RESEARCH PAPER

von Hippel innovation

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ABSTRACT

Round about 1940, a number of elements related to innovation processes were pulled together and organized as 'Schumpeterian innovation'. The result was to provide framing and focus – a useful new paradigm – to guide further innovation-related research. Today, we have reached the same point with respect to a new collection of innovation phenomena, defined relatively recently, that together contribute to a fundamentally different innovation paradigm. This paper explains these components – many developed and empirically tested only within the last four decades – and describes the overall new paradigm to which they contribute. The paper argues that it is appropriate to name this new paradigm after the individual who first envisioned it and, together with many collaborators, gradually characterized and tested the components needed to develop and explain the functioning of 'von Hippel innovation'.

KEYWORDS

innovation, von Hippel, Schumpeter, innovation theory

Introduction

This paper argues that there is a missing concept in innovation studies at a high-level – specifically, an entire component paradigm – that once recognized by a simple act of naming it properly and appropriately can furnish much needed clarity to a suite of concepts, while also sharpening the boundaries with, and relationship to, a complementary paradigm (namely, Schumpeterian innovation). Furthermore, the mere act of naming this paradigm into existence also contributes a new analytic element to the theory of innovation and towards an evolutionary history of innovation. Ironically, the solution proposed here – namely, to call it 'von Hippel innovation' – is a solution to a problem initially created by von Hippel himself, by a series of names he gave to various phenomena over the course of decades of study (lead-user innovation, open and user innovation, private-collective innovation, democratized innovation, free innovation, among other concepts). Now it is plainly gauche to name theories after oneself, and the full logic of the paradigm emerged only slowly, so there was never any prospect of the scientifically correct name arriving much sooner.

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However, this paper is intended to make the case that this problem is solvable now, and that there is benefit in doing so for the community of innovation scholars.

The modern science of innovation has many distinct subfields of study, including entrepreneurship and firm-level innovation, industrial dynamics and strategy, industry and technology life cycles, innovation systems and policy, and transformative change (e.g., Dosi, 1982: Fagerberg and Verspagen, 2009; Martin, 2012, Fagerberg *et al*., 2013; Salter and Alexy, 2014; Schot and Steinmueller, 2018). Yet this surface variation can, to a significant degree, be traced to the work of Joseph Schumpeter and his evolutionary theory of economic change (Nelson and Winter, 1982; Giersch, 1984; Swedberg, 1991; Scherer, 1992; Hospers, 2005; de Liso, 2022). Schumpeter's legacy is a complex intellectual framework (Haberler, 1950) and is not always explicit in innovation research and policy, such as the RAND-type approaches to technological dynamics and competition (beginning with the early work of Richard Nelson and Ken Arrow), or the newer attention to systems transitions and missions (e.g., Schot and Kanger, 2018), which tend to be formulated directly with R&D investment variables and strategic complementarities, and so on. Nevertheless, these are as much basic elements of the Schumpeterian paradigm as the analytic expressions of Schumpeter's hypothesis about the fundamental nature of industrial capitalism and its propelling forces of innovation. Indeed, different types of innovation process are named after different phases of Schumpeter's thinking – e.g., Schumpeter-Mark I and Schumpeter-Mark II, for entrepreneur-driven innovation that widens technology and monopolistic innovation that deepens technology respectively (Malerba and Orsenego, 1996).

The paper's first claim is that the modern paradigm of innovation is known as Schumpeterian – whether implicitly, as in much neoclassical innovation economics and critical innovation studies (as in this journal), or explicitly, as in self-styled evolutionary economics (the International Joseph A. Schumpeter Society, publisher of the *Journal of Evolutionary Economics*) – because the ideas first formulated by Schumpeter collectively represent the cardinal directions of the scientific paradigm. These are that innovation is the engine of capitalism, that it works through firms, that it requires investment and institutions, that it transforms economies. The second claim, the proper subject of this paper, is that a new paradigm is emerging, based on initial discoveries first made almost 50 years ago (von Hippel, 1976), and that the appropriate name for this new paradigm is 'von Hippel innovation'. The context is that the existing panoply of names for a broad class of innovation phenomena does not work well and contributes to imprecision. This is because the various names are either too low-level and multiple (e.g., user innovation, household innovation), or refer confusingly to phenomena outside the paradigm (e.g., open innovation, soft innovation). Plainly, naming is a process that is undertaken by a community and that depends upon legitimacy, and of course, is valuable only to the extent it facilitates clarity and provides illumination. The purpose of this paper is to make the case for a particular naming convention that achieves these things in order to advance innovation science.

On naming things well

Any scientific paradigm benefits from having a name so that it may be understood as a whole. This enables those working within it, and those engaging from without, to be able to refer to its entirety, and also its specificity, with simple precision. Sometimes that name is usefully connected to a person who made foundational contributions in organizing and developing the theory, with the naming convention indicating a line of development from fundamentals (e.g., Darwinian theory of evolution, Keynesian macroeconomics). A quick detour in intellectual history illustrates why this is useful. In the mid-1930s, Alan Turing developed the concept of an unlimited memory capacity state machine with reversible read-write head, or automatic machine, which he called an 'a-machine', as an abstract model of computation. In a review, Alonzo Church cleaned that up by calling it a 'Turing machine' (today we just call it a computer). Eponymy is a standard academic naming convention (e.g., Venn diagrams, Cherenkov radiation, von Neumann architecture). Intensely practical considerations also guide naming things too, including taxonomic integrity and precision, and of course, scientific legibility and legitimacy.

Yet beyond institutional tidying-up, a more urgent reason is the explosion in prevalence and consequence in modern economies and societies of the phenomena we seek to name. This explosion happened because of the combined effect of the near ubiquity of digital technologies (especially computers and the internet), and growing global wealth driving household capital formation (including human capital). This explosion is recent – we're still living through it. Benkler (2016), for instance, points to two main reasons for the explosion in user innovation and production in the commons: (1) the widespread capital (especially computers) now in place in households raises capabilities; and (2) the fall in search and communication costs (i.e., connected computers) lowers costs of community collaboration. These drivers of information and communications technology were powerful industrial trajectories of Schumpeterian innovation itself. The vast accumulation of skills and tools in households was a direct spillover from economic growth of industrial economies. So, in a direct sense, the era of Schumpeterian innovation made possible the explosion of von Hippel innovation and there is an evolutionary historical relation between these two paradigms of innovation. We need to be able to communicate clearly about it for research, business and policy. Different names indicate differences in the mechanism and processes by which innovation types work. Von Hippel innovation is distributed and decentralized, and operates through different institutional mechanisms (i.e., it occurs mostly in the commons, rather than mostly in firms, as with Schumpeterian innovation). The economics of these two paradigms of innovation is therefore also different, with, for instance, von Hippel innovation being driven largely by local knowledge, whereas Schumepeterian innovation is powered by specialized knowledge. Yet they do interact and co-evolve, as the canonical von Hippel (2006) diagram of free innovation and producer innovation (Schumpeterian innovation) illustrates (Figure 1).

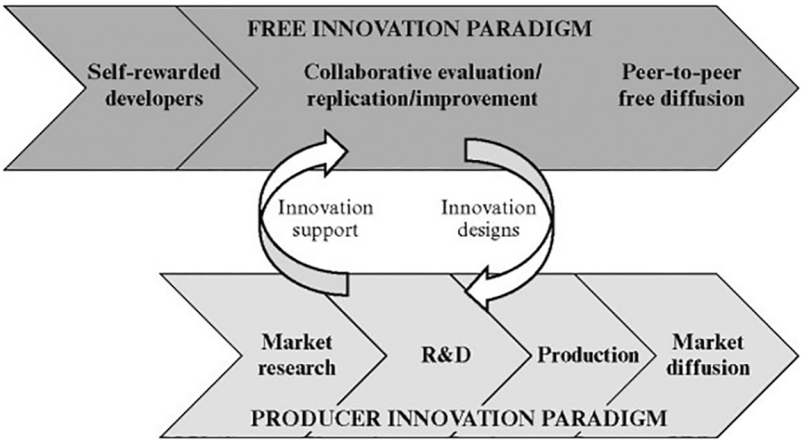

Figure 1. How Schumpeterian innovation and von Hippel innovation interact

A new name brings order to classification. The problem is rife and longstanding, although endemic to a multidisciplinary field whose basic subject matter is structural novelty and uncertainty. Many different dynamic phenomena – invention, creativity, problem-solving, adoption and diffusion – operate at very different levels (e.g., cognitive, behavioural, organizational, social), and employ different mechanisms (search, communication, learning, optimization, etc.). Yet, they are nevertheless bundled together under the name 'innovation' and referenced interchangeably in theory construction. There is also a tendency to cast common types of innovation (e.g., industrial innovation) too widely, which has led to a minor industry carving out sub-species of innovation (e.g., services innovation, agricultural innovation, public sector innovation, etc.). Some esteemed scholars of innovation (historians, mostly) have succeeded in naming a type of innovation as a kind of shorthand for their whole theoretical apparatus. Key instances of this are Nathan Rosenberg's concept of 'radical innovation', Robert Allen's 'collective invention', Clayton Christensen's

'disruptive innovation' and Joel Mokyr's concepts of 'micro-invention and macro-invention'. These are in some ways consequences of the success of the field of innovation studies and its rapid growth. But there has also been analytic confusion.

The problem is apparent when we consider a cluster of research programmes and analytic concepts that are closely related, but differently labelled, which risks obscuring the deep connections; for instance:

- *lead-user innovation*, i.e., lead-users are the prime agents engaged (von Hippel, 1976, 1986, 1988)
- *open-user innovation*, i.e., innovation that does not seek intellectual property protection or seek to create proprietary ownership models (von Hippel, 2010)
- *user and open collaborative innovation* (Baldwin and von Hippel, 2011)
- *toolkits* for distributed innovation (von Hippel and Katz, 2002)
- *private-collective innovation*, because the mutual sharing and development of innovations is often concentrated in a voluntary community (von Hippel and von Krogh, 2006)
- *household innovation* and producer innovation (Gambardella *et al.,* 2017)
- *democratized innovation*, i.e., innovation that engages all citizens as potential contributors (von Hippel, 2006)
- *common innovation* (Swann, 2014) and *soft innovation* (Stoneman, 2010)
- *free innovation*, i.e., zero-price in the 'market' at point of exchange (von Hippel, 2017).

A different problem runs in the opposite direction. The same 'open innovation' label has one meaning when used in the context of collaborative innovation (*sensu* Baldwin and von Hippel, 2011), a different meaning in the context of distributed software development, i.e., open source (*sensu* Lerner and Tirole, 2002, but cf. O'Mahoney, 2003), and a different meaning still in the context of business strategy and business models, i.e., horizontal permeability of ideas between business units (Chesbrough, 2003). It is not uncommon for survey pieces to somewhat fudge all three (and more!) meanings into the same paper (e.g., Dahlander and Gann, 2010; Huizingh, 2011; Felin and Zenger, 2014). To be clear, this observation is not a critique of these authors. In part, these naming problems and analytic confusion are attributable to the messy and unreconstructed history of the various fields that compose innovation theory and analysis (Salter and Alexy, 2014). Some of the plethora is a result of product differentiation (e.g., Chesbrough and Bogers, 2014), or normal-science endeavours to generalize the producer-centric framework, with all non-Schumpeterian innovation phenomena swept up as special cases. And some of the naming plethora is simply a consequence of the rapid evolution in innovation itself, as new phenomena emerge and are sequentially named (e.g., with the rise of crowd-sourcing and crowdfunding because of internet affordances) without dealing with the technical debt (to use a programming metaphor) this creates. We have the equivalent of 'software bloat' in our conceptual classification and labelling systems. So, how to fix this? How to 'refactor this codebase', as it were? The simple solution is to recognize that the sequence and totality of works that von Hippel and colleagues have constructed constitute a coherent paradigm of innovation.

The lead-user innovation that von Hippel first identified in 1976 was not the first sighting of this sort of non-standard (i.e., non-Schumpeterian) innovation in the wild. Many other descriptions of innovation in households or invention without seeking to gain profit had been reported in the literature. The phenomenon was already known, but its significance lay unappreciated. These types of innovation are difficult to measure and, more generally, were thought not to be individually large or systemically important (Trott *et al*., 2013). No one had seriously theorized why and how they might be important. Almost 50 years later, we are now at a point where we have a new paradigm built around the reality of these phenomena and we need to rebuild the foundations of innovation science – starting with a deeper abstraction from which we can build a more general (evolutionary) theory of innovation that contains both industrial dynamics (Schumpeterian paradigm) and community dynamics (von Hippel paradigm).

Schumpeter's theory of innovation

Innovation is the process of creating new ideas and developing them for use to solve economic problems. For most of human history, the institutional incentives to invention and innovation were weak and often actually perverse. Baumol (1990), for instance, explains how in many historical regimes entrepreneurial activity was incentivized towards economically unproductive or even destructive outcomes. But even in the modern era, much innovation still falls into what Swann (2014) sees as 'common innovation', done by households without regard to business, or what Stoneman (2010) calls 'soft innovation', focusing on aesthetic or intellectual changes. But then a few centuries ago the institutional and industrial revolutions harnessed industrial innovation as a driver of economic and social dynamics (North, 1990, 1994; Allen, 2011). This introduced the factory as not only a site of specialized capital for production (e.g., Smith's pin factory), but also for innovation (e.g., the R&D lab, first clearly seen in the German chemical industry (Murmann, 2004). Along the way, many classical economists, historians, social philosophers and engineers had noticed this new organizational and institutional phenomenon at work. Major causal factors in the industrial revolution were the technological trajectories of steam, steel, machine tools and chemicals, combined with massive concentrations of capital about these technologies. But a deeper causal factor was the new way that firms could specialize in innovation by investing in R&D as a powerful new form of market competition. The classical economists had long understood the benefits of economic specialization and the division of labour, limited only by the extent of the market. But it was Schumpeter who explained that entrepreneurial firms were the locus of innovation in this story. Schumpeter overlaid an industrial account of the production of innovation through economic specialization in assembling innovation resources within a firm as an allocation of capital based on an entrepreneurial vision. He showed how that capability was a driver of competition in industries and markets.

The Schumpeterian canon

Across a series of groundbreaking works in the early part of the twentieth century, Joseph Schumpeter identified innovation as the main driver of market-capitalism and sought to understand it as the central dynamic process in economic change in historical time. He explained the role of the entrepreneur and venture finance, the industrial dynamics of technological trajectories, and the evolutionary institutional context of innovation (respectively Schumpeter, 1912, 1939, 1942). His works were interdisciplinary mixes of theory, history, empirics and political economy. He saw innovation as the primary source of long-run economic growth, the origin of most new economic value and societal well-being, and simultaneously a major cause of social, cultural and economic disruption.

These two stylized facts about innovation – as the main driver of economic dynamics and as inherently and essentially disruptive – were first established by Schumpeter in *Theory of Economic Development* (1912) and in *Capitalism, Socialism and Democracy* (1942):

> Capitalism is by nature a form or method of economic change and not only never is but never can be stationary. … The fundamental impulse that sets and keeps the capitalist engine in motion comes from the new consumers' goods, the new methods of production or transportation, the new markets, the new forms of industrial organization that capitalist enterprise creates. … This process of Creative Destruction is the essential fact about capitalism. (Schumpeter, 1942: p.83)

But note how Schumpeter, writing across several famous passages, specifically defines innovation:

> By innovations I understand such changes of the combinations of the factors of production as cannot be affected by infinitesimal steps or variations on the margin. They consist primarily in changes in methods of production or transportation, or changes in industrial organisation, or in the production

> of a new article, or in the opening up of new markets or new sources of material. (Schumpeter, 1927: p.295)
>
> What we, unscientifically, call economic progress means essentially putting productive resources to use hitherto untried in practice, and withdrawing them from the uses they have served so far. This is what we call 'innovation'. (Schumpeter, 1928: p.378)
>
> The historic and irreversible change in the way of doing things we call innovation … innovations are changes in production functions which cannot be decomposed into infinitesimal steps. Add as many mail-coaches as you please, you will never get a railroad by so doing. (Schumpeter, 1935: p.4)

From these definitions, Schumpeter laid out a range of auxiliary hypotheses – centring the innovation process in the industrial firm, initiated by entrepreneurial competition and shaped by market selection. In *Business Cycles* (1939), he attributed large-scale macroeconomic dynamics to the adoption trajectories of technological innovation. This built on earlier historians who discovered the presence of distinct technological cycles or waves (Kitchin, Juglar, Kondratieff) and was subsequently the analytic foundation for more detailed sociological theories of innovation diffusion (Rogers, 2003) and institutional analysis of technoeconomic waves (Freeman and Soete, 1997; Freeman and Louçã, 2001; Perez, 2003). Schumpeterian innovation is historically visible, institutionally targeted and administratively legible. It accretes quality data in business and technology histories, patent records or in company registries. Much of the research programme of modern innovation economics is analysis of precisely these data.

Schumpeter's theory of innovation was a deep insight into the dynamics of a market-capitalist economy. It contrasted sharply with the dominant paradigm in economic analysis and policy of the time which focused on *spending* (e.g., Keynesian demand-side macroeconomics) or *investment* (classical supply-side economics). For Schumpeter, innovation was the main driver of economic change, not consumer or investor sentiment, capital accumulation, factor supply or economic planning. Schumpeter's genius, and the source of his lasting influence, was to shift an understanding of economic change from the classical focus on factors of production – land, labour and capital – and their neoclassical economic motion towards equilibrium as a result of the actions of rational economic agents or government planning, to focus instead on a new dynamic factor – the creation of new ideas, the growth of knowledge and the process of innovation (Nelson and Winter, 1982).

Schumpeter published across economic theory, sociology, economic history and political economy through the first half of the twentieth century. His work became the foundation of the modern sciences of innovation that emerged and flourished through the second half of the twentieth century. These Schumpeterian progeny do not form a singular field, but spread across several disciplines that include economics, business, management, sociology, geography, history, as well as planning, engineering, and public policy, and which are composed of such cross-cutting fields as:

- economics of technical change and innovation economics (Griliches, 1957; Mansfield, 1968; Hall and Rosenberg, 2010)
- evolutionary economics (Nelson and Winter, 1982; Dopfer and Potts, 2008)
- sociology of innovation (Rogers, 2003)
- science and technology studies (Pinch and Bijker, 1984)
- organization of innovation and technology management, economic geography (Fagerberg and Verspagen, 2009)
- entrepreneurship (Baumol, 1990; Casson, 2008)
- innovation studies (Martin, 2012; Fagerberg *et al*., 2013).

Across this breadth is a common focus on innovating firms and their capabilities (Teece, 1986; Dosi, 1982), a focus that now extends to a broader institutional analysis of the innovation environment.

Producer-centred innovation

The Schumpeterian paradigm focused on industrial dynamics driven by profit-seeking firms that compete through entrepreneurship and innovation. Schumpeter's view was that 'it is … the producer who as a rule initiates economic change, and consumers are educated by him if necessary' (1912: p.65). The logic of his argument that end users would not generally innovate is that innovating producers can generally expect to distribute their costs of developing innovations over many consumers. End users, in contrast, depend only on their own in-house use of their innovation and other types of self-reward to justify investments in innovation development. Given this contrast, it seemed reasonable that producers, apparently in a position to invest more than individual end users and to exploit these opportunities for specialization and scale, would be the typical locus of innovation.

This theoretical targeting made producer innovation the focus of extensive empirical research. This was helped by producers accreting quality data in many forms, such as patent records and company registries. Much of the research programme of modern innovation economics is analysis of these data. Schumpeter's views and the producer innovation paradigm came to be widely accepted by economists, business people and policymakers, and this is still the case today. Sixty years later, Teece (1996: p.193) echoed Schumpeter: 'In market economies, the business firm is clearly the leading player in the development and commercialization of new products and processes'. Similarly, Romer (1990: p.74) viewed producer innovation as the norm in his model of endogenous growth: 'The vast majority of designs result from the research and development activities of private, profit-maximizing firms'. Baumol (2002: p.35) made producer innovation central to his theory of oligopolistic competition: 'In major sectors of US industry, innovation has increasingly grown in relative importance as an instrument used by firms to battle their competitors'. Schumpeter's description of industrial innovation as centred in entrepreneurial firms, seeking profit in markets, supported by venture finance and intellectual property, with dynamic effects through industrial organization (what he felicitously called 'creative destruction') has since become the standard analytic framework for the study of innovation and the practice of innovation strategy and policy.

Development and maturity of Schumpeterian theory

Schumpeter died in 1950, but the Schumpeterian research programme of innovation came of age in the second half of the twentieth century. With the rise of business schools ministering to the growing need for frameworks to guide industrial economic growth policy, the Schumpeterian programme of the dynamics of industrial economies and societies through the lens of innovation became a useful framework to guide research, strategy and public policy. The focus on the economics of new technology and its strategic importance was pioneered in the 1950s in the US, especially at think tanks such as RAND. By the 1970s, multidisciplinary research institutes focused on innovation began to emerge (e.g., SPRU, PREST, ISI, MERIT) (Fagerberg *et al*., 2005). Through that same period, the massive growth in historical and empirical administrative data that maps well to the main objects in Schumpeterian theory of innovation – measures of firms, patents, market growth, venture capital investment and so on – has bolstered research output.

There are now thousands of innovation researchers, with a plethora of handbooks and specialist journals, societies with regular global conferences,and well-established research centres around the world devoted to 'the growing demand for a better understanding of the nature of the innovation process for management and policy purposes' (Martin, 2016). Dosi *et al*. (2006) write of the 'Stanford-Yale-Sussex synthesis' for the confluence of work on the economics of information and technological knowledge and the way it is exploited and developed in modern economies. Innovation Studies, in the Schumpeterian tradition, is nowadays a relatively mature field. But there is also a burgeoning sense that this is beginning to fray as a consequence of the accumulation of

scientific anomalies, i.e., basic facts that do not fit the canonical model. For instance, as Martin (2016: p.432) explains:

> the empirical focus of our studies has failed to keep pace with the fast changing world, especially the shift from manufacturing to services and the increasingly urgent need for sustainability. The way we conceptualise, define, operationalise and analyse 'innovation' seems somewhat rooted in the past, leaving us less able to grapple with other less visible or 'dark' forms of innovation.

Yet the Schumpeterian theory of innovation refers only to a particular type of innovation, namely one centred on entrepreneurship in capitalist firms, supported with intellectual property and venture finance, measured with patents and R&D spending, and structured by industrial innovation policy to support innovating firms (Bloom *et al*., 2019). There is a growing awareness that the Schumpeterian programme might be better understood as a contingent theory based on historical, technological and institutional conditions that have been dominant, or powerfully ascendant, for the past few hundred years in the most economically formidable parts of the world. Of course, Schumpeter's theory was not of the origin of innovation *per se*; rather it was a theory of the origin of economic growth and dynamism, which he located in innovation. Schumpeter never sought to develop a general theory of innovation, but rather a theory of the structural consequences of a particular, predominant type of innovation for the economy. We must look beyond the Schumpterian framework for a more general scientific account of the nature and causes of innovation.

Von Hippel innovation

What von Hippel did

Fortunately, the outlines of this challenge are now reasonably well understood, largely as a result of the work of Eric von Hippel, who has played a role over the past 50 years similar to that played by Schumpeter in the early twentieth century, namely establishing a broad theoretical framework, building a statistical argument and seeking to understand the socio-cultural and institutional context. Now, of course, von Hippel was not claiming to have discovered human creativity and problem-solving *in situ*. That research programme was plainly advancing in psychology and related fields (Newell and Simon, 1972). Nor was von Hippel's claim to extend the economics of household production (e.g., Lancaster, 1966; Becker, 1976), as a model of household R&D. Rather, what von Hippel discovered and explained was a 'source of innovation' that was new for economists and other innovation researchers. He first found this in scientific instruments, where surgeons and engineers dominated innovation rather than the manufacturers of commercial grade versions of those instruments (von Hippel, 1976, 1977, 1978; von Hippel and Finkelstein, 1979). By gathering evidence across a large number of domains of use (which decades later extended to systematic country studies (e.g., von Hippel *et al*., 2012), von Hippel built up a substantial body of evidence that innovation by these 'lead users' differed from innovation by producers (i.e., Schumpeterian innovation) in important but systematic ways.

Core elements of von Hippel innovation

The von Hippelian paradigm introduces additional significant variables:

STICKY INFORMATION

End users who actually use an innovation within a system of use have sticky information advantages with respect to understanding – explicitly or tacitly – both the need for an innovation and the 'system of use' within which that innovation will function (von Hippel, 1994). End users of

production systems – producers – who will produce an innovation at scale have the best information on their system of production use with respect to manufacturing methods.

SYSTEMS OF USE

Those who actually use an innovation have a wider solution space with respect to implementing system innovations involving changes across multiple system components (von Hippel, 2007, 2021).

VALUE CREATION AND INCENTIVES

The mode of gaining benefit from innovation is fundamentally local in von Hippel innovation. Innovators who benefit from innovation use, rather than diffusion to others, do not need to care about the likely extent of the market.

FINANCE AND CAPITAL

The level of innovation investment required to begin to obtain returns is orders of magnitude lower than in Schumpeterian innovation. Users have lower costs required in terms of getting all elements in place to gain intended benefits. Users need only create a functioning device and put it to local use. Producers must invest in engineering to a higher commercially expected level of product quality and reliability – and must also invest in setting up volume production, invest in marketing, distribution, invest in spare parts production and field service, etc. – tasks not required of user innovators.

ECONOMIES OF SPECIALIZATION AND SCALE IN DEVELOPMENT

Producers have historically had an advantage in innovation because they can profit more from selling multiple innovation copies than any individual user can profit locally from one or a few copies of that same innovation – and so they historically have been able to afford more co-located equipment and specialized developers (e.g., Edison Labs, Bell Labs). Today, the field has levelled with respect to this factor, because end users can also virtually co-locate cheaply, share specialized tools and so on. This advantage arises because of the increased ability to build innovation resources in the commons.

PROPERTY RIGHTS AND TRANSACTION COSTS

Von Hippel innovation enables economies from free sharing of information rather than incurring the transaction costs of IP-controlled information. Users can do this, because they do not need innovation control for their own internal profit.

USER INNOVATION HAPPENS FIRST

All of these independent elements end up with a general pattern in the locus of innovation with respect to innovation type and timing in which users pioneer functionally novel innovations – systematically acting before producers do (Potts, 2019). In contrast, producers tend to develop what Riggs and von Hippel (1994) call ‘dimension of merit’ improvements to existing products, which are dimensions of product improvement that are likely to be valued by most consumers, such as more energy efficiency, lower cost, stronger materials and so on.

SELF-REWARD INCENTIVES

The von Hippel innovation paradigm involves individuals or firms developing new products and services for their own use – they are end users rather than producers seeking to sell their innovations to others. For this reason, their incentives are not profits from sales, at least directly, but take the form of self-rewards. For example, individual end-user motives include benefits expected from direct use

of their innovations, as well as the learning and satisfaction from engaging in the process of innovation. Profit-seeking firms making process equipment for their own, in-house factory use expect benefits indirectly from improvements in the production of products and services they sell to others.

FREE REVEALING

As a next element in this user innovation process, end-user innovators may freely reveal their innovation-related information to others, both because hiding is costly, and to enable others to build on the innovation with benefits from improvements flowing also to the original developer. This pattern will be familiar in open-source software development projects. What is generally being revealed by free innovators is design information, not free copies of physical products. In the case of products or services that themselves consist of information, such as software, a design for an innovation can be identical to the usable product itself. In the case of a physical product, such as a wrench or a car, what is being revealed is a design 'recipe' that must be converted into a physical form before it can be used. In free peer-to-peer diffusion, this conversion is generally done by individual adopters – each adopter creates a physical implementation of a free design at private expense in order to use it. Finally, free diffusion of unprotected design information via peer-to-peer transfer to free riders may occur, as well as free transfer to producers interested in manufacturing the user-developed design for general commercial sale.

Analytic properties

RATIONAL CHOICE

Von Hippel innovation is consistent with the *rational actor* model. Agents are rationally using their own resources because these resources, such as skills and capital, are fully cost accounted for from other market or household investments, and are mostly non-rivalrous. Furthermore, agents then often freely give away ideas because the full benefit has accrued to themselves by solving their own problem (Harhoff *et al*., 2003). There is no necessity to disseminate freely, though many von Hippelian innovators do so anyway. Moreover, the costs of protection will usually well exceed expected benefits.

NEW ABUNDANT RESOURCES

Von Hippel innovation creates economic value because it cheaply and efficiently uses a resource that producer innovation can access only at very high cost, namely local information (von Hippel, 1994, 1998). Because sticky local information is a naturally occurring renewable resource, greater use of it 'democratises innovation' (von Hippel, 2006). But more abstractly, von Hippel innovation is decentralized innovation (occurring at the edges), against the centralization in firms (and tendency towards monopoly) in Schumpeterian innovation.

EFFICIENCY AND PRODUCTIVITY GAINS

The individual benefit of von Hippel innovation follows from the way it is produced using local information, and so can be produced faster and with better fit to the specific local problem (Henkel and von Hippel, 2005). So not just cheaper but also faster and better. The aggregate social welfare benefit then accrues to the spillovers created (Gambardella *et al*., 2017, Potts *et al*., 2024).

ALIGNMENT WITH DOMINANT TECHNOLOGICAL TRAJECTORIES

These advantages are likely to continue developing and accelerating as a result of innovation in digital technologies, such as the internet (continually falling costs of communication, search and

sharing tools) and through innovation in digital platform toolkits (von Hippel, 2001; von Hippel and Katz, 2002). One may model von Hippelian innovation in two dimensions, with one being *design cost* and the other *communication cost* (Baldwin and von Hippel, 2011). Indeed, as better search and match technologies intersect with better ways to create idea pools and platforms, innovation itself will continue to evolve as the costs of both the design and communication parts of the innovation process fall. This is what von Hippel and von Krogh (2016) call 'need solution pairs', which economize on innovation by reducing the cost of problem formulation and going directly to viability testing.

Towards a general theory of innovation

As a scholarly field, innovation cuts across several disciplines, including strategic management and industrial organization, economics, design and engineering, intellectual property and legal regulation, but also economic geography and macroeconomics, where it is a focus for policy. Innovation is also central to studies of technology and culture, specifically their organization and dynamics, as well as creativity and problem-solving. So, the field – the multidisciplinary sciences of innovation – is a composite of history, psychology, anthropology, cultural studies, sociology, geography, management, law, engineering as well as economics. This means that a general theory of innovation first of all needs to transcend these disciplinary boundaries. It must be an evolutionary theory of the growth of knowledge and institutions (Loasby, 1999). The argument made here to formulate a whole type of innovation as von Hippel innovation is not to subsume Schumpeterian innovation within a broader new paradigm, but rather to illustrate that both are types of innovation, each described by a distinct paradigm. A general theory of innovation will seek to unify these different paradigms.

The universe of innovation is of course much broader than Schumpeter's definition. For instance, von Hippel (2017: pp.1–2) defines 'free innovation' as:

> … a functionally novel product, service or process that (1) was developed by consumers at private cost during their unpaid discretionary time and (2) is not protected by its developers, so it is potentially acquired by anyone without payment. … Free innovation is carried out in the 'household sectors' of national economies. [It] is a form of household production.

This definition touches none of the Schumpeterian primitives. There are no firms, no intellectual property. There is no finance, nor entrepreneurs, nor markets. Yet it is plainly economic innovation that is driving and shaping modern economies. Schumpeter's theory was not a general theory of innovation, with a range of non-market and non-firm exceptions. Rather, it was a theory of the importance of innovation to the dynamics of market-capitalist economies.

That market-capitalist economies have come to completely dominate our world over the past century in part explains this confusion of the significance and generality of the Schumpeterian paradigm. What has happened instead is the accumulation of anomalous and alternative theories of innovation as a kind of penumbra of heterodoxies against the Schumpeterian orthodoxy (e.g., Godin, 2017; Godin *et al*., 2021; Edwards-Schachter, 2021). But as Popper, Kuhn and Lakatos explain, orthodoxies are overturned and scientific revolutions proceed through the gradual accumulation of empirical anomalies that are eventually understood and integrated with a fundamentally new set of theoretical explanations. Innovation is solving problems with useful knowledge to create value. The value created is proportional to the rate and directions of discovery of useful knowledge, how far that knowledge spreads and where and how it is put to use. There are many ways this can happen, and a general theory must seek, abstractly, to cover them all.

What properties should a more general theory of innovation have? First, it should seek a more general account of the origin of innovation in problem-solving, allowing for a variety of incentives and motives (in the Schumpeterian framework, this is limited to profit). Second, it should

seek a broader comparative account of the organizations and institutions that are designed or selected for, including the comparative advantages and costs of each. Schumpeterian innovation, for instance, is mostly an institutional theory of firms and markets, whereas von Hippel innovation is mostly an institutional theory of commons and clubs (communities). Third, and closely related, a general theory of innovation will need to explain the different resource requirements of innovation under different modes, the forms of governance required and the characteristic problems in each. For instance, Schumpeterian innovation, using specialist knowledge and resources, and requiring concentrated finance, has a strong need for intellectual property rights to furnish protection to lower the hazards of investment under such extreme market uncertainty. Von Hippel innovation, with a different structure of resource requirements, requires none of these institutional supports. But it faces different problems from a social welfare perspective, specifically with respect to incentivizing diffusion of ideas. Fourth, this implies that the public policy requirements differ substantially between these different modes of innovation.

Towards a new history of innovation

The universe of innovation theory has, for most of its history, focused on those parts that are clearly visible (that take place in firms, in consequence of investment, and that are institutionally recorded in market transactions and patents). A major discovery in modern cosmology is the theoretical prediction and empirical confirmation of dark matter, of inertial mass that could not be directly seen, but logically must exist. And so it seems that innovation dark matter also exists, and perhaps in similar proportions. To be clear, von Hippel alone did not discover these new sources of innovation, as many working on problems in innovation and technological change had pointed to these anomalous phenomena. But it was von Hippel who first clearly understood its significance and scale, and who sought to map its extent and consequences, and to develop a systematic understanding of the phenomena in the same way that Schumpeter did for producer innovation in firms.

A major reason to advance a concept of von Hippel innovation is to ensure that the evolutionary history of innovation is correct. Having a more modular analytic concept of Schumpeterian and von Hippel innovation, with the different clusters of institutions and systems of incentives, as well as behaviours and resources they represent, enables us to formulate a more complex evolutionary history of innovation. This was the argument Ostrom (2009) made with respect to the resolution of collective action problems in the governance of common pool resources in the evolutionary analysis of institutional diversity. We need to understand both paradigms, and how they relate to each other and coevolve. Some phases of economic history display a dominance of Schumpeterian innovation, other phases dominance of von Hippel innovation.

On a millennial timescale, Schumpeterian innovation is high-modern. It is an evolutionary consequence of market-capitalist institutions that facilitated certain sorts of specific property rights and forms of economic organisation that have adapted to the industrial economy. Von Hippel innovation is emergent from the capabilities laid down by cheap and ubiquitous computing and communication (Benkler, 2016). But von Hippel innovation is also the atavistic form of human evolutionary problem-solving that works with local information and resources (Torrance and von Hippel, 2016). This is to make an obvious point, namely that before capitalism there was of course innovation, but it was institutionally different, and worked with different incentives. ‘Ancestral innovation’ was local, mostly without scale and specialization, unfinanced and occurring at sites of production. This was a species of von Hippel innovation. But new technologies, especially the internet and digital platforms, have fundamentally changed the basic economics of user innovation or household innovation or free innovation, lowering the costs of discovery and sharing of ideas and designs. This, too, is von Hippel innovation. Moreover, it points to a more evolutionary process in the way innovation works in human cognition and in the modern world (see Stock-Homburg *et al*., 2021; von Hippel and Kaulartz, 2021, on ‘need-solution pairs’). When the same word describes these very distinct phenomena, we can better understand why at a deeper level they are the same

underlying process and logic. This advances us towards a more general theory and understanding of innovation.

At a timescale of centuries and decades, spanning the transitions from the feudal era to post-industrial global capitalism, we can formulate a theory of broad 'innovation eras' that differ in the shifting applicability of these different factors represented in an analytic model of Schumpeterian and von Hippel innovation. As an initial theoretical conjecture, for instance, consider the new history of innovation through four distinct eras:

- **Artisan era (eighteenth century)** – pure von Hippel innovation: user innovation the only innovation pattern, innovation constrained by skill, no role for organization, finance or market development.
- **Small producer era (early nineteenth century)** – mixed von Hippel and Schumpeter paradigms active: emergence of market opportunity and institutions, but costly because of underdeveloped institutions.
- **Big producer era (long twentieth century)** – Schumpeter innovation institutionally dominant (but von Hippel paradigm also active in background): economies of innovation development specialization with respect to developer skills and tools, and capital allocation; specialization and economies of scale advantages dominate advantages of local information; market development reduces uncertainties; aligned policy frameworks de-risk Schumpeterian innovation.
- **Free innovation era (early twenty-first century)** – rapid growth of von Hippel paradigm: user and producer equality with respect to digital development tools, effective specialization via self-recruited teams – and now equal access to large-scale, costly-to-acquire information via GPT-type tools; general shift to distributed, democratized user-centred innovation platforms and processes.

Conclusion

It was Harvard colleague Paul Sweezy who in 1943 wrote a review titled 'Professor Schumpeter's theory of innovation'. Today it is common to allude to the vast range of different industrial forms of innovation as 'Schumpeterian innovation'. Von Hippel's exhaustive body of innovation studies has underpinned the development, with a variety of co-authors, of a general framework that explains the incentives, institutions and mechanisms through a rational agent model in terms of local or 'sticky' information, toolkits and other platform technologies. It is with respect to this general theoretical account of many phenomena, on the surface very different (e.g., medical procedures, agricultural irrigation, sporting equipment and techniques, the behaviours of French chefs and so on), that we nevertheless refer to the coherent and broad phenomena of 'von Hippel innovation'.

The elements of Schumpeterian innovation are how it creates and realizes value by analytic focus on profit-seeking, innovating firms. The theoretical paradigm seeks to explain the origin of economic dynamics, drawing on investment under uncertainty by firms developing dynamic capabilities for innovation. This framework extends to entire systems of innovation made up of the institutional elements needed to support these firms and the types of industrial transformations they can make. The core elements of von Hippel innovation are systematically different. First, innovation creates economic value because it cheaply and efficiently uses a resource that producer innovation can only access at very high cost, namely 'sticky' local information (von Hippel, 1994). The individual benefit of von Hippel innovation follows from the way it is produced using local information and cross-subsidized capital, namely that it can be produced faster and with better fit to the specific local problem (Henkel and von Hippel, 2005). These individual and social welfare advantages (Gambardella *et al*., 2017) are likely to continue developing and accelerating as a result of innovation in digital technologies and through innovation in digital platform toolkits. Like Schumpeter, von Hippel discovered a prime mover of the economy and a new source of innovation.

Schumpeter found it in entrepreneurial capitalist firms. Von Hippel found it in skilled and curious individuals. He first found this in scientific instruments, where it was the users (e.g., surgeons and engineers) who dominated innovation, rather than manufacturers of commercial-grade versions of these instruments. By gathering evidence across a large number of domains of use (later extending to systematic country studies, e.g., von Hippel *et al*., 2012), von Hippel built a substantial body of evidence showing how innovation by lead users differed from innovation by producers in important but systematic ways.

The development of innovation theory will benefit from adopting a new naming convention away from 'open innovation' and 'user innovation' to the simple rubric of *von Hippel innovation*, as the analytic counterpart to Schumpeterian industrial and producer innovation. This terminology is simpler, cleaner and more precise, and reflects priority. These are unambiguous benefits for scientific communication and institutional legitimacy. An additional benefit is that 'von Hippel innovation' gives us a new analytic concept with which to advance and develop the science of innovation.

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