論 文 の 内 容 の 要 旨

論文題目　Multi-level Empirical Studies on the Network Externalities of Information Security
（情報セキュリティのネットワーク外部性に関するマルチレベルの実証研究）

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Information technology (IT) is one of the role players nowadays. It is not only used to link businesses together, but also used to connect people from different parts of the world together. Such connectivity brings us a so-called borderless society which allows governments, businesses, and individuals easily reach each other.

The expansion of the information network becomes an incentive for attacker to intrude into the system through system vulnerability and steals various kinds of information which are now considered as one of valuable assets. With the interconnection between nodes in the network, security breach at one of the nodes could affect other nodes via the interconnection.

Network externalities, thus, becomes one of very important topic in the field of information security. That is because the topic of network externalities is a study that focuses on consequence effect from the action of an individual on others. Actually this is how the economic concepts can be applied into the field of information security.

This thesis introduces our analyses regarding problems of network externalities in the field of information security. The analyses were conducted in 2 levels: national level and firm/operator level. The findings from our study show several importance of the information security.

In the study regarding network externalities in the national level, we analyze the interdependency under information security risks. We use two-step approach to analyze both sectoral and regional interdependencies under

information security risks. In addition, the result collection process was introduced to suggest some empirical findings. Then we clarify the characteristics of interdependencies of information security from both sectoral and regional viewpoints. After that the changes of interdependency after the occurrence of the Great East Japan Earthquake on March 2011 were also emphasized in our analyses. Furthermore, the analyses were done in both sectoral and regional perspectives.

According to our results in sectoral perspective, the demand-side sectors can be classified into 5 classes due to their characteristic. In addition, most of the Japanese industries fall into the classes where consideration on interdependency from regional perspective is required. In regional perspective, the results from the analysis show that economic scale of a region has great influence on the characteristic of interdependency. The analysis results under impact from the earthquake show importance of critical sectors. Furthermore, once such disaster occurs, the damage on the information security could be expected at the area where the disaster occurs, as well as the region with the largest economic scale.

In the study regarding network externalities in the firm or operator level, we introduce the approach to analyze the security and interconnectivity of the Japanese loyalty programs. Available online system for the loyalty programs allows points or miles of loyalty programs to be considered as one of virtual currencies. We refer to the economics perspective of the currency as a part to consider characteristic of this virtual currencies. Therefore liquidity is what we consider beside security efforts and actual security levels of the loyalty program system.

After that linear regression analysis is used to find the implications regarding security-liquidity. In our work, we focus on the origin loyalty program since illegal exchanges originate from compromised LP accounts. We found that liquidity is significant to the impact on the loyalty program systems once the security incidents occur. Furthermore, we also found supportive evidences of an importance of network externalities from our analyses. The results also suggest operators of the loyalty program to implement stronger security-related requirements at their system. In addition, consideration on the level of security of their partners' system is also recommended.

After studying about network externalities in both national and firm/organization levels, we discuss more about network externalities. By this, we show how knowledge from our study in national level can be used to provide more useful information and suggestions. We use the case of the network of loyalty

programs as our example. To do so, we consider on the average size of expense on security countermeasure, the value of IS measure, and the sectoral characteristics of industries which operate loyalty program. From our discussion, we found that industry 20, which include airlines, might be the weakest link in the network of the Japanese loyalty program. Operators from this industry are suggested to take action in order to improve the security of their loyalty program system. However we still suggest other industries to pay attention on the matter of information security.