Full Length Article

The direct and indirect effects of economic wealth on time to take-off

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A R T I C L E   I N F O

A B S T R A C T

Our objective is to decompose the influence of the economic wealth on the time to sales take-off into a direct effect and an indirect effect through *time to introduction*. We use a traditional regression based and an advanced counterfactual framework for our analysis, based on adoption data for four generations of mobile phone from 172 countries. Our study extends the sales take-off literature by better understanding how the commercialization stage (time to introduction) affects the confirmation stage (time to sales take-off) in innovation diffusion while controlling for local market structure, socio-economic, demographic and cultural variables suggested in the literature. We show that economic wealth exerts: a positive direct effect by shortening sales take-off time; a negative indirect effect by shortening time to introduction which tends to extend time to sales take-off. The uncovering of this relationship is achieved by treating time to introduction as a mediating variable, departing from previous studies where it is treated as an exogenous variable. We further show that the negative indirect effect is diluted in the case of high income countries but not in the case of upper middle-income countries. A sensitivity analysis shows the robustness of our findings. Our findings will help firms develop optimal market entry strategies considering the resources available.

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1. Introduction

Our objective is to explore the relationship between the time to sales take-off for a technology and a country's prosperity, bearing in mind the time taken by the country to launch that technology. We focus our analysis on the introduction and subsequent diffusion of mobile phone technology in 172 countries.

Telecommunications is a highly capital-intensive industry, thus the timing of the decision to introduce cellular technology in a country is at firm level, influenced by the country's wealth. In contrast, the decision makers who drive sales take-off are mainly individual consumers or households. Sales take-off is the beginning of the growth period in a product's life cycle, it occurs when a new product's sales growth rate crosses a threshold based on penetration level. We use the timing threshold formula developed by Tellis, Stremersch, and Yin (2003) and Golder and Tellis (1997).

Understanding the determinants of the time to sales take-off and its variability across countries brings significant managerial benefits for international marketing strategies. These benefits include better allocation of investment and marketing resources to manufacturing, distribution, pricing, promotions and inventory management. Better understanding of take-off timing aids management of the transition from introductory to growth stage, enhancing the commercial success of the innovation. The literature on sales take-off has primarily focussed on the determinants of cross-country differences; studies are descriptive in nature (see Golder & Tellis 1997) and show the association between socio-economic and cultural variables and take-off times without causal

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inference. National prosperity is widely identified as a key driving factor of technological diffusion. In addition to economic wealth, the literature identifies a number of factors which facilitate or hinder the innovation diffusion process such as local market structure, social heterogeneity, cultural dimensions, international trade and investment, geographical proximity and population density among other covariates.

The time to introduction of a technology has been considered as a determinant of time to sales take-off but its impact is not well articulated in the literature. In modeling the time to sales take off; time to introduction is treated as either an independent or a control covariate rather than as an endogenous or mediating variable. A mediator describes the mechanism by which a key driver affects the final stage of the outcome variable. We believe, to quote VanderWeele (2015), 'that a particular intermediate state or variable or exposure may be responsible for some of, or most of, the effect of the cause on the outcome'. Most authors identify economic wealth as the most likely causal driver of time to sales take-off. However, economic wealth also drives the time to introduction of a technology and literature has ignored this indirect effect of economic wealth on sales take-off times through the mediator of the time to introduction.

In this study, our goal is to provide a comprehensive treatment of the influence of time to introduction on sales take-offs and thereby decompose the impact of economic wealth into direct and indirect, or mediated effects. We attempt to assess how much of the effect of the key driver, economic wealth, on the outcome, time to take-off, operates through an intermediate stage, time to introduction, and how much acts more directly. We use counterfactual analysis as our main approach to modelling the mediation effect, controlling for local market structure, socio-economic, demographic and cultural variables suggested in the literature. Our findings will shed light on optimal market entry strategies for a new technology to achieve earlier product acceptance.

The structure of the paper is as follows. In Section 2, we review the relevant literature. In Section 3, we propose our research hypotheses, describe our methodological framework, and describe our data. Section 4 contains an analysis of our results and a discussion of our findings in relation to our research hypotheses. Section 5 concludes with the implications and limitations of the work.

2. Review of literature

We will briefly describe the background to mobile technology to give a context for the literature review. Cellular telephony is one of the most significant innovations of the past 30 years, global mobile connections are close to a global average of one connection per capita. There are four generations of technology associated with cell phones, commonly known as 1G, 2G, 3G, and 4G.

The analog technology used in 1G mobile network was introduced in 1978, this was superseded by the digital technology of 2G in 1991. The 3G technology for 'smart' phones such as mobile Internet and multimedia messaging was introduced in 2000. 4G was introduced in 2009 facilitating more data-intensive use of social media and downloading of pictures and videos.

2.1. Key drivers of time to introduction and time to sales take-off

Widely identified as a major driving factor of technological diffusion, prosperity has been operationalised as national income, measured by GDP, or by membership of different economic regions. National income is favoured by many authors, for example: Dekimpe, Parker, and Sarvary (2000); Talukdar, Sudhir, and Ainslie (2002); Comin and Hobijn (2004, 2010); Stremersch and Tellis (2004); and Chandrashekaran and Tellis (2008). Economic region membership is identified by Perkins and Neumayer (2005) as the key driver for the introduction of a technology. We use economic region in our subsequent analysis as the key driver as our focus is on group or regional differences, not individual differences.

The literature on sales take-off has primarily examined the determinants of cross-country differences, and most studies are descriptive in nature (see Golder & Tellis 1997), showing the association between socio-economic and cultural variables and take-off times without causal inference. Time to introduction has been treated as an exogenous variable in modelling time to sales take-off, see for example Tellis et al. (2003) rather than as an endogenous or mediating variable. The literature is ambiguous in terms of the impact of time to introduction on take-off times. For example, Golder and Tellis (1997) find no significant link between year of introduction and take-off time but note that this might be due to multicollinearity with other explanatory variables in the model. They also note the possibility of a missing link between the key drivers and time to introduction in their time to sales take-off model. Subsequently, Chandrashekaran and Tellis (2008) find a negative impact of time to introduction implying that products introduced later take off faster than those introduced earlier. The ambiguity is partly due to the apparently unintuitive nature of the findings and the lack of a compelling argument for "why" a negative impact occurs and partly due to ignoring the indirect effect of economic wealth on sales take-off times through time to introduction. We attempt to assess the direction and magnitude of the effect of the key driver, economic wealth, on the outcome, time to take-off, operate through an intermediate stage, time to introduction, and how much acts more directly.

2.2. Contrasting benefits of late and early introduction

Most technologies originate in economically leading countries and are introduced there first, see Comin and Hobijn (2004). Firms in developed countries benefit from: skilled labor, high capital–labor ratios, low interest rates and sufficient financial resources to absorb any losses. These advantages make early introduction more profitable in developed than in developing countries. (see Bell & Pavitt 1997; Rogers 1995). Although technologies are introduced earlier in developed countries, latecomer (developing) countries take advantage of technological advances made by earlier adopters (Gerschenkron 1962). Perkins and Neumayer (2005)