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Automotive Modal Lock-in: The role of path dependence and large socio-economic regimes in market failure

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ABSTRACT

This paper addresses less recognised factors which influence the diffusion of a particular technology. While an innovation's attributes and performance are paramount, many fail because of external factors which favour an alternative. This paper, with theoretic input from diffusion, lock-in and path-dependency, presents a qualitative study of external factors that influenced the evolution of transportation in USA. This historical account reveals how one technology and its emergent systems become dominant while other choices are overridden by socio-political, economic and technological interests which include not just the manufacturing and service industries associated with the automobile but also government and market stakeholders. Termed here as a large socio-economic regime (LSER), its power in ensuring lock-in and continued path-dependency is shown to pass through three stages, weakening eventually as awareness improves. The study extends to transport trends in China, Korea, Indonesia and Malaysia and they all show the dominant role of an LSER. As transportation policy is increasingly accountable to address both demand and environmental concerns and innovators search for solutions, this paper presents important knowledge for innovators, marketers and policy makers for commercial and societal reasons, especially when negative externalities associated with an incumbent transportation technology may lead to market failure.

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1. Introduction

Adoption and diffusion of innovation studies generally concur that the attributes of an innovation are paramount in determining success (Rogers, 1962; Bass, 1969). However, many innovations which may have superior attributes and performance fail because of external factors which favour the status quo (Arthur, 1989; David, 1985; Berkhout et al., 2003). An understanding of how the market initially chooses a technology and how that choice and its aggregate system is maintained despite possibly superior alternatives is important for innovators, marketers and policy makers, for both commercial and societal reasons, especially when negative externalities associated with an incumbent technology and the aggregate system based on the technology lead to market failure.

There has been widespread discussion about the intertwined trends of world population growth, economic growth in emerging economies and global warming (Duncan et al., 2012; Dutta and Radner, 2006, 2012; Friedman, 2008; Sari and Soytaş, 2009; Ward and Shively, 2012). Integral to these trends is energy consumption with ever increasing demand and

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resultant emissions and pollution contributing to climate change. A major energy user and therefore significant contributor to these contemporary problems is the automobile (Marsden and Rye, 2010), which, in association with urban growth in both developed and emerging economies, contributes to another concern—urban transport congestion. These major and integrated issues present a compelling case to examine the history of product choice and the life cycle of the automotive transport industry with the intent to identify factors that have contributed to its current dominant status and then, to use this information to formulate appropriate industry and public policy to address them.

A core issue is the exercise of rational choice in the adoption and endurance of a technology, irrespective of the basis of costs and efficiency of the chosen technology (Altman, 2000; Hensher et al., 2008). Successful adoption and diffusion of a technology may be influenced by numerous factors, some easily perceptible such as the attributes of the product as well as other less visible, more emotional, forces. The main attribute considerations, as described by Rogers (1962) in his seminal work on diffusion of innovations, include: the product's relative advantage or aspects of superiority; its compatibility with existing user habits, situations and infrastructure; how easy it is to understand, adapt to and use; how easy it is to access and trial or to be observed, described and communicated; and the actual or perceived risks in adopting the product. These factors are tangible and measurable and so they can be argued for and adopted on rational grounds. However, the adoption criteria extend to socio-institutional factors, many of which are based on custom, situation and habitual behaviour, which often override rational argument. Recent studies of rail passenger use in Australia give supportive evidence of this behaviour trait, finding that despite significant increase in rail patronage, it was not likely to displace private car usage and that cost to commuters such as fare price had little impact on commuter choice of train or private car use (Wijeweera and Charles, 2013; Wijeweera et al., 2014).

In addition to product characteristics, Rogers cited the social system in the target users' environment and how parties therein interact and communicate with each other and the relative power and influence of opinion leaders and change agents as critical determinants of adoption (Cho et al., 2012; Dearing, 2009). In this regard, the power and influence of government and industry institutions are highly relevant.

As with many studies of choice and the adoption of new products and technologies, the referent literature for this paper builds on the linked theories of path dependency and lock-in, as pioneered by David (1985) and Arthur (1989), and the work of other authors who have subsequently contributed to the breadth and rigour of these concepts. For example Altman (2000), in considering the economics of inefficiency and market failure, refers to irrational choice and the influence of path dependence and lock-in in observing that there may be multiple solutions to identical problems and that the dominant solution may be suboptimal.

This implies that the exercise of choice can be flawed, influenced by non-product related factors; however, what Altman (2000) does not include – not directly or explicitly but perhaps covered within the range of externalities – are the forces of key institutional bodies such as:

- The major industry corporations and the network of businesses that constitute the industry and its markets, e.g. automotive manufacturers, oil producers and their respective supply and distribution chains and service networks that make up the automotive industry.
- Government and policy makers charged with decision making that aims to satisfy the lifestyle and economic growth objectives and social well-being of their constituents.
- Customers, users and public beneficiaries who have adopted the technology and its various products into the fabric and habit forms of their everyday life.

Theoretic inputs in this paper draw from diffusion, lock-in and path dependence literature with special linkage to forces that evolve in concert with new technologies and which shape consumer choice to explore how one technology – the internal combustion engine (ICE) and its emergent systems – becomes dominant while other choices are overridden by socio-political, economic and technological interests. A historical account of the motor industry in the United States of America (USA) and its resultant private transport modal system is compiled, identifying the forces and externalities that shape the market and drive path-dependent growth. Insights from this are then applied to a further study of private vehicle ownership in China, the Republic of Korea (ROK), Indonesia and Malaysia. This study shows the magnitude of the trend in private automotive adoption and the forces which influence transport mode preference and which ultimately lead to market failure. By showing these trends and the associated significant environmental and societal threats should these trends continue possible solutions can be deduced by policy makers and society. By understanding the patterns of adoption and institutional power of the past, more effective analysis of present situations of growth can be undertaken leading to efficient future policy to address the consequences of unbridled global private automotive growth.

2. Literature review

The concepts of path dependence, lock-in and market failure are central to many studies addressing the choice and adoption of products and technologies, notably those which produce sub-optimal market equilibriums notwithstanding the availability of superior alternatives. The pioneering work of David (1985) and Arthur (1989) shared a number of fundamentals about the dynamics of path dependence and lock-in. In summary, they contend that random or chance events can determine the adoption and subsequent achievement of a non-Pareto efficient equilibrium and that, once 'selected', path dependence will occur if that initial chance event then becomes progressively 'locked-in' through the emergence of increasing

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