

Will the momentum of the electric car last? Testing an hypothesis on disruptive innovation

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Abstract

In this paper we study to what extent electric propulsion is disrupting ‘the order’ in the automotive industry with six extensions to Christensen’s notion of disruptive innovation (1997). For decades the automotive sector has relied on the internal combustion engine (ICE) as the established propulsion technology, but due to environmental regulation and geopolitical scarcity problems associated with fossil fuel use, electric propulsion is increasingly applied as sole or additional power source.

We elaborate the Christensen typology, rooted in industrial analysis, with a regime evolution framework based on changes in technology and the institutional context of production and use, with special attention to consumer perspectives and government regulation. We offer a hypothesis for structural conditions for market disruption and test this hypothesis against the development trajectory of full-electric vehicles (FEV). Drawing on evidence from a range of recent FEV studies, our analysis suggests that the disruptive niche of full-electric mobility is insufficient to displace the ICE regime.

Keywords: disruptive innovation, transition, product competition, co-evolution, automotive engine technology, incumbents

Extended summary

Christensen (1997) distinguished between sustaining and disrupting innovations. Disruptive innovations bring to the market a very different value proposition than had been available previously. Typically, in the eyes of mainstream customers, they initially perform worse on some key functionalities, but offer lower price (low-end market innovations) or unique

features to compensate (new-market innovations), which may be attractive for a share of existing or new customers.

In this paper we study to what extent electric propulsion is disrupting ‘the order’ in the automotive industry with six extensions to Christensen’s notion of disruptive innovation (1997). For decades the automotive sector has relied on the internal combustion engine (ICE) as the established propulsion technology. With environmental regulation and geo-political scarcity problems associated with fossil fuel use, alternatives to the ICE vehicle have been proposed, including: the battery-electric or full-electric vehicle (FEV), the fuel-cell vehicle (FCV), the hybrid electric vehicle (HEV), and the plug-in hybrid electric vehicle (PHEV). The analysis is not only topical but also interesting from the point of view that Christensen himself in one of the versions of his book *The Innovator’s Dilemma* singled out battery electric vehicles as a potential disruptive technology. At the time, the conventional wisdom was that battery electric vehicles would be a niche product because of inherent disadvantages of small range and high purchase price as a result of the high costs of battery packs.

In this paper we analyse the co-evolution of product offerings and demand dynamics for FEVs. We investigate the price and performance curve of FEVs and in so doing elaborate the Christensen typology, rooted in industrial analysis, with a regime evolution framework based on changes in technology and the institutional context of production and use, with special attention to consumer perspectives and government regulation as important determinants of demand. In order to systematize our study, we offer a nested hypothesis for structural conditions for market disruption and compare this hypothesis against the FEV development trajectory. Drawing evidence from a range of recent FEV studies, our analysis suggests that the disruptive niche of full-electric mobility is insufficient to displace the ICE regime. While FEVs have been diffusing rapidly recently thanks to product improvements, supportive government policies and media attention, our analysis identifies that momentum¹ is unlikely to be sustained because FEVs suffer from a web of constraints and weak “innovation motors”. An important constraining factor is the strong competition from more fuel-efficient gasoline and diesel cars and competition from hybrid electric vehicles. Our conclusion, based on an analysis of micro-macro links, product competition and webs of constraints is that the prospect of FEVs disrupting the automobile market is low, despite major product investments from some automobile manufacturers and despite imaginative business model concepts such as battery leasing. The PHEV fits better with consumer needs and the current regime of automobility based on individual ownership of cars.

The paper is structured as follows. Section 2 reviews Christensen’s notion of disruptive innovation and elaborates it for changes in the institutional context of production and use. It offers a hypothesis on when market disruption is likely to be successful. Section 3 discusses the emergence of alternative engines between 1990 and 2014 and tests this market disruption hypothesis for the current momentum of the full-electric vehicle. Section 4 discusses the hypothesis in the context of innovation ‘motors’ and ‘webs of constraints’, whereas Sections 5

¹ An early version of this paper was presented at a workshop entitled ‘Electrification of the car: will the momentum last?’ in 2012, and the title of our paper resounds the workshop title (see also Bakker and Farla [2014] introducing a Special Issue on the workshop).

draws conclusions about the validity of our hypothesis in this sector for the current time period.

[„This paper presents preliminary results of the European POLFREE project, which explores of new concepts and paradigms that can bring about a radical increase in resource efficiency, and a vision for a resource-efficient economy in the EU, with suggestions also for new more resource-efficient business models for firms, and ideas for a global governance regime. Several other abstracts that are submitted to this conference present work from this project. We suggest to group them together in a session"]