(Form 1)

Kyoto University	Doctor of Economics	Name	Dengwei Qi
Thesis Title	Three Essays on Learning And Dynamic Coordination Games （学習と動学調整ゲームに関する三つの小論）		

(Thesis Summary)

This dissertation studies coordination games with incomplete information from perspectives of dynamics and learning. Those games represent economic problems such as currency crises, investment crashes, and bank runs.

The dissertation has three chapters. Chapter 1 considers a dynamic version of global games, where a continuum of agents decide when to make an irreversible investment over given finite periods. Initially, each agent is privately informed about the underlying state of the economy, on which the profitability of the investment depends. Further, in each period she obtains information about the other agents' past investment decisions, from which she can learn more about the state. In this dynamic global game, the agents face a tradeoff between more profit opportunities from investing early and more precise information about the state from delayed investment. A main result is to establish uniqueness of equilibrium by symmetric threshold strategy. The author also shows that the value of information is strictly positive: an added stage and the learning opportunity thereby increase the agents' equilibrium payoffs. In particular, the agents will completely learn the state if the number of periods goes to infinity. Another interesting result is about the efficiency of learning. Namely, the equilibrium can be superior to the one under an alternative framework where there is no learning but the agents receives signals about the state in each period as in the initial period. A key logic to this result is that the learning via others' actions reflects their aggregate signals and hence provides more precise information than individual learning over the periods provides.

Chapter 2 studies a model of asset trading over given finite periods, where the agents learn both publicly and privately about the underlying state which affects the value of the asset. In each period, a continuum of agents trade the asset based on their information. At the end of each period, each agent learns about the state from two channels. One is the publicly observable price (this is a signal of the current aggregated actions), and the other is a private signal from her learning activity. Based on the added information, the agent decides the trade in future periods. The main result is the equilibrium characterization and the speed of learning along the equilibrium. More concretely, the author shows uniqueness of symmetric strategy equilibrium. In the equilibrium, the agents will completely learn the state if the number of periods goes to infinity, and the speed of convergence is linear.

Chapter 3 revisits global coordination games. It is well-known that when public and private information coexist, the game has a unique

equilibrium if and only if the public information is imprecise in comparison with the private information. In order to investigate the issue further, the author sets up a dynamic game whose last stage has the global coordination game and whose earlier stages have a prediction game by Vives (1997). The idea of the prediction games in all periods but the last is to provide the agents more opportunities to learn, both publicly and privately, the state variable which affects both the prediction game and the global coordination game. A main result of this chapter is about difficulty in resolving equilibrium multiplicity. Namely, even if precise private information is available, multiple equilibria may arise when the periods are long. The intuition is related to the result on the learning speed in Chapter 2. A fast learning in the prediction game stages allows the agents to play a global coordination game close to complete information in the last period, which typically possesses multiple equilibria.

(Form 2)

(Thesis Evaluation Summary)

This dissertation studies various issues on global games and coordination games with incomplete information. This class of games is applicable to many economic phenomena featuring coordination, such as bank runs, speculative attacks, and so forth. Throughout the dissertation, the author considers a dynamic version of those games, and the purpose of this extension is to examine how economic agents learn the underlying, unobservable state of the economy over time.

Chapter 1 of this dissertation extends global games to dynamic environments. The agents are initially and privately informed about the state variable and update their beliefs over time, through the private signals about the past actions they receive every period. Tractability is a virtue of this chapter. Following the formulation of earlier papers, the author sets up information structure in which the learning over time can be explicitly and concisely described. This tractability allows the author to compare this model with several variants and to establish interesting results such as a positive effect of adding more stages on the equilibrium, complete learning of the state when the number of stages goes to infinity, for example. This paper adds much to the literature on dynamic versions of coordination games with incomplete information.

Chapters 2 and 3 consider dynamic environments where the economic agents learn the state of the world through two channels. One is learning via publicly available information, and the other is learning via information each agent individually and privately acquires. Such coexistence of public learning and private learning is plausible in asset trading, where the agents learn both from publicly observable prices and from their private learning activities, and in coordinated investment problems, where they learn the economic situation from public announcements of government authorities and from their own daily activities. Chapters 2 and 3 study the asset trading and the investment problem, respectively.

A main contribution of Chapter 2 is characterization of equilibria and a limit result on complete learning in equilibrium when the number of stages goes to infinity. The chapter also includes a result on the speed of convergence in the limit result. In comparison with a related model by Vives (1993) where only public learning is available, the speed of convergence to complete learning is shown to be much faster, indicating a positive role of coexistence of public and private learning channels.

Chapter 3 considers a dynamic version of global games. In all periods but the last one, a given game which serves as a channel of public and private learning is repeatedly played, and in the last period a global game is played given the accumulated information. The author reexamines the delicate relationship between the relative quality of public and private information and the

equilibrium uniqueness, shown in the literature on global games. The author shows that coexistence of public and private learning allows the agents to infer the true state more quickly and thus makes multiplicity of equilibrium in the last-period global game more likely to occur. This is an interesting observation in itself, and is a nice application of the idea presented in Chapter 2.

This dissertation considerably adds to our understanding of coordination problems under incomplete information, especially in their dynamic versions. Nevertheless, it also leaves something to be desired. First, throughout the chapters, the author pursues tractable frameworks and relies on several parametrizations and simplifications. While it seems interesting to ask to what extent the equilibrium uniqueness and the result on positive roles of added stages in Chapter 2 are valid in general frameworks, the author's analysis is silent on that issue. Further, the analysis of the models with public and private learning is compared only with models where only public learning is available. A comparison with models with private learning only, or with any other relevant frameworks, may make the author's contribution clearer.

However, those critiques are something the author can deal with in his future research and do not negate the overall contribution of this dissertation.

Due to those evaluations, this dissertation is recognized as worthy of a doctoral degree in economics. This decision has been made after the thesis defense on January 26, 2023.