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# Market failure in the diffusion of consumer-developed innovations: Patterns in Finland



Jeroen P.J. de Jong<sup>a,b</sup>, Eric von Hippel<sup>c,\*</sup>, Fred Gault<sup>d,e</sup>, Jari Kuusisto<sup>f</sup>, Christina Raasch<sup>g</sup>

<sup>a</sup> RSM Erasmus University, Rotterdam, The Netherlands

<sup>b</sup> Utrecht School of Economics, Utrecht, The Netherlands

<sup>c</sup> MIT Sloan School of Management, Cambridge, MA, USA

<sup>d</sup> UNU-MERIT, Maastricht, The Netherlands

<sup>e</sup> Tshwane University of Technology, TUT-IERI, South Africa

<sup>f</sup> University of Vaasa, Vaasa, Finland

<sup>g</sup> TU Munich School of Management, München, Germany

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## ABSTRACT

Empirical studies have shown that millions of individual users develop new products and services to serve their own needs. The economic impact of this phenomenon increases if and as adopters in addition to the initial innovators also gain benefits from those user-developed innovations. It has been argued that the diffusion of user-developed innovations is negatively affected by a new type of market failure: value that others may gain from a user-developed product can often be an externality to consumer-developers. As a result, consumer innovators may not invest in supporting diffusion to the extent that would be socially optimal. In this paper, we utilize a broad sample of consumers in Finland to explore the extent to which innovations developed by individual users are deemed of potential value to others, and the extent to which they diffuse as a function of perceived general value. Our empirical analysis supports the hypothesis that a market failure is affecting the diffusion of user innovations developed by consumers for their own use. Implications and possible remedies are discussed.

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## 1. Introduction and overview

Empirical research finds that tens of millions of citizens spend tens of billions of dollars annually developing and modifying consumer products to better serve their own needs (von Hippel et al., 2011). Driven by the ever-increasing quality of freely available design and communication tools, single and collaborative user innovation is expected to become even more prominent in the future (Baldwin and von Hippel, 2011).

The social welfare benefits of single and collaborative user innovation by citizens will be considerably enhanced if citizen-developed innovations of general value diffuse to others who can benefit from them. However, from microeconomic theory, there is reason to hypothesize that free, peer-to-peer diffusion of user innovation will be inefficiently low from a social welfare perspective. As von Hippel et al. (2014) have argued, when innovation diffusion involves free revealing rather than market transactions, innova-

tors will find the benefits that accrue to adopters to be partially or entirely an externality from their point of view. As a result, user innovators can be expected to invest less than might be socially desirable to inform or assist others to adopt, even when their innovations would be highly valuable to others – a market failure. In the specific circumstances focused upon here, we say that a market failure exists if user innovators and adopters, taken together, would have higher net benefits from the user innovation if the user innovator invested more in diffusion. This type of market failure is novel in the innovation literature.

In this paper, we empirically explore the market failure hypothesis just described via a sample of 176 innovations developed for personal use by individual consumers in Finland. In overview, we found that 85% of the consumer developers report that what they had developed highly satisfied their own needs. Moreover, drawing on multiple questions, we concluded that, in our respondents' view, 61% of their innovations are deemed useful to some or many others. Still, actual commercial and/or peer-to-peer diffusion only occurred for 19% of the innovations.

We further find that effort exerted to achieve peer-to-peer diffusion is not affected by the innovators' assessment of the general

\* Corresponding author. Fax: +1 617 253 2660.

E-mail address: [evhippel@mit.edu](mailto:evhippel@mit.edu) (E. von Hippel).

value of the innovation, and consequently, innovations with higher perceived value to other users are not more likely to spread to peers than are low-valued ones. In contrast, commercial diffusion effort exerted is related to perceived general value. These findings are in line with the existence of a market failure of the type hypothesized by von Hippel et al. (2014).

Our concluding discussion increases our understanding of its inner workings and points out avenues for future research as well as practical implications for policy and business.

**2. Review of the literature**

In this section, we review the literature on the frequency and importance of innovation and innovation diffusion by users, the pathways by which user innovations diffuse, users' incentives to diffuse their innovations, and the likelihood of diffusion-related market failure.

*2.1. Extent of product development and modification by consumers*

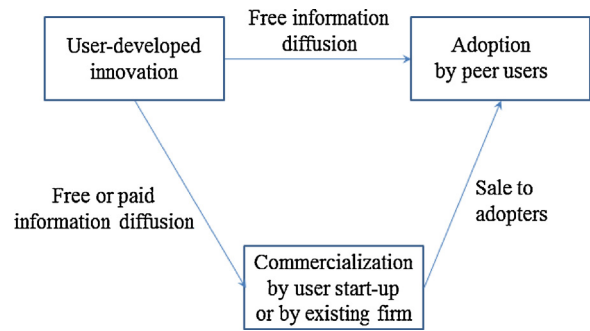
Representative national surveys of citizens above age 18 in the UK, US, and Japan, show that millions of individuals in each of these nations develop or modify consumer products to better serve their personal needs (von Hippel et al., 2011). In the UK, the fraction of user innovators was found to be 6.1% of the population, in the US it was 5.2%, and in Japan it was 3.7%. The scope of consumer innovation in all three nations was found to be very broad, ranging from improvements to vehicles, to products used in patient home care, to improvements in sporting products.

In the UK, von Hippel et al. (2012) estimated that consumer-developers on average spent 7.1 days and £1098 out-of-pocket costs per year. At the macro-level and when evaluating person-days at average UK workforce salaries, total annual spending by consumers on innovation was estimated to £3.2 billion. In comparison, estimated annual R&D expenditures by companies on consumer products were £2.2 billion. Similar findings have been reported for the US and Japan (von Hippel et al., 2011). These findings show that both the scale and scope of user innovation is substantial.

*2.2. Diffusion pathways*

Consumers as user innovators are motivated to create innovations to serve their own needs – not those of others, and consumer needs have been shown to be heterogeneous (Franke and von Hippel, 2003). At the same time, what one consumer requires may fit what another wants better than commercially-available products, and so some user innovations may prove to be of general value. When user innovations are valuable to others, diffusion enhances social welfare (Gambardella et al., forthcoming). User innovations are especially likely to be of general value when they have been developed by 'lead users', who are characterized by needs that foreshadow general demand. Producers who purposefully seek out innovations developed by lead users as a basis for commercial products have found this to be a profitable practice (Lilien et al., 2002).

The diffusion pathways user innovations might follow are as shown in Fig. 1 (Baldwin et al., 2006; de Jong and von Hippel, 2013). At the top of Fig. 1, we see that users who innovate may choose to



**Fig. 1.** Pathways via which user-developed innovations diffuse.

reveal information regarding their innovations without charge to other users (peers) interested in adopting them. This diffusion may be purposeful, or simply be the result of spillovers of unprotected information, as when a novel product is used by a user innovator in a public setting (Strandburg, 2008).

Diffusion can also be accomplished less directly, with producers obtaining information from user innovators so that they can adopt the innovation (and further develop it if needed) and then offer it to a broad audience for general sale. As can be seen at the left side of Fig. 1, the information may be freely revealed to the producers on the same terms as it is revealed to adopting users: freely revealed information has no restrictions upon who may access it. Or, some user innovators may choose to not freely reveal their innovation-related information but instead receive some kind of compensation (e.g., pay, royalties, and favors) (de Jong and von Hippel, 2009). Or alternatively, they may start their own firm for that same purpose (Shah and Tripsas, 2007). In any of these commercial pathways, the innovation ends up being offered for general sale, and in that way diffused.

*2.3. Prevalence of innovation diffusion by individual users*

It has been empirically documented that user innovators may freely reveal what they have developed, for others to examine, imitate, or modify without any compensation to the innovator. The practices visible in open source software development were important in bringing this phenomenon to general awareness. In these projects it was clear policy that project contributors would routinely and systematically freely reveal code they had developed at private expense (Raymond, 1999). However, free revealing does not imply that others will adopt what has been freely revealed. In the case of innovations by individual users, survey evidence shows that diffusion exists in only a fraction of the identified cases. As can be seen in Table 1, the diffusion rate, via commercial and/or peer-to-peer channels, varies from 5.0% to 17.1%. This is the case even though, as can also be seen in Table 1, only a small percentage of individual consumers have legally protected their innovation-related knowledge as intellectual property.

Note that, on their own, the figures for diffusion shown in Table 1 are not evidence for under-diffusion. Although, this matter was not studied prior to the empirical study we will report on here, many or even most of the innovations in earlier studies may have been of interest only to the innovating user. In such cases, non-diffusion is not evidence of a shortfall in investment in diffusion by the user

**Table 1**  
Protection of and diffusion of user innovations developed by consumers.

Source	Country	Data year	Sample	Protection with IPRs	Diffusion
von Hippel et al. (2012)	United Kingdom	2009	104 innovations by consumers ≥ 18 years	1.9%	17.1%
Ogawa and Pongtanalert (2011)	USA	2010	114 innovations by consumers ≥ 18 years	8.8%	6.1%
Ogawa and Pongtanalert (2011)	Japan	2011	83 innovations by consumers ≥ 18 years	0.0%	5.0%

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