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Analysis of the Evolution of Sectoral Innovation System Based on System Dynamics – The Case of Chinese Automotive Sector

（Thesis submitted for the degree of Executive Doctorate in Business Administration）

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ABSTRACT

The research theme of this dissertation is about the dynamics and mechanism that influence and change the performance of the automotive sector's innovation system, as well as how those identified key factors fit, interact, and impact each other in the context of China. This research interest started with my thinking about the effectiveness of leap-forward development policies that have been implementing by the Chinese government in the field of new energy vehicles (NEVs) and intelligent connected vehicles (ICVs) in recent years, as well as the possibility of the leapfrog with "overtaking on a new track" approach for Chinese indigenous companies, as proposed by many industry experts and scholars. These calls and policies are based on the fact that China's auto industry has been "big but not strong" and encouraged by an ambition of 'becoming the global industry leader', which comes out along with the rise of China's economy and the powerful influence of China's auto industry in the global automotive world.

Much research reveals that knowledge, technology, learning process, and innovation capability form a firm's base of core competence which drive a firm's competitiveness. No firm alone has all resources required to form its base of core competence, they are embedded in a complex innovation network, or an innovation system. Furthermore, industry life cycle theories show that the relationship between technological and industry evolution processes are inextricably linked. Automotive is a paradigmatic "mature" industry, leapfrogging works only if the underlying technologies are generally available but not dominant in other markets. In this case, Chinese indigenous companies, as well as the government policies, need appropriate strategy to help simultaneously acquire these "underlying technologies" available for them by a variety of learning processes and be innovative to develop those technologies "dominant in other markets" through their own internal innovation activities.

A firm's innovation capabilities are rooted in the resources that the innovation system provides, and dynamically affected by the system's structure, linkages, and feedback. Existing research on sectoral innovation system has been based on the research achievements of national and regional innovation system, with the underlying assumption of 'free market economy' (opposed to planned economy). They do not place the government intervention at a prominent role in shaping a sector's innovation system. This cannot well explain why China's auto industry is still "big but not strong" after nearly 30 years of rapid development. This dissertation argues that in the context of China, government intervention should be an important and independent source of changing dynamics, with positive or negative effects, for re-shaping the industry's innovation

system and an indispensable stock variable that affects the innovation performance of individual enterprises within the industry.

This dissertation has improved the analytical framework of sectoral innovation system based on existing literature and employs the System Dynamics approach to formulate a simulation model to examine the mechanism of the dynamic evolution of the sectoral innovation system. The subsequent empirical research part uses both case study and statistical and econometric methods and the data of the past 20 years (2001-2020) to verify the dynamic hypotheses of the System Dynamics model. This paper concludes that: 1- to examine whether laggards in long-established industries like automotive have opportunities to catch up even leapfrog some development stages, the sectoral innovation system as well as the industry's technological paradigm and regime have always been the central of the research. 2- the competitive advantage of firms derives from the accumulation and creation of the STI (Science, Technology and Innovation) and DUI (Doing, Using and Interacting) knowledge through six patterns of learning process. 3) government subsidies do have positive impact in increasing the stock of both DUI knowledge and STI knowledge of firms, but with different degree of effectiveness. Government intervention is necessary resources only to improve the innovation capability of firms, but it does not always bring positive effects, as for instance the interaction between government subsidies and firms' self-investment in R&D tends to arise a mutual extrusion effect; 4) intellectual capital is a key factor for firms to improve their STI knowledge, which is one of the fundamental resources for firms to gain first-mover competitive advantage. There is a positive linear relationship between the internal R&D investment and the stock of STI knowledge, that is, the higher the level of firm's R&D self-investment, the higher the level of STI knowledge stock of firms. 5) The DUI learning methods remain as the main approach to build internal innovation capability for Chinese firms, of which technology transfer still plays significant role; 6) The formation of the industry innovation pattern is the result of the long-term mutual influence of the industry technology paradigm, market demand conditions and the national innovation system, while the innovation strategy at the firm level is driven by the dynamic interaction of three dimensions: industry technology push, market pull and simultaneous push and pull by government regulations and policies. Government intervention has always been playing significant role in this regard but has never been an endogenous factor for a firm or even a sector to develop global competitiveness.

Key Words: Competitive advantage, Technological innovation, Sectoral innovation system, System dynamics approach, China automotive industry

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