulator, Bank
Exporter's Bank	Ensure the successful transaction	Be able to deal with the international transaction	Importer's bank
Importer's Bank	Provide a credit for importer and ensure the successful transaction	Be able to deal with the international transaction	
Manufacture	Produce the required clothes within required time	Be able to produce the clothes: Have the certification of quality of clothes	Exporter, Regulator, Material Supplier
Material Supplier	Provide required material	Be able to supply the required material	Manufacture
Shipping Agent	Assist Exporter to transports the goods and make relative exporting procedures	Have resources of LSP; Have certification of shipping agent	Regulator, LSP
LSP	Transport the goods to destination	Have resources for transporting; Be able to transport crossing the border	
Insurance Supplier	Insure the transportation	Be able to insure	
Regulators (export)	Regulate the export process	Have specialists to regulate the process	

Appendix A.3.2: Role table for second level organization of clothes export case

Role	Sub-role	Objective	Capability	Dependency
Exporter	Seller	Get orders from Importer	Be able to get orders from other countries	Export Specialist, Inspector
	Export Specialist	Deal with the export procedures to let the clothes be exported	Understand the export procedures of clothes	
	Inspector	Inspect the quality of clothes	Be proficient in clothes	
	Finance	Ensure each finance transaction is clear and correct	Have finance knowledge	Seller
Importer	Buyer	Buy the clothes from other countries	Be able to contact with clothes exporter	Finance, Import Specialist
	Finance	Ensure each finance transaction is clear and correct	Understand the finance knowledge	
	Inspector	Inspect the quality of sample clothes before place order	Be proficient in clothes	
Manufacture	Seller	Get clothes orders	Be able to contact with exporters	Producer
	Buyer	Buy the necessary materials for producing clothes	Be proficient in clothes materials	
	Producer	Produce the required clothes	Be able to produce clothes meeting the requirements	Buyer, Seller
Regulator (export)	Customs(Import)	Regulate the export process	Be able to inspect the export procedures and approve the legal import process	Quota Approver, Business trade Regulator, Quality Inspector
	Tax Administration	Deal with tax refund	Be able to inspect the tax	Customs
	Quota Approver	Control the quantity of export	Be able to give the quota to eligible exporter	
	Business trade Regulator	Regulate the international business trade	Be able to set reasonable laws to facilitate the business trades	
	Quality Inspector	Ensure the quality of clothes	Have specialist on clothes	

Appendix A.4.1: Role table for top level organization of dairy products export case

Role	Objective	Capability	Dependency
Exporter	Export eligible dairy products to other countries	Be able to produce eligible dairy products; Have AEO certification;	Importer, LSP, Regulator
Importer	Import eligible dairy products from other countries	Have import license; Be able to get eligible dairy products	Exporter, Regulator
Logistics Service Provider(LSP)	Transport the dairy products with good condition to the destination within required time	Have resources for transporting; Be able to transport crossing the border	Regulator
Regulator	Regulate the whole process and quality of dairy products	Have specialists to regulate the process	Exporter

Appendix A.4.2: Role table for second level organization of dairy products export case

Role	Sub-role	Objective	Capability	Dependency
Exporter	Export Specialist	Deal with the export procedures to let dairy products be exported	Understand the export procedures of apples	
	Seller	Get the orders abroad	Have distribution channels; Have strong negotiation ability	Export Specialist, Keeper
	Keeper	Keep the dairy products with good condition	Have good environment for keeping apples	Producer, Inspector
	Inspection system	Ensure the quality of dairy products	Understand the international and national regulations; Be professional in inspecting the quality of dairy products	
	Producer	Produce eligible milk and dairy products	Have enough resources and knowledge to produce	
Importer	Import Specialist	Deal with import procedures to let dairy products be imported	Understand the import procedures of dairy products	
	Buyer	Get eligible dairy products abroad	Be able to buy eligible dairy products abroad	Import Specialist
Regulator	Customs(Import)	Regulate the import process	Be able to inspect the import procedures and approve the legal import process	Export Regulator
	Export Regulator	Regulate the export process and the quality of export products	Be able to inspect the export process and quality of the export goods	Customs(Import)
LSP	Assigner	Organize the dairy products transport	Be able to manage the transport; Be able to transport crossing the border	Inspector
	Carrier	Transport dairy products in good condition within required time	Be able to transport physical products: Have cooling system in transporting	Assigner, Inspector
	Temperature Monitor	Keep the dairy product in good environment	Be able to control the temperature for dairy product during transportation	

Appendix A.4.3: Role table for third level organization of dairy products export case

Exporter	Producer	Milk Producer	Produce eligible milk	Be able to raise cow and get milk	Technical Consultant
		Dairy Products Producer	Produce eligible dairy products	Be able to produce dairy products	Milk Producer, Technical Consultant
		Technical Consultant	Guide the producer produce eligible products	Be familiar with the regulations; Have enough raising knowledge	
		boarder Inspector	Inspect the import license and products at the boarder	Understand the regulations of import	Approver
Regulator	Export Regulator	Customs (Export)	Ensure the export process is legitimate	Be able to inspect the export procedures and approve the legal export process	Healthy Certifier, Origin Certifier
		Healthy Certifier	Regulate the dairy products quality	Be able to make standards of the dairy products quality and certify the quality of the products	
		Origin Certifier	Certify the origin place	Be able to certify quality of the origin place	
		Tax Administration	Deal with the tax refund		Customs(Export)

Appendix A.5.1: Role table for top level organization of paper export case

Role	Objective	Capability	Dependency
Exporter	Export more eligible paper to other countries	Be able to get AEO certification	Importer, Regulator, LSP, Supplier
Importer	Import more eligible paper from other Countries	Have import license; Be able to find seller	Exporter, Regulator
Supplier	Supply the required materials for producing the paper	Be able to provide the necessary materials	
Regulator	Ensure the whole process is legitimate;	Have specialists to regulate the process and provide the certification	Exporter
Logistics Service Provider(LSP)	Transport the products to the destination	Have resources for transporting; Be able to transport crossing the border	Exporter

Appendix A.5.2: Role table for second level organization of paper case

Role	Sub-role	Objective	Capability	Dependency
Exporter	Export Specialist	Deal with the export procedures to let paper be exported	Understand the export procedures	
	Seller	Get the orders abroad	Have distribution channels; Have strong negotiation ability	Export Specialist, Quality Inspector
	Quality Inspector	Ensure the quality of paper meet AEO standards	Understand the AEO regulations; Be professional in inspecting the quality of paper	Producer
	Producer	Produce paper	Have enough resources and knowledge to produce	Buyer
	Buyer	Buy the necessary materials for producing paper	Have resources of the materials supplier	Finance
Importer	Buyer	Get eligible paper abroad	Be able to get contact with AEO company	Import Specialist
	Import Specialist	Deal with import procedures to let paper be imported	Understand the import procedures of paper	
Regulator	Customs (Import)	Regulate the import process	Be able to inspect the import procedures and approve the legal import process	Customs (Export), AEO
	Customs (Export)	Regulate the export process and the quality of export products	Be able to inspect the export process and quality of the export goods	Customs(Import), AEO
	AEO Certifier	Regulate the company and provide the certification to the eligible company	Be able to inspect the companies and certify them	

Appendix A.5.3: Role table for third level organization of paper case

Regulator	Customs (Import)	Approver	Ensure the import process is legitimate	Have resources of eligible exporters	
		Boarder Inspector	Inspect the import license and products at the boarder	Understand the regulations of import	Approver
	Customs (Export)	Approver	Ensure the export process is legitimate		
		Boarder Inspector	Inspect the export documents at the boarder	Understand the regulations of export	Approver

Appendix A.6.1: Role table for top level organization of shipment between US and Mexico

Role	Objective	Capability	Dependency
Owner of the goods	Get more finished goods with low costs	Have spare parts; Be the member of NAFTA	Processing Manufacture, Broker, LSP, Regulator
Processing Manufacture	Assemble the spare parts	Be able to assemble the spare parts; Be the member of NAFTA	Broker, LSP, Regulator, Owner of the goods
Broker	Help company achieve the export-import process	Understand the specific export-import procedure	Regulator
LSP	Provide the logistic service within required time	Have resources for transporting; Be able to transport crossing the border	Regulator
Regulator	Regulate the export-import process	Have specialists to regulate the process	

Appendix A.6.2: Role table for second level organization of shipment between US and Mexico

Role	Sub-role	Objective	Capability	Dependency
Owner of the goods	Business Negotiator	Find the Manufacture to assemble the spare parts	Have the resources of the manufacture with NAFTA; Have strong negotiation ability	
	Consigner	Prepare the spare parts to transport		Business Negotiator
	Inspector	Inspect the finished good	Be able to make sure the finished good meet the requirement	Business Negotiator
	Consignee	Receive the finished good		Inspector
Processing Manufacture	Business Negotiator	Find the Owner of the goods to get more orders	Have the resources of the Owner with NAFTA; Have strong negotiation ability	
	Consignee	Receive the spare parts		Business Negotiator
	Producer	Assemble the spare parts	Be able to assemble meet the requirements	Consignee
	Inspector	Inspect the finished good	Be able to make sure the finished good meet the requirement	Producer
	Consigner	Prepare the finished good to transport		Inspector
LSP	Assigner	Organize the logistics services to make sure each transport is successful	Be able to organize the transport; Make sure that the transport is legitimate	Inspector
	Truck Driver	Transport physically goods to destination	Be able to drive the truck	Assigner
	Inspector	Make sure every transport meet the requirements of regulations	Have knowledge of the regulations	
Regulator	Customs(Owner)	Ensure the export-import process is legitimate		Customs(Manufacture), NAFTA maker
	Customs(Manufacture)	Ensure the import-export process is legitimate		Customs(Owner), NAFTA maker

	NAFTA maker	Let more company be the member of NAFTA to facilitate the processes	Have specialists to regulate the processes; Be able to inspect the processes	

Appendix B: Symbol and explanations

Symbol	Explanation	Symbol	Explanation
C_I	costs of importer	T	time of the business trade
C_E	costs of exporter	T_{IE}	time of inspection for export
C_P	costs of processor	T_{II}	time of inspection for import
C_F (C_f)	costs of farmers (costs of farmers per kg)	T_{ie}	time of sending order from importer
C_{ER}	costs of export regulations	T_{ep}	time of sending order from exporter
C_{IR}	costs of import regulations	T_{pf}	time of sending order from processor
C_{IS}	storage fee for importer	T_{fp}	time of sending apple from farmer to processor
C_{IA} (C_{ia})	costs of apples for importer (costs of apples for importer per kg)	T_p	time of processing apples
C_{ES}	storage fee for exporter	T_{et}	time of sending apple from processor to airport
C_{EA} (C_{ea})	costs of apples for exporter (costs of apples for exporter per kg)	T_{ew}	time of waiting for export inspection
C_p	costs of processing for processor	T_{ei}	time of export inspection
C_A (C_a)	costs of apples for processor (costs of apples for processor per kg)	T_t	time of sending apple from export airport to import airport
$C_{s/d}$	costs of storage fee per day	T_{iw}	time of waiting for import inspection
$C_{p/d}$	costs of processing per day	T_{ii}	time of import inspection
$C_{ei/d}$	costs of export inspection for regulators per day	T_{it}	time of sending apple from airport to importer
$C_{ii/d}$	costs of import inspection for regulators per day		

Appendix C. 1: Codes for simulation on Netlogo (single business trade)

```
globals [ days ]

breed [apples apple]
to setup
  clear-all
  create-turtles 25
  set-background
  set-importer
  set-exporter
  set-processor
  set-producer
  set-er
  set-ir
  create-turtles 1
end

to set-background
  ask turtles [
    set label-color black ]
  ask patches [
    if pxcor < -9 [
      set pcolor 99]
    if pxcor > -10 [
      set pcolor 19 ] ]
  ask patches [
    if pxcor < -12 and pxcor > -26 and pycor > 1 and pycor <
15
    [ set pcolor 118 ] ]
  ask patches [
     if pxcor < -12 and pxcor > -26 and pycor > -15 and
pycor < -1
    [ set pcolor 68 ] ]
  ask patches [
     if pxcor < 8 and pxcor > -6 and pycor > 1 and pycor <
15
    [ set pcolor 48 ] ]
  ask patches [
     if pxcor < 8 and pxcor > -6 and pycor > -15 and pycor <
-1
    [ set pcolor 68 ] ]
  ask patches [
     if pxcor < 26 and pxcor > 12 and pycor > 1 and pycor <
15
    [ set pcolor 48 ] ]
  ask patches [
     if pxcor < 26 and pxcor > 12 and pycor > -15 and pycor
< -1
    [ set pcolor 48 ] ]
end

to set-importer
  ask turtles [
    set label-color black ]
  ask turtle 0 [
    setxy -16 8
    set color black
    set size 4
    set shape "person business"
    set label "Buyer"]
  ask turtle 1 [
    setxy -22 8
    set color black
    set size 4
    set shape "person business"
    set label "Importer-Specialist" ]
end

to set-exporter
  ask turtles [
    set label-color black ]
  ask turtle 2 [
    setxy -3 10
    set color black
    set size 4
    set shape "person business"
    set label "Seller"]
  ask turtle 3 [
    setxy 1 6
    set color black
    set size 4
    set shape "person business"
    set label "Exporter-Specialist" ]
  ask turtle 4 [
    setxy 5 10
    set color black
    set size 4
    set shape "person business"
    set label "Buyer" ]
end

to set-processor
  ask turtles [
    set label-color black ]
  ask turtle 5 [
    setxy 16 5
    set size 4
    set shape "person business"
    set color black
    set label "Collector"]
  ask turtle 6 [
    setxy 16 11
    set size 4
    set shape "person"
    set color black
    set label "Sort & Grade"]
  ask turtle 7 [
    setxy 22 11
    set size 4
    set shape "person"
    set color black
    set label "Packager"]
  ask turtle 8 [
    setxy 22 5
    set size 4
    set shape "person"
    set color black
    set label "Kepper"]
end

to set-producer
  create-turtles 1
  ask turtle 9 [
    setxy 19 -6
    set size 4
    set shape "person farmer"
    set color black
    set label "Farmer"
    set label-color black ]
end

to set-er
  ask turtles [
    set label-color 0 ]
  ask turtle 10 [
    setxy 1 -4
    set size 4
    set shape "person police"
    set color 0
    set label "Export-Customs" ]
  ask turtle 11 [
    setxy -4 -6
    set size 3
    set shape "person police"
    set color 115
    set label "Health" ]
  ask turtle 12 [
    setxy -1 -9
    set size 3
    set shape "person police"
    set color 0
    set label "Origin-Place" ]
  ask turtle 13 [
    setxy 1 -12
    set size 3
    set shape "person police"
    set color 0
    set label "Storage" ]
  ask turtle 14 [
    setxy 3 -9
    set size 3
    set shape "person police"
    set color 15
    set label "Package" ]
  ask turtle 15 [
    setxy 6 -6
    set size 3
    set shape "person police"
    set color 45
```

```
    set label "Quality" ]
end

to set-ir
  ask turtles [
    set label-color 0 ]
  ask turtle 16 [
    setxy -19 -4
    set shape "person police"
    set size 4
    set color black
    set label"Customs"]
  ask turtle 17 [
    setxy -22 -9
    set shape "person police"
    set size 3
    set color 115
    set label "Health" ]
  ask turtle 18 [
    setxy -19 -11
    set shape "person police"
    set size 3
    set color 15
    set label "Package"]
  ask turtle 19 [
    setxy -16 -9
    set shape "person police"
    set size 3
    set color 45
    set label "Quality" ]
end

to go
  move-order1
  move-order2
  move-order3
  declare
  get-apple-processor
  inspect-export
   ifelse export-approve?
  [ ask turtle 10 [
      set shape "check" ]
    ask turtle 25 [
      set shape "airplane"
      set color green
      set heading 270
      fd 20 ]
    set days days + 2
   ]
  [ ask turtle 10 [
      set shape "x" ]
    ask turtle 25 [
      set shape "truck"
      set heading 45
      fd 20]
    stop ]
  inspect-import
  ifelse import-approve?
  [ ask turtle 16 [
      set shape "check" ]
    ask turtle 25 [
     set shape "truck"
     set heading 0
     fd 10 ]
    set days days + 2]
  [ ask turtle 16 [
      set shape "x" ]
    ask turtle 25 [
      die ]
    stop
  tick
end

to move-order1
  ask turtle 20 [
    setxy -14 8
    set heading 75
    set shape "arrow"
    set color red
    set size 2 ]
  ask turtle 0 [
    shine ]
  ask turtle 20 [
    fd 10
    die ]
  ask turtle 2 [
    shine ]
  set days days + 3
end

to move-order2
  ask turtle 21 [
    setxy 6 10
    set shape "arrow"
    set heading 120
    set size 2
    set color red ]
  ask turtle 4 [
    shine ]
  ask turtle 21 [
    fd 10
    die ]
  ask turtle 5 [
    shine ]
  set days days + 3
end

to move-order3
  ask turtle 22 [
    setxy 16 5
    set shape "arrow"
    set heading 165
    set size 2
    set color red ]
  ask turtle 22 [
    fd 10
    die ]
  ask turtle 9 [
    shine ]
end

to declare
  ask turtle 23 [
    setxy -22 8
    set shape "letter opened"
    set color white
    set size 2 ]
  ask turtle 24 [
    setxy 1 6
    set shape "letter opened"
    set color white
    set size 2 ]
  ask turtle 1 [
    shine ]
  ask turtle 3 [
    shine ]
  ask turtle 23 [
    set heading 170
    fd 10
    die ]
  ask turtle 16 [
    shine ]
  ask turtle 24 [
    set heading 180
    fd 10
    die ]
  ask turtle 10 [
    shine ]
end

to get-apple-processor
  ask turtle 25 [
    setxy 19 -6
    set shape "apple"
    set size 2
    set color green]
  ask turtle 9 [
    shine ]
  ask turtle 25 [
    set heading 345
    fd 11]
  ask turtle 5 [
    shine ]
  ask turtle 25 [
    set heading 0
    fd 6 ]
  ask turtle 6 [
    shine ]
  ask turtle 25 [
    set heading 90
    fd 6 ]
  ask turtle 7 [
    shine ]
  ask turtle 25 [
```

```
    set shape "box"
    set heading 180
    fd 6 ]
  ask turtle 8 [
    shine ]
  set days days + 5
end

to inspect-export
  ask turtle 25 [
    set shape "truck"
    set heading 245
    fd 22 ]
  set days days + 1
  ask turtle 10 [
    shine ]

  ask turtle 25 [
    set shape "apple"
    set heading 250
    fd 6 ]
  set days days + 1
  ask turtle 11 [
    shine ]

  ask turtle 25 [
    set heading 135
    fd 3 ]
  set days days + 1
  ask turtle 12 [
    shine ]
  ask turtle 25 [
    fd 4 ]
  set days days + 1
  ask turtle 13 [
    shine ]
  ask turtle 25 [
    set heading 45
    fd 3 ]
  set days days + 1
  ask turtle 14 [
    shine ]
  set days days + 1
  ask turtle 25 [
    fd 4 ]
  set days days + 1
  ask turtle 15 [
    shine ]
  ask turtle 25 [
    set heading 300
    fd 6 ]
  set days days + 1
  ask turtle 25 [
    shine ]
end

to inspect-import
  ask turtle 16 [
    shine ]
  ask turtle 25 [
    set shape "apple"
    set heading 210
    fd 6 ]
  set days days + 1
  ask turtle 17 [
    shine ]
  ask turtle 25 [
    set heading 135
    fd 3.5 ]
  set days days + 1
  ask turtle 18 [
    shine ]
  ask turtle 25 [
    set heading 45
    fd 3.5 ]
  set days days + 1
  ask turtle 19 [
    shine ]
  ask turtle 25 [
    set heading 330
    fd 5.5 ]
  set days days + 1
end

to shine
  set color white
  set color 0
end
```

Appendix C. 2: Codes for simulation on Netlogo (multiple business trades)

```
globals [ n
          m ]
breed [ businesses business ]
businesses-own [step
                counter
                initial-days
                days
                days-order1
                days-order2
                days-order3
                days-to-processor
                days-processing
                days-to-export
                days-export-inspection
                days-export-inspect
                days-export-wait
                days-to-import
                days-import-inspection
                days-import-inspect
                days-import-wait
                days-to-importer
                costs-of-farmer
                costs-of-apples-importer
                costs-of-apples-exporter
                costs-of-apples-processor
                costs-of-storage-per-day
                costs-of-processing-per-day
                costs-of-inspect-per-day
                costs-of-exporter
                costs-of-importer
                costs-of-processor
                costs-of-export-regulators
                costs-of-import-regulators
                costs-of-sanction
                cheating?
                catch?
               ]

to setup
  ca
  background
  initiation
end

to background
  ask patches [
    if pxcor <= -10 [
       set pcolor 99 ]
    if pxcor > -10 [
       set pcolor 19 ]
    if (pxcor < -15 and pxcor > -35 and pycor > 2 and pycor
< 20) [
       set pcolor 118 ]
    if (pxcor < 15 and pxcor > -5 and pycor > 2 and pycor <
20) [
       set pcolor 48 ]
    if (pxcor < 40 and pxcor > 20 and pycor > 2 and pycor <
20) [
       set pcolor 48 ]
    if (pxcor < 40 and pxcor > 20 and pycor > -18 and pycor
< 0) [
       set pcolor 48 ]]
  create-turtles 2 [
    set shape "house"
    set color 38
    set size 8
    set label "customs"
    set label-color black ]
  ask turtle 0 [
    setxy -25 -6
    stamp die]
  ask turtle 1 [
    setxy 5 -6
    stamp die]

end

to initiation
  create-businesses nums-of-trades [
    set shape "arrow"
    set size 2
    set heading 90
    setxy -34 + random 18 3 + random   15
    set costs-of-storage-per-day 50
    set costs-of-inspect-per-day 25
    ifelse random 100 <= percentage-of-self-regulation
      [set color 55
       set costs-of-farmer (0.18 + random-float 0.05) *
kgs-of-apples-per-batch
       set costs-of-apples-importer (0.55 + random-float
0.1) * kgs-of-apples-per-batch
       set costs-of-apples-exporter (0.42 + random-float
0.06) * kgs-of-apples-per-batch
       set costs-of-apples-processor (0.28 + random-float
0.04) * kgs-of-apples-per-batch
       set costs-of-processing-per-day (0.02 +
random-float 0.02) * kgs-of-apples-per-batch
       ifelse random 100 <=
percentage-of-violations-in-self-regulation
         [ set cheating? true
           set label "V"
           set label-color black ]
         [ set cheating? false ]
         set catch? false ]
       [set color 15
       set costs-of-farmer ( 0.12 + random-float 0.04 ) *
kgs-of-apples-per-batch
       set costs-of-apples-importer (0.45 + random-float
0.05) * kgs-of-apples-per-batch
       set costs-of-apples-exporter (0.30 + random-float
0.06) * kgs-of-apples-per-batch
       set costs-of-apples-processor (0.21 + random-float
0.04) * kgs-of-apples-per-batch
       set costs-of-processing-per-day (0.013 +
random-float 0.003) * kgs-of-apples-per-batch
       set cheating? false
       set catch? false ]
    set step 0
    set days-export-wait 0
    set costs-of-sanction 0
    set counter 0
    set initial-days random 90
    set days-export-inspection days-export-inspect +
days-export-wait
    ]
  set n 1
  set m 1
end

to go
  get-apple-importer
  import-inspect
  get-apple-import
  export-inspection
  get-apple-export
  processing
  get-apple-processor
  order3
  order2
  order1
  begin?
  if all? businesses [step >= 13]
  [ output
    show count businesses with [cheating?]
    show count businesses with [cheating? and catch?]
    stop ]
  ask businesses [
   set counter counter + 1 ]
  tick
end

to begin?
  ask businesses [
    if step = 0 [
      if initial-days = counter [
        set step step + 1
            set days-order1 1 + random 1
            set counter 0 ]
    ]
  ]
end

to order1
  ask businesses [
    if step = 1 [
      if days-order1 = counter [
        fd 30
        set step step + 1
```

```
            set days-order2   1 + random 2
            set counter 0 ]
      ]
   ]
end

to order2
   ask businesses [
      if step = 2 [
         if days-order2 = counter [
            fd 25
            set step step + 1
            set days-order3 1 + random 2
            set counter 0 ]
      ]
   ]
end

to order3
   ask businesses [
      if step = 3 [
         if days-order3 = counter [
            set heading 180
            fd 20
            set step step + 1
            set days-to-processor 1 + random 2
            set counter 0 ]
      ]
   ]
end

to get-apple-processor
   ask businesses [
      if step = 4 [
         if days-to-processor = counter [
            set shape "apple"
            set heading 0
            fd 20
            set step step + 1
            if color = 15 [
               set days-processing 2 + random 3 ]
            if color = 55 [
               set days-processing 2 + random 3 ]
            set counter 0 ]
      ]
]
end

to processing
   ask businesses [
      if step = 5 [
         if days-processing = counter [
            set shape "box"
            set step step + 1
            set days-to-export 2 + random 2
            set counter 0 ]
      ]
   ]
end

to get-apple-export
   ask businesses [
      if step = 6 [
         if days-to-export = counter [
            set shape "truck"
            facexy 5 -6
            move-to patch (6 + random 5) -9
            set step step + 1
            set counter 0
            if color = 55 [
               ifelse random 100 < 5
               [ set color 45
                  set days-export-inspect 4 + random 3 ]
               [ set days-export-inspect 1]
                 ]
            if color = 15 [
               set days-export-inspect 4 + random 3]
      ]
 ]
   ]
end

to export-inspection
   ask businesses with [ step = 7 and color = 55 ] [
         if counter = days-export-inspect [
              set step step + 2
              set counter 0
              set days-to-import 2 + random 3] ]

       if n = 1
          [ if any? businesses with [(step = 7 and color = 15) or
(step = 7 and color = 45)]
             [ ask max-one-of businesses with [ (step = 7 and
color = 15) or (step = 7 and color = 45)] [ days-export-wait] [
                  set shape "apple"
                  set heading 0
                  move-to patch 5 -6
                  set step step + 1
                  set counter 0 ]
               set n n + 1     ] ]
          if n = 2
          [ if any? businesses with [(step = 7 and color = 15) or
(step = 7 and color = 45)]
             [ ask max-one-of businesses with [ (step = 7 and
color = 15) or (step = 7 and color = 45)] [ days-export-wait] [
                  set shape "apple"
                  set heading 0
                  move-to patch 6 -6
                  set step step + 1
                  set counter 0 ]
               set n n + 1     ] ]
          if   n = 3
          [ if any? businesses with [(step = 7 and color = 15) or
(step = 7 and color = 45)]
             [ ask max-one-of businesses with [ (step = 7 and
color = 15) or (step = 7 and color = 45)] [ days-export-wait] [
                  set shape "apple"
                  set heading 0
                  move-to patch 7 -6
                  set step step + 1
                  set counter 0 ]
               set n n + 1     ] ]

     ask businesses with [ (step = 7 and color = 15) or (step =
7 and color = 45)] [
           set days-export-wait counter ]

     if n = 4
     [ ask businesses with [(step = 8 and color = 15) or (step =
8 and color = 45)] [
             if ( counter = days-export-inspect ) [
              ifelse cheating?
                 [ set heading 180
                    set shape "apple"
                    fd 6
                    set step 13
                    set catch? true
                    set                              costs-of-sanction
costs-of-apples-exporter * 5]
                 [ set step step + 1
                    set shape "box"
                    set heading 270 fd 3
                    set days-to-import 2 + random 3 ]
                 set counter 0
                 set n n - 1] ] ]
     if n = 3
     [ ask businesses with [(step = 8 and color = 15) or (step =
8 and color = 45)] [
            if ( counter = days-export-inspect ) [
              ifelse cheating?
                 [ set heading 180
                    set shape "apple"
                    fd 6
                    set step 13
                    set catch? true
                    set                              costs-of-sanction
costs-of-apples-exporter * 5]
                 [ set step step + 1
                    set shape "box"
                    set heading 270 fd 3
                    set days-to-import 2 + random 3 ]
                 set counter 0
                 set n n - 1] ] ]
     if n = 2
     [ ask businesses with [(step = 8 and color = 15) or (step =
8 and color = 45)] [
             if ( counter = days-export-inspect ) [
              ifelse cheating?
                 [ set heading 180
                    set shape "apple"
                    fd 6
                    set step 13
                    set catch? true
                    set                              costs-of-sanction
```

```
costs-of-apples-exporter * 5]
                [ set step step + 1
                  set shape "box"
                  set heading 270 fd 3
                  set days-to-import 2 + random 3 ]
                set counter 0
                set n n - 1] ] ]

end

to   get-apple-import
   ask businesses [
     if step = 9 [
        if counter = days-to-import [
           set shape "airplane"
           set heading 270
           fd 30
           set step step + 1
           set counter 0
           if (color = 55 or color = 45) [
              ifelse random 100 < 5
              [ set color 44
                 set days-import-inspect 4 + random 3 ]
              [ set days-import-inspect 1 ]
                ]
           if color = 15 [
              set days-import-inspect 4 + random 3] ]
     ]
   ]
end

to import-inspect

   ask businesses with [ (step = 10 and color = 55) or (step =
10 and color = 45) ] [
        if counter = days-import-inspect [
            set step step + 2
            set counter 0
            set days-to-importer 2 + random 2] ]

     if m = 1
        [ if any? businesses with [(step = 10 and color = 15)
or (step = 10 and color = 44)]
           [ ask max-one-of businesses with [ (step = 10 and
color = 15) or (step = 10 and color = 44)] [ days-import-wait]
[
                set shape "apple"
                set heading 0
                fd 3
                set step step + 1
                set counter 0]
                set m m + 1     ] ]
        if m = 2
        [ if any? businesses with [(step = 10 and color = 15)
or (step = 10 and color = 44)]
           [ ask max-one-of businesses with [ (step = 10 and
color = 15) or (step = 10 and color = 44)] [ days-import-wait]
[
                set shape "apple"
                set heading 0
                fd 3
                set step step + 1
                set counter 0 ]
                set m m + 1     ] ]
        if   m = 3
        [ if any? businesses with [(step = 10 and color = 15)
or (step = 10 and color = 44)]
           [ ask max-one-of businesses with [ (step = 10 and
color = 15) or (step = 10 and color = 44)] [ days-import-wait]
[
                set shape "apple"
                set heading 0
                fd 3
                set step step + 1
                set counter 0]
              set m m + 1     ] ]

    ask businesses with [ (step = 10 and color = 15) or (step =
10 and color = 44)] [
         set days-import-wait counter ]

    if m = 4
    [ ask businesses with [(step = 11 and color = 15) or (step
= 11 and color = 44)] [
          if ( counter = days-import-inspect ) [
             ifelse cheating?
                [ set heading 180
                  set shape "apple"
                  fd 6
                  set step 13
                  set catch? true
                  set                    costs-of-sanction
costs-of-apples-exporter * 5]
                [ set step step + 1
                  set shape "box"
                  set heading 270
                  fd 3
                  set days-to-importer 2 + random 2]
            set counter 0
            set m m - 1] ] ]
    if m = 3
    [ ask businesses with [(step = 11 and color = 15) or (step
= 11 and color = 44)] [
          if ( counter = days-import-inspect ) [
             ifelse cheating?
                [ set heading 180
                  set shape "apple"
                  fd 6
                  set step 13
                  set catch? true
                  set                    costs-of-sanction
costs-of-apples-exporter * 5]
                [ set step step + 1
                  set shape "box"
                  set heading 270
                  fd 3
                  set days-to-importer 2 + random 2]
            set counter 0
            set m m - 1] ] ]
    if m = 2
    [ ask businesses with [(step = 11 and color = 15) or (step
= 11 and color = 44)] [
          if ( counter = days-import-inspect ) [
             ifelse cheating?
                [ set heading 180
                  set shape "apple"
                  fd 6
                  set step 13
                  set catch? true
                  set                    costs-of-sanction
costs-of-apples-exporter * 5]
                [ set step step + 1
                  set shape "box"
                  set heading 270
                  fd 3
                  set days-to-importer 2 + random 2]
            set counter 0
            set m m - 1] ] ]

end

to get-apple-importer
   ask businesses [
     if step = 12 [
        if counter = days-to-importer [
           set step step + 1
           set shape "truck"
           set heading 342 + random 40
           fd 12 + random 10 ] ]
     end

to output
   ask businesses [
     if step >= 13 [
          set days-export-inspection days-export-inspect +
days-export-wait
          set days-import-inspection days-import-inspect +
days-import-wait
          set days days-order1 + days-order2 + days-order3
+ days-to-processor + days-processing + days-to-export +
days-export-inspection + days-to-import +
days-import-inspection + days-to-importer
          set costs-of-importer days-import-inspection *
costs-of-storage-per-day + costs-of-apples-importer
          set costs-of-exporter days-export-inspection *
costs-of-storage-per-day + costs-of-apples-exporter +
costs-of-sanction
          set costs-of-processor days-processing *
costs-of-processing-per-day + costs-of-apples-processor
          set                    costs-of-export-regulators
days-export-inspect * costs-of-inspect-per-day
          set                    costs-of-import-regulators
days-import-inspect * costs-of-inspect-per-day
          show days
```

```
            show days-export-inspection
            show days-import-inspection
            show costs-of-farmer
            show costs-of-importer
            show costs-of-exporter
            show costs-of-processor
            show costs-of-export-regulators
            show costs-of-import-regulators
            ifelse ( color = 55 or color = 45 or color = 44)
          [ show ["self-regulation"] ]
          [ show ["direct-control"] ]
          ]
      ]
end
```