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Lead Markets in Age-Based Innovations

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Abstract¹

The trend of population aging is affecting an increasing number of countries around the world, especially advanced economies. One consequence of a growing population share of aged persons is a shift in consumer needs, reflected by a rising number of products and services designed particularly for elderly users. Thus, population aging is a catalyst for new markets and a driver of innovation. A common objective of such age-based innovations is the delay of an age-associated decline in individual autonomy or the restoration of autonomy losses already incurred. In particular, age-based innovations aim to compensate age-associated deficiencies in sensory perception, cognitive skills, and musculoskeletal status. Age-based innovations are marked by a high level of heterogeneity, both in terms of functionality (e.g. mobility, mental stimulation, financial services) and in terms of industry (e.g. consumer electronics, automotive, banking).

Different countries undergo population aging at different times and with different magnitude. As some countries have experienced the phenomenon earlier than others, they have had more time to react and create innovations in response to it. This brings about the question of lead markets – country markets with “the characteristic that product or process innovation designs adopted early become the globally dominant design and supersede other innovation designs initially adopted or preferred by other countries” (Beise 2001, p.10). Do such lead markets exist within the field of age-based innovations? Moreover, is there possibly a single lead market which consistently leads adoption and diffusion across the heterogeneous range of age-based innovations? Finally, is extant lead market theory applicable to the entirety of age-based innovations – a field of business, where innovation is driven not only by profitability-focused stakeholders but also by a multitude of other stakeholders? These questions delineate a research gap at the intersection of lead market research and age-based innovations research. In order to answer them, a multi-methodology approach was adopted.

First, four case studies on the development, commercialization, and initial adoption were conducted (stair lifts, rollators, reverse mortgages, assistive social robots). Characteristic lead-market-lag-market patterns of innovation adoption could be demonstrated and lead markets identified. At the same time, evidence highlighted the diversity of lead markets within the different product and service categories, eliminating the possibility of a single lead market for all age-based innovations. Furthermore, an integrated analysis based on extant lead market theory and Beise’s system of lead market factors was carried out, highlighting country-specific differences in lead market potential for age-based innovations – with Japan, Germany, and the United States presenting the most favorable conditions for lead market development. This theory-driven analysis was complemented with an online survey addressing market participants and focusing on their perception of lead market location, underlying factors, and adjacent themes.

In the course of the study it became increasingly evident that extant lead market theory – almost exclusively relying on demand-side factors – would not adequately explain innovation adoption in a number of cases. In particular, highly age-specialized innovations appeared to be subject to additional influences. As a consequence, a typology of age-based innovations

¹ This working paper is based on the doctoral thesis “Lead Markets in Age-Based Innovations” by Nils Levsen, submitted at Hamburg University of Technology in 2014.

based on age specialization and technological development risk was derived. With the aid of an expert interview series it could be shown that different types of stakeholders drive innovation in the different quadrants of this typology – with immediate consequences on innovation adoption: Profit-focused companies frequently shun highly age-specialized products and services. Instead, user innovators and passionate innovators spearhead innovation – as long as technological risk remains relatively low. Highly age-specialized innovations with high technological risk are mainly developed through public intervention (e.g. publicly financed institutions or funding through public grants). Since, however, both stakeholder types in highly age-specialized innovations frequently lack capabilities (e.g. marketing and sales channels) or incentives (e.g. focus on domestic public needs) needed for swift international roll-out of their innovations, adoption and diffusion occurs much more domestically than extant lead market theory would suggest. This identification of two supply-side preconditions for theory applicability adds an important facet to lead market theory, likely relevant even beyond the field of age-based innovations.

Introduction

The population aging trend undergone by many advanced economies has been identified as a major demand driver and catalyst for age-based innovation². Evidence is abundant – and will be presented in the course of this study – that the sheer growth and affluence of elderly populations within these countries will lend increased commercial relevance to the development and commercialization of products and services designed to address their particular needs. Thus, there is a certain degree of timeliness to research into the diffusion of age-based innovations. From a managerial vantage point, understanding the significance and location of lead markets in this field may be a helpful piece of the puzzle, for instance for a company contemplating an expansion of its age-related business to capture opportunities based on positive growth prospects.

However, this strictly commercial and growth-minded approach that regards age-based innovations as a potentially promising opportunity to expand business does not convey the entire story of the development and diffusion of such innovations today and in the past. In fact, presuming markets for age-based innovations to be entirely driven by a dominant logic of a self-interested homo economicus – be it as a single businessman or in its various collective organizational forms, such as corporations – would miss important points. This is not to say that these motives and stakeholders bear little relevance in this field, in particular whenever age-based innovations augur adequate returns and risk appears manageable. Yet, throughout this study innovators that seem to be guided by motives other than immediate financial benefit come into view. This is especially true for those age-based product and service categories eschewed by more financially-driven stakeholders. Instead, both innovators guided by very personal and often altruistic intentions and innovators focusing on the greater public good and a country's social systems fill the gap left by the more profit-seeking and risk-wary entities.

² This effect has been subject to analysis on both a conceptual level (e.g. Kohlbacher, Herstatt 2011) as well as on the level of individual industries, for instance financial services (Mitchell et al. 2006), residential construction (Smith et al. 2008), and transportation (Alsnih, Hensher 2003).

These divergent groups of stakeholders involved in the innovation process of age-based products and services contrast both in their capabilities and in their incentives to achieve innovation diffusion on a national and international level. These differences directly influence at what time potential users in different geographies are presented with adoption opportunities, which, in turn, are prerequisites for lead market development³. Thus, a substantial share of this work is devoted to unraveling the effects of such atypical, not primarily financially-driven innovators on lead market emergence, shedding light on a yet unexplored aspect of lead market theory.

A two-pronged gap in extant research can be identified: From the vantage point of age-based innovation research there is gap with regard to understanding the international diffusion processes and lead markets within the particular product and service field. From a lead market theory standpoint little research has been conducted aimed at identifying the theory's limits of applicability and potentially existing boundary conditions for its valid use. In this theory-building effort the field of age-based innovations serves as an exemplary testing ground intended to permit the deriving of more universal conclusions about lead market theory irrespective of its future application domains.

Regarding the aspect of age-based innovation research, there is a rather complete dearth of lead market studies in this field within extant scientific literature. Understandably, one might argue that lead markets and international innovation diffusion is quite appropriately an uncharted area in a niche research field as modest as age-based innovations. After all, not every unexamined question requires examination. However, it appears that there is good reason for a closer investigation: After Drucker attested to population aging as a trend that drives innovation as early as 1985⁴ a modest but growing body of research on age-based innovations has started to accumulate. Many of these studies focused on two of the more pressing issues – the designing of suitable and effective products for the elderly on the one hand and addressing the manifold challenges in silver marketing⁵ on the other⁶. By contrast, country-specific demand side forces as determinants of successful innovation adoption went largely unstudied. However, actual use – and therefore adoption – of a novel product or service is a key element distinguishing an innovation from a mere invention (Roberts 2007). Thus, increasing the understanding of age-based innovation adoption is not only sensible in light of this segment's growing commercial relevance due to ongoing population aging but also in terms of a need for a scientifically more comprehensive view of the field. There may even be a rather philanthropic rationale for a study of lead markets in age-based innovations: Lead markets have been shown to yield superior innovation designs through intense design competition, weeding out inferior design alternatives (Beise 2001). In combination with lead markets' confirmed ability to facilitate international diffusion of their design choice (ibid.), a

³ It follows directly from Beise's work on lead markets that the opportunity to adopt an innovation – in other words its availability – is a requirement for lead market development (Beise 2001, 2004).

⁴ Drucker 1985, as cited in Narayanan, O'Connor 2010

⁵ Whenever the term "silver" (e.g. silver market, silver products, silver consumer) is used in this work, it respectfully refers to aged users rather than to the precious metal, semantically playing on both an age-related change in hair follicle pigmentation as well as on the business opportunities associated with population aging. This usage of the term has been adopted by numerous scholars in this field (e.g. "The Silver Market Phenomenon" (Kohlbacher, Herstatt 2011), "From Grey to Silver" (Kunisch et al. 2011)).

⁶ See for example Kohlbacher, Herstatt 2011.

better understanding of lead market location and underlying determinants may accelerate access to sophisticated age-based products and services for more elderly users worldwide, improving their individual autonomy and quality of life.

Regarding the theory-building aspect the field of age-based innovations shows some promise for the identification of boundary conditions in the applicability of lead market theory. The merits of lead market theory in explaining early adoption and subsequent international diffusion have been demonstrated in a number of case examples. However, little research has been conducted with regard to potential preconditions required for the applicability lead market theory. While it may be possible that these preconditions were implicitly met in extant case studies, it is equally possible that case examples where lead market theory did not yield expected results went underreported in scientific literature. Whatever the case, a comprehensive understanding of the conditions required for a theory to work and its limits in applicability are important insights and will aide in its practical application. The distinctive stakeholder structure involved in age-based innovation projects – including innovators as diverse as altruistic entrepreneurs as well as researchers financed by public funding – is partly a departure from more market- and profit-oriented industries, in which lead market theory has been repeatedly applied. Compared to the latter, innovators in the field of age-based innovation may differ both in their capabilities to serve international markets and in their incentives to do so. These special conditions on the supply side of innovation beg the question whether lead market theory remains applicable in such an environment – and how diffusion takes place in case it does not.

A number of structural and methodological aspects require consideration before selecting an approach to investigate the research gap of lead markets in age-based innovations. This work seeks to address a range of several research questions, some of them rather in line with extant lead market research, yet others quite explorative in nature. Therefore, this work is structured into a number of research packages, each conceived to address a particular facet and employing a methodology suited to do so. As a consequence, multiple methodologies have been used within the overall investigation. The employed methodologies vary in their reliance on primary or secondary data, a more broadly or narrowly defined analytical focus, and – where empirical data collection is concerned – in the number of participants and the richness of gathered information. To the knowledge of the author, this is the first work to adopt an integrated approach of applying lead market theory to a group of innovations⁷, which is quite diverse along multiple dimensions: While all being aimed at elderly users, age-based innovations may differ radically in functionality and technical sophistication, are developed and manufactured within different industries, and include both products and services. As a consequence of this heterogeneity, some countries may exhibit demand conditions that are conducive to the adoption of certain age-based innovations and at the same time detrimental for others. This adds to the complexity of the task and to the explorative nature of this work.

⁷ There have been previous studies (e.g. Beise, Rennings 2005) focusing on different innovations under a common theme. However, these were not integrated in the sense of attempting to identify a lead market for the entire group of innovations.

On a final note of this introduction, this study – as any piece of research verging on gerontological themes – is subject to a number of general pitfalls prevailing in this research field. First, neither do age-associated effects affect human beings in a homogenous manner, nor do all of them necessarily occur in every individual (Kohlbacher et al. 2011). Age-associated effects on the human body may appear at different ages and reach different degrees of severity; singular events may contrast with more steady effects, and dissimilar combinations of age-associated effects may impinge upon different individuals (ibid.). Therefore, any line of reasoning based on individual cases of elderly human beings is greatly impeded. Second, terms, such as “elderly”, “aged”, or “of high age” may refer to considerably different chronological ages in different regions and countries, depending on context factors (e.g. average life expectancy, legally mandated retirement age)⁸. Thus, any analysis of a country’s exposure to population aging is foremost a longitudinal exercise, and comparisons between countries of different development status (e.g. OECD countries vs. developing countries) will in all likelihood be misleading. Finally, it may be tempting to conduct comparative analyses on a multitude of dimensions between younger and older demographic groups – and results will often yield stark differences. However, careful differentiation between correlation and causality should be exercised; while age correlates with many socio-demographic variables (e.g. income, wealth, level of education) the number of causal relationships between age and other variables is much more limited⁹.

Research Questions

In an attempt to comprehensively investigate the research field, the following five research questions were addressed in the doctoral thesis:

- RQ 1: Do lead markets exist within the field of age-based innovations?
- RQ 2: Is there a single lead market for all age-based innovations or do various countries take lead market roles in the different product and service categories within this field?
- RQ 3: Which countries are at present most likely to become lead markets for age-based innovations and for what reasons?
- RQ 4: Which countries do providers of age-based innovations identify as lead markets and to which factors do they attribute lead market development?
- RQ 5: Is extant lead market theory applicable to the entire field of age-based innovations and sufficient to explain lead market location, or which additional explanations are necessary in order to explain lead market development given the market conditions in this field?

⁸ By country, life expectancies at birth ranged from 44.0 years (Sierra Leone) to 82.7 years (Japan) in the 2005-2010 period, indicating the wide range of meanings of “high age” (United Nations, Department of Economic and Social Affairs 2013).

⁹ This differentiation between causality and correlation is not of purely scholarly interest but may have grave consequences in elderly people’s daily lives. Several researchers consider the “social construction” (Kelley-Moore 2010, p. 96) of – as they argue, factually non-existent – causal relationships between advanced age and other variables as a form of discrimination (ageism). Examples include the purported relationship of aging and disability (Kelley-Moore 2010) and the one between aging and declining workplace performance (Rupp et al. 2006).

Phenomenological Background: Lead Markets

Lead market theory has been preceded by at least three major ancestral strands of research. First, lead market theory integrates findings about competition for adoption between alternative technologies and the concept of a dominant design, pioneered by Abernathy and Utterback (Abernathy, Utterback 1978). Second, it is connected with earlier research into country-specific innovation systems and international diffusion of innovations. Third, lead market theory relates to research into the internationalization of R&D and the geographic allocation of resources necessary for innovation.

In 2001, German researcher Marian Beise published seminal work on lead markets, integrating previous research into design competition, international diffusion, and the relevance of geographic choices for innovating companies (Beise 2001)¹⁰. After integrating previous definition attempts into a now widely accepted lead market definition he went on to formalize country-specific market conditions relevant for innovation diffusion into a set of lead market factors. His work includes an extensive case study in the field of cellular telephony that offers empirical evidence for this approach. Furthermore, Beise expounded his thinking on the identification and forecasting of lead markets. Beise defined lead markets as having “the characteristic that product or process innovation designs adopted early become the globally dominant design and supersede other innovation designs initially adopted or preferred by other countries” (Beise 2001, p. 10). Therefore, Beise took a strictly demand-oriented view that focuses on the location of adoption rather than the origin of an innovation. Moreover, he was relatively specific in that he prioritizes adoption – a measurable variable – over previous, potentially less definite demand-oriented concepts, such as the “stimuli” proposed by Bartlett (Bartlett, Ghoshal 1990). This lead market definition put forward by Beise will be used in the context of this work.

While demand-centered approaches to understanding innovation diffusion may possibly appear unexceptional today, it should be pointed out that this view was a departure from an earlier, supply-centered paradigm. Previous scholars had frequently attributed country differences in innovativeness and innovation diffusion to differences in the availability of technological and scientific capabilities – in other words, differences in supply-side capabilities¹¹. Beise’s focus on demand conditions was not only reflected in the lead market definition but also in his subsequent description of lead market factors (Beise 2001, pp. 84–108), which almost exclusively relate to demand characteristics of a market rather than capabilities of the supplying parties (e.g. number of engineers and researchers, proprietary knowledge, organizational setup of innovating companies).

In the 2001 publication Beise ascribed the development of lead markets to five country-specific lead market factors¹², which in turn rely on the country’s socio-political, ecological, and cultural system. In addition, he acknowledged the roles of additional influences for lead market development: factor conditions, supporting industries, research infrastructure, and –

¹⁰ There are earlier contributions by Beise on the topic of lead markets (e.g. Beise, Belitz 1998; Beise 1999), however, not nearly as comprehensive.

¹¹ See e.g. Posner 1961 and Hufbauer 1966, as cited in Beise 2001.

¹² Demand advantage, price advantage, transfer advantage, export advantage, and market structure advantage

last but not least – chance (Beise 2001)¹³. Each of the five lead market factors includes a range of sub-factors; in fact, Beise initially referred to lead market factors as “groups of nation-specific characteristics” (Beise 2001, p. 84), accentuating their collective nature.

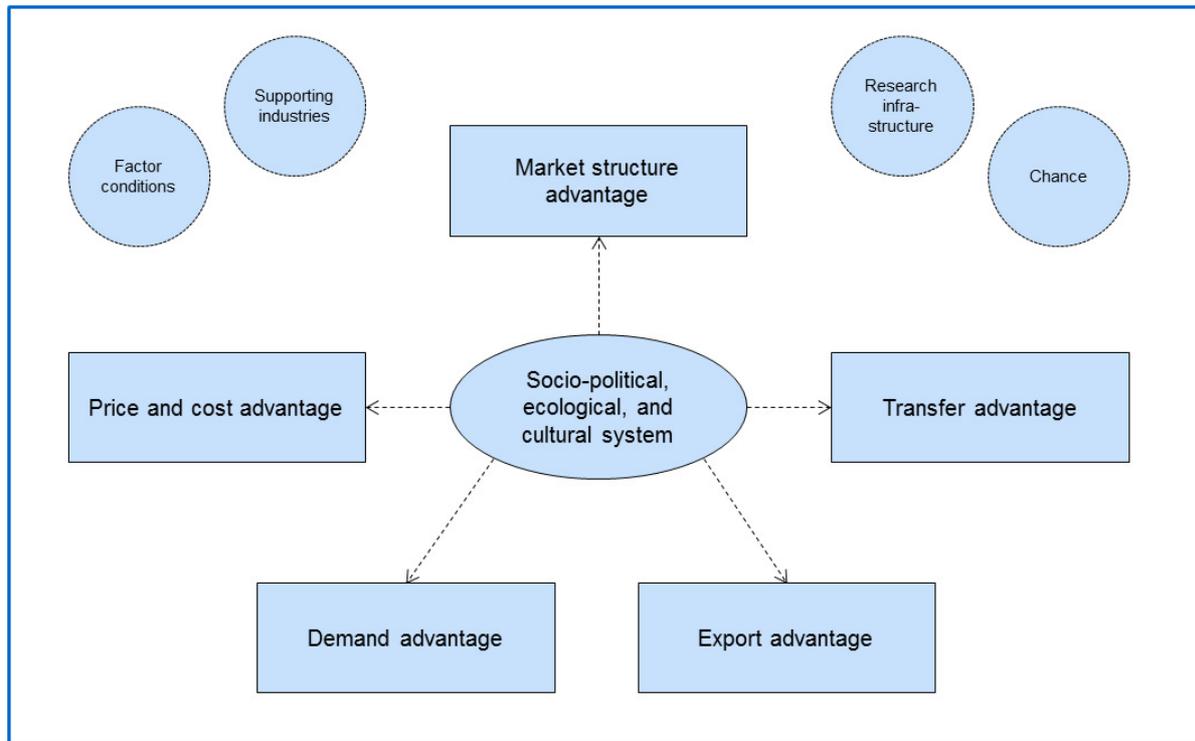


Figure 1: Overview of lead market factors and related factors of national competitiveness¹⁴

Phenomenological Background: Aging and Age-Based Innovations

Based on Boehm et al., demographic change refers to the ongoing “historically unprecedented demographic transition that is having – and will have – profound effects on our population’s size and age structure” (Boehm et al. 2011, p. 3). Taking a very long-term perspective the United Nations expect the share of the world population of people 60 years or older to increase from 11% in 2010 to 21% in 2050 (United Nations, Department of Economic and Social Affairs 2013). Demographic change has three separate antecedents – increases in life expectancy, reductions in fertility rate, and changes in migration rate. Population aging and population decline are direct effects of demographic change (Boehm et al. 2011).

Demand advantage as a lead market factor is closely linked to exogenous trends “in which specific innovations become increasingly beneficial or preferable in most countries” (Beise, Cleff 2004, p. 13). Demographic change has three characteristics that make it a potential candidate for the occurrence of a demand advantage. First, it is an exogenous trend with an effect on demand. Due to changing needs and possibilities aged people partly require different products and services (e.g. mobility helps, such as rollators) compared to younger people (Fisk et al. 2009). Thus, if an increasing share of the population is made up of aged people,

¹³ Beise is not unambiguously clear with regard to the impact of these four elements on lead market development. Although he introduces these elements early on in his publication, subsequent chapters focusing on lead market identification and lead market forecasting appear to heavily rely on the five lead market factors and less so on these four additional elements.

¹⁴ Beise 2001, p. 85. Caption of figure provided as in original source.

this will subsequently cause shifts in demand toward products and service responding to older people's needs and preferences. Second, demographic change is a global trend that will affect most countries (Henseke 2011). This is a key element for the development of a demand advantage. If an exogenous trend only affects one or very few countries, innovation activity might very well result as a response. However, if this underlying trend were not to spread to other countries, the very demand conditions that stimulated these innovations in the first place would likely not spread either. As a result, innovations optimized for the needs and preferences of the one – or the few – countries affected by the trend would not be suited to the demand conditions in other countries, rendering the innovations idiosyncratic (cf. Beise 2001, p. 12). Third, demographic change has been affecting and will continue to affect different countries at different times and with different intensities, creating a delay between countries exposed to it earlier and other countries exposed later (United Nations, Department of Economic and Social Affairs 2013)¹⁵. This time delay presents an opportunity for customers in the countries that feel the effects of the trend early: They have lead time to try out different innovation designs as well as gain experience and sophistication – creating the kind of advanced and demanding customer group that drives further innovation in this market and thus contributes to the country's demand advantage (Beise 2001).

Already having used the term age-based innovation a number of times at this point, it requires closer attention in order to create a shared understanding of what this term shall mean throughout this document, summed up in the following working definition: “*Age-based innovations are products and services developed and marketed taking into account needs and preferences of people of old age*” (Iffländer et al. 2012). The concept of age-based innovations is rather abstract, combining the intangible ideas of age and of innovation. One possible view on age-based innovations is that of products and services for sustaining and regaining individual (or personal) autonomy¹⁶ (Ford et al. 2000; Randers, Mattiasson 2003; Kohlbacher et al. 2011). Human beings lose parts of their individual autonomy with advancing age in a more or less continuous manner, as physical and mental decline increasingly limit independent and self-governed living (Kohlbacher et al. 2011). Age-based innovations, irrespective of form and specific application, are indeed mainly designed to either slow this process or reverse some elements of it: A rollator (re-)allows mobility for many aged people otherwise facing trouble walking. A reverse mortgage (re-)endows aged people with financial flexibility, many of whom have a high share of illiquid assets otherwise¹⁷. Age-based innovations share a number of special characteristics:

¹⁵ An example of a trend that affects countries virtually without delay would be a price change of a globally traded commodity – market prices around the world align near instantly due to electronic trading.

¹⁶ While the term autonomy is used in a multitude of medical, legal, philosophical, social, and political contexts with various nuances in meaning, the essential underlying concept is that of self-governance (cf. Stanford University 2009).

¹⁷ The individual autonomy concept for age-based innovation has its merits as it provides one possible starting point for a systematic scanning for unmet needs and then developing and implementing age-based innovations. However, even this concept may be a bit vague when delineating age-based from other non-age-based innovations: Do not many of them also increase individual autonomy? One may argue that many innovations, for example in mobility (e.g. cars) and communications (e.g. cell phones), increase individual autonomy irrespective of user age; traveling fast or communicating across great distances clearly increases autonomy irrespective of user age.

- Age-based innovations may essentially draw on three different design approaches (Kohlbacher et al. 2011): Creating wholly new goods *designed for age (DFA)*¹⁸, adapting existing goods in a way that makes them more suitable or attractive for aged persons (*adapted for age, AFA*)¹⁹, or incorporating design principles of universal design²⁰, making them *independent of age (IOA)*²¹.
- Many age-based innovations are not exclusively for the elderly, further blurring the line between age-based and other innovations (cf. Kohlbacher et al. 2011). One reason for this is the functional proximity of many age-based innovations to medical and health products. Many diseases (e.g. musculoskeletal, sensory health problems) and handicaps foreshadow physical or mental limitations that are for most people only associated with old age (cf. the study on disabled people as potential lead users for age-based innovations by Helminen 2011).
- Distinct marketing and advertising requirements of age-based innovations are another special characteristic. Age perceptions of seniors are typically 8-12 years below their chronological age (Kohlbacher, Chéron 2012) and there is strong identification with persons that are about that much younger (Kohlbacher et al. 2010).
- Split roles between buyer and user are a further marketing- and sales-related peculiarity of age-based innovations, where product selection and buying decision is not controlled by the user in many cases, but may rather lie with third parties, such as institutional buyers (e.g. nursing homes) (Kohlbacher, Herstatt 2011)²².

Despite these shared characteristics age-based innovations remain a category with a high level of internal heterogeneity by at least two dimensions. In the first dimension, there is heterogeneity of products and services: The wide variety of products and services spans an enormous range of functional applications. They are most diverse in appearance and marketed through various sales channels – defying many traditional typologies of a product or service category definition. Different companies from various sectors of the economy provide them. In the second dimension, there is substantial heterogeneity with respect to target groups – not only in terms of potential age sub-categories such as the “young old” and the “very old”²³ but also in other terms, e.g. health condition, financial status, and personal values (cf. Kohlbacher, Chéron 2012): While advanced age is a common denominator, there may be marked differences in product and service design for the “old, rich and healthy” compared to the “old, poor and sick” (Kohlbacher 2011, p. 293).

¹⁸ Termed “new silver product” by Kohlbacher et al. (Kohlbacher et al. 2011, p. 5)

¹⁹ Termed “adapted silver product” by Kohlbacher et al. (Kohlbacher et al. 2011, p. 5)

²⁰ US architect Ron Mace pioneered universal design. In fact, universal design encompasses more than age-invariant usability but rather describes “the concept of designing all products and the built environment to be aesthetic and usable to the greatest extent possible by everyone, regardless of their age, ability, or status in life” North Carolina State University n.d.. Initial publications regarding the universal design concept focused mainly on housing and architecture rather than consumer products (e.g. Mace 1976)

²¹ Termed “ageless/agenneutral product” by Kohlbacher et al. (Kohlbacher et al. 2011, p. 5)

²² Kohlbacher and Herstatt mainly differentiate between customer and user: “...to ensure adequate and early integration of representatives (customers and users)...” (Kohlbacher, Herstatt 2011, p. viii). There may in fact be more parties involved in different parts of the purchasing process, e.g. insurance for financing and a physician for a prescription. Implications for product development can be far-reaching – a cost-conscious insurance company may have different design preferences for an age-based product than a comfort-oriented user.

²³ Identified by Tesch-Römer, Wurm 2009 as 65 to below 85 years (young old) and 85 years and above (very old)

Multi-methodological Research Approach

A multi-methodological approach was adopted to address the five research questions (Figure 2). A series of four case studies was followed by a theory-driven integrated analysis of different countries' lead market characteristics. This was then complemented by an empirical market participant study, capturing their views of lead market existence, location, and underlying factors. Based on these three elements, intermediate results were documented and propositions with regard to RQ5 – the applicability of lead market theory in the field – were developed. Finally, these propositions were tested in a second empirical study, an expert interview series.

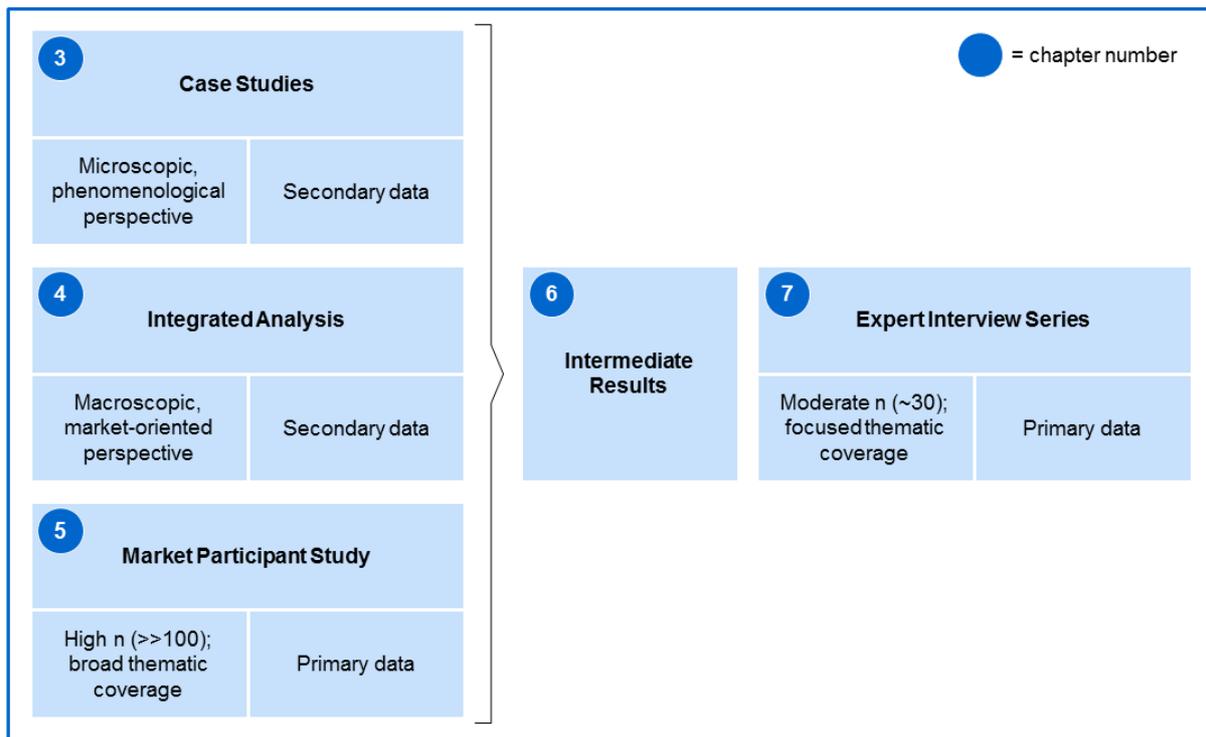


Figure 2: Structure and selected methodological characteristics of main research chapters

Case Studies

A series of four case studies regarding innovation development, commercialization, and initial adoption was conducted. These case studies were aimed at answering RQ1 (lead market existence) and RQ2 (single lead market for all age-based innovations). Each case study analysis included three main elements (Figure 3). First, the investigated product or service category was briefly introduced and the age-based character of the respective innovation explained. Second, a chronological timeline detailed the events relating to the development of the innovation, its first commercialization, and the initial phase of adoption and diffusion. This timeline represented a fact base for subsequent analysis. Third, innovation adoption and diffusion patterns were analyzed and observations were documented, the leading and lagging roles of different country markets discussed, and conclusions with regard to lead market location drawn.

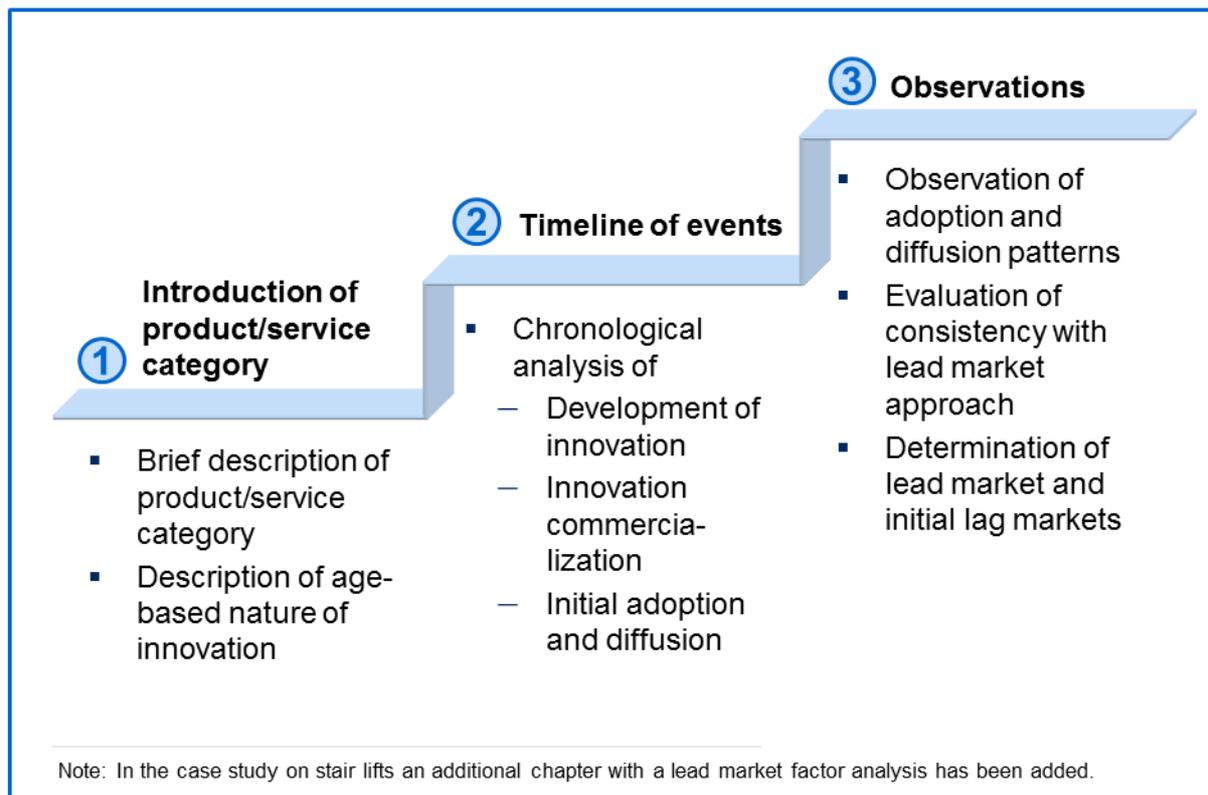


Figure 3: Case study analysis structure

Four age-based product and service categories were selected for case study research – stair lifts, rollators, reverse mortgages, and assistive social robots. The selection of product and service categories for the case studies followed a number of criteria. First, it was necessary to focus on categories clearly addressing the needs of elderly people without substantial numbers of non-elderly users. The non-elderlies' adoption behavior might have been different from the elderlies', thus potentially diluting any line of reasoning. Second, different branches of industry had to be included in order to achieve a modicum of representativeness of the industrial diversity found within age-based innovations. For the same reason, both products and services needed to be included. Finally, the analyzed innovations had to fulfill different functions from a user perspective (e.g. mobility, financial liquidity, care) in order to account for the wide range of functional applications found in age-based innovations.

Category	Function / benefit	Product or service	First available
Stair Lifts	Indoor mobility	Product	1920s
Rollators	Outdoor mobility ²⁴	Product	1970s
Reverse Mortgages	Financial liquidity	Service	1930s
Assistive Social Robots	Social interaction and mental stimulation	Product	2000s

Table 1: Diversity in product and service category selection for case study research

In the three case studies about stair lifts, rollators, and reverse mortgages lead market existence could be shown²⁵ – not only were there characteristic country-specific delays in

²⁴ There are, however, also some rollators designed for indoor use available, e.g. Schulte Haus-Rollator (Schulte Holzprodukte GmbH 2013).

²⁵ Stair lifts: lead market United States; rollators: lead market central Scandinavia (Sweden, Norway); reverse mortgages: lead market United Kingdom

adoption and diffusion but also the spreading of lead market designs into the lag countries with no or minimal design alteration. At times, this spread occurred through actual exports (e.g. Scandinavian rollators to other European countries). In other instances, the spreading of a lead market design occurred through knowledge transfer and local product reproduction within the lag markets, as in the case of stair lifts. For assistive social robots – the most recent of innovations investigated within the case studies – evidence of lead market existence is still scarce due to the early stage of commercialization. As assistive social robots for elderly care have only recently left the stage of purely scientific research and begun to enter the stage of commercialization, Japan appears a likely candidate for future lead market, but evidence remains inconclusive²⁶. All in all, the case studies demonstrated that lead markets do exist for individual product and service categories within age-based innovations. At the same time, however, the cases underscored the diversity of lead markets for different age-based innovations: Taking just the three instances of stair lifts, rollators, and reverse mortgages out of the innumerable existing age-based product and service categories, it can be asserted that three different country markets took lead market roles. Even though no clear lead market emergence could be documented for the assistive social robots at this time, most evidence points to yet another lead market country. Therefore, it is necessary to conclude that there is no single country that takes a universal lead market role across the entirety of age-based innovations.

Integrated Analysis

In order to address RQ3, country-specific advantages with regard to lead market development have been systematically identified, analyzed, and compared between countries. The central objective of this analysis has been the identification of the country or the countries, which are best positioned to take on a lead market role in the adoption and diffusion process of age-based innovations based on extant lead market theory. The analytic approach has adhered closely to Beise's system of lead market factors – demand advantage, price advantage, transfer advantage, export advantage, and market structure advantage. Country results for the five lead market factors have been summarized in Figure 4. An integrated analytic approach has been adopted, arguing on the level of age-based innovations as a whole rather than on the level of individual products and services. Three out of the five lead market factors – demand advantage, price advantage, and export advantage – could be analyzed on this aggregate level to yield meaningful country-specific results, representing strong or moderate country-specific advantages. The analysis of transfer advantage has only provided a directional result, pointing toward a group of countries. Market structure advantage did not yield results of informative value on the aggregated level of analysis.

One country, Japan, benefits from strong country-specific advantages across the three lead market factors demand-, price-, and export advantage. In other words, Japan is a country at the forefront of the population aging trend while, at the same time, being a large and income-rich market with a strong export orientation. The directional result of transfer advantage also points to Japan as one of the largest economies in the OECD, suggesting that product

²⁶ This is in line with the Kohlbacher's findings as of 2012: "Japan has potential to become lead market for care-robots – at least on the level of products/individual solutions, but (despite) demand advantage no lead market yet" (Kohlbacher 2012, p. 20).

adoptions in Japan will receive a high level of international attention. Two countries, the United States and Germany, benefit from strong country-specific advantages with regard to two lead market factors each. Germany benefits strongly in terms of demand advantage and export advantage, representing the country's early exposure to population aging and the export orientation of its economy. Moreover, Germany benefits moderately in terms of price advantage, representing its significant market potential and market growth in age-based innovations. The United States benefit strongly from price advantage and export advantage, indicating their large and growing market potential for age-based innovations as well as their strong involvement in the export of goods and services. Both Germany and the US benefit directionally from transfer advantage due to the disproportionately high media attention bestowed upon large OECD countries. However, the United States are conspicuously missing in the demand advantage category: The US will experience population aging with notable time delay compared to other countries, having a significantly younger population than Japan and a number of European countries. In 2010, the median age of the US population was 37.1 years, 7.2 and 7.8 years lower than the median population ages of Germany and Japan respectively (United Nations, Department of Economic and Social Affairs 2012). Whereas in the year 2010 Japan and Germany were ranked first and second place in terms of highest median population age, the US were only ranked 53rd (ibid.), underscoring how much less the US remain currently affected by population aging. Thus, it appears necessary to remove the United States from the list of countries with the highest lead market probability for age-based innovations, reducing it to Japan and Germany. While the Asian island nation appears to have a slight advantage over Germany, the significance of this supposed lead remains debatable, given the overall probabilistic nature of the concept of lead market potential.

	<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="width: 15px; height: 15px; background-color: #1a3d4d; margin-right: 5px;"></div> Strong country-specific advantage <div style="width: 15px; height: 15px; background-color: #0070c0; margin-left: 20px; margin-right: 5px;"></div> Moderate country-specific advantage </div>		
Demand advantage	Germany	Austria	Portugal
	Japan	Greece	Spain
		Italy	Switzerland
		Netherlands	
Price advantage	Japan	China	Italy
	United States	Germany	
Transfer advantage	<ul style="list-style-type: none"> ▪ Limited country-specific advantages on aggregate level across age-based innovations ▪ Large OECD economies, China, and Russia with moderate advantage on international demonstration effect 		
Export advantage	Germany	China	Singapore
	Japan	France	
	United States	Netherlands	
Market structure advantage	<ul style="list-style-type: none"> ▪ Limited country-specific advantages on aggregate level across age-based innovations 		

Figure 4: Country-specific lead market advantages for age-based innovations

Market Participant Study

The market participant study addressed RQ4, investigating the views that market participants in the field of age-based innovations take on lead markets: Are lead markets in age-based innovations an academic concept only or do market participants also perceive country-specific differences and cross-national diffusion patterns? And if so, which factors do market participants perceive as drivers of this phenomenon? Are there specific countries that are consistently perceived as leaders in adoption and diffusion or do country roles of leader and laggard change? Do common factors drive lead market development for the entire class of age-based innovations or are there noticeable differences between the diverse products and services covered by this term? To date, lead market research has methodologically been largely relying on two types of investigations – first, the study of longitudinal adoption and diffusion patterns based on sales data and second, the analysis of lead market potentials for individual innovation commercialization projects. To the author’s knowledge, there is no study available that addresses a larger number of market participants in order to inquire about their awareness of lead markets and underlying lead market factors. However, such an

approach seems necessary, since only the market participants' awareness of lead markets offers them the opportunity to adjust their innovation management activities in order to reap benefits from prevailing lead market patterns.

In order to address a large number of potential participants from different geographic locations, facilitate study participation, and collect answers in a standardized and comparable manner an online survey²⁷ was chosen to implement the market participant study (Punch 2005; Sekaran, Bougie 2010). In order to account for the diversity of the field of age-based innovations, the online survey incorporated a multi-category approach with six different product and service categories, creating the opportunity to analyze similarities and differences between various age-based products and services. Selection of product and service categories was guided by the following criteria:

- Products and services: Consideration of both age-based product and service innovations
- Diverse industries: Consideration of diverse branches of industries (e.g. health care, financial services, consumer goods, personal services)
- Distinct age element: Focus on products and services with a distinct age element rather than those with appeal to a wide range of age groups in order to ensure a close link to market demand from aged customers and avoid "noise" from non-aged customers

Therefore, the following six categories were selected:

- *Assisted travel*: Travel arrangements for elderly customers that include the availability of a physician or paramedic throughout journey and stay
- *Special furniture*: Furniture as well as kitchen and bath fixtures designed to meet the needs and physical limitations of elderly people
- *Stair lifts*: Electrical devices to help elderly people cope with stairs
- *Rollators*: Wheeled walking frames to help elderly people walking
- *Reverse mortgages*: Financial services designed to allow elderly people swap their housing assets in return for increased liquidity
- *Telecare*: Remote services (e.g. daily check-ins, emergency calling services) for elderly people via telecommunications

In total, the market participant study included 41 questions covering six content sections (e.g. lead market location, underlying drivers, customers and innovation, sales and distribution). By the time of the closing of the survey, a total of 213 participants had taken part, representing an overall response rate of 7.3% based on 2,928 survey invitees.

In the following, selected results of the market participant study are presented. Participants mostly agreed with the international spreading of trends and product innovations (Q1, 70% agreement) and with the international diffusion of successful product models (Q2, 69%

²⁷ Also referred to as internet survey (Punch 2005)

agreement). In both cases, however, there are substantial differences in agreement between the different categories: While internationality is well supported for assisted travel, rollators, stair lifts, and telecare this seems to be less the case with reverse mortgages. Special furniture is left in the middle with a majority affirming internationality of trends but not so with international adoption of successful product models. Across all categories, there is broad support for country differences in product acceptance and demand between different countries (Q3, 94% total agreement, no category below 91% agreement).

Question Item	Total	Assisted Travel	Reverse Mortgages	Rollators	Special Furniture	Stair Lifts	Telecare
n =	213	16	15	79	10	39	54
Q1: Internationality of product trends / innovations	70%	84%	47%	71%	60%	76%	65%
Q2: International diffusion of successful products	69%	88%	45%	73%	44%	81%	56%
Q3: Differences in product acceptance and demand	94%	100%	100%	91%	92%	94%	94%

Table 2: Participant agreement with Likert scale items in first section of market participant study

All three items in this first section are important prerequisites for functioning lead markets – the differences in product acceptance and demand creating a gradient between countries which can be leveled over time by the international diffusion of successful product designs, resulting in a hallmark lead-lag-pattern. There is broad agreement (Q4, overall agreement 85%, no category below 69%) that specific countries are repeatedly (“usually”) the first to adopt new trends and innovations.

Question Item	Total	Assisted Travel	Reverse Mortgages	Rollators	Special Furniture	Stair Lifts	Telecare
n =	197	15	15	72	10	35	50
Q4: Specific countries usually leading adoption	85%	71%	93%	87%	92%	69%	95%

Table 3: Participant agreement with Likert scale items in second section of market participant study

In the following, results of the question item regarding perceived lead market location are listed per product and service category:

- In the survey version on assisted travel 47% of respondents (n = 15) indicated Germany as the lead market, followed by the United States (13%). Six other countries²⁸ each received one vote.
- In the survey version on reverse mortgages 87% of participants (n = 15) selected the United States as lead market location, leaving 13% to two other countries²⁹.
- In the survey version on rollators a total of 57% of participants (n = 72) indicated Central Scandinavia – either Norway (31%) or Sweden (26%) – as lead market

²⁸ Albania, Austria, Brunei, Denmark, Finland, and Greece (6.7% each)

²⁹ Angola and Brazil (6.7% each)

location³⁰. 29% selected Germany and 8% chose the Netherlands, leaving 6% to three other countries³¹.

- In the survey version on special furniture 30% of respondents (n = 10) saw Germany as lead market, followed by Sweden (20%) and five other countries³².
- In the survey version on stair lifts 43% of participants (n = 35) indicated Germany as perceived lead market, closely followed by the United Kingdom (40%). Other countries mentioned include the Netherlands, the United States (6% each), and Switzerland (3%)³³.
- In the survey version on telecare 26% of respondents (n = 50) selected the United States as lead market, closely followed by the United Kingdom and Germany (24% each). Sweden reached 8% of votes. The remaining votes were split between six countries³⁴.

Among factors perceived as contributing to lead market location, market size, and customer sophistication garnered most agreement by study participants, attaining 89% and 86% agreement respectively. Support for market size as a determining factor is particularly evenly spread across categories with no category reaching less than 85% agreement.

Intermediate Results and Typology of Age-Based Innovations

At this point, research on the early adoption of age-based innovations had not only demonstrated the vast diversity of products and services in this field but also great differences with regard to the lead market locations and the underlying drivers for lead market development. Nevertheless, a number of recurring observations appeared to emerge with regard to country-specific early adoption patterns. As, however, these observations seemed to be limited to particular sets of age-based innovations, it was necessary to create sub-groups in a way that gives proper consideration to these limitations. Therefore, before describing observed phenomena in early adoption and lead market development, a typology of age-based innovations has been introduced.

There are numerous established frameworks to differentiate between different types of innovations, e.g. product vs. process innovations (Utterback, Abernathy 1975), competency-enhancing vs. competency-destroying innovations (Anderson, Tushman 1990), innovations that sustain existing businesses vs. those that disrupt them (Christensen 2000), and the concept of architectural innovation (Henderson, Clark 1990). The typology introduced in the following is not an attempt to compete with any of these frameworks but should rather be

³⁰ Votes have been combined for Sweden and Norway in the light of the results of the prior case study on rollators. The thought of a combined view of Scandinavia as rollator lead market was also explicitly stated by one study participant.

³¹ United States (2.8%), Denmark, and Switzerland (1.4% each)

³² Denmark, Japan, Netherlands, United Kingdom, United States (10% each)

³³ One vote for Afghanistan has been deleted during data cleaning. Afghanistan was the top item in the drop down menu of the survey. Given this fact and the major technological lag of Afghanistan compared to other countries it can be inferred that the study participant did not know how to properly operate the menu and did not mean to indicate Afghanistan.

³⁴ Denmark, France, India, Japan, New Zealand, and Norway (2% each); two countries were excluded during data cleaning (Afghanistan, Saint Kitts/Nevis).

understood as one way of sorting age-based innovations into different sub-groups that may help understand observed patterns in early adoption. Therefore, the proposed typology is designed to differentiate between sub-groups of age-based innovations that behave – in the context of early adoption – in an externally heterogeneous and internally homogeneous fashion. It is important to emphasize that the mere grouping of age-based innovations does not make any – potentially unfounded – predictions about their characteristics but simply arranges them in a way that facilitates further research.

For our purposes, age-based innovations have been differentiated along two dimensions. The first dimension is labeled “technical risk / R&D funding requirements”. It represents the research and development costs of inventing and commercializing an age-based innovation and the risk of failure due to technical shortcomings. The second dimension is labeled “age specialization of innovation”. Age-based innovations cover an extreme breadth in this dimension, ranging from products and services that do not even reveal their age-friendly design and seem to appeal to consumers of all ages to products and services that are distinctly and noticeably only designed for aging users.

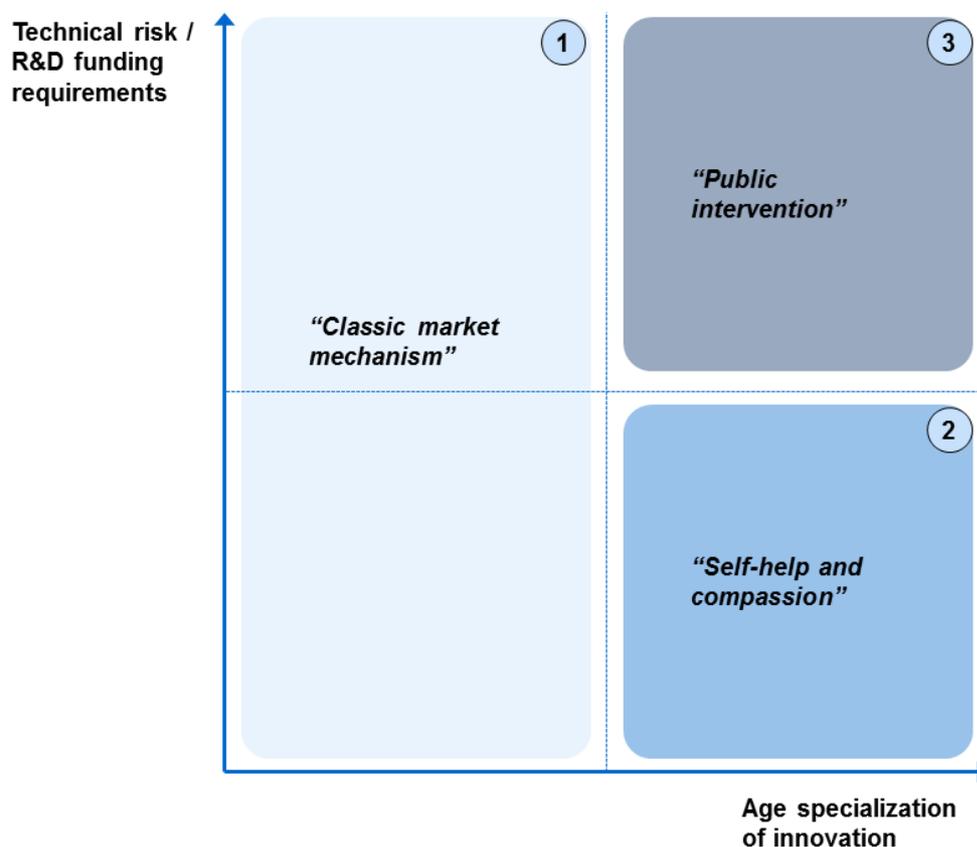


Figure 5: Conceptual typology of age-based innovations by early adoption characteristics

Given these two dimensions, three sub-groups of age-based innovations have been established based on the working hypothesis that age-based innovations within each of these sub-groups share commonalities with regard to early adoption and lead market development (Figure 5). Sub-group 1 covers the two quadrants of innovations with low age specialization and will, for now, be called “classic market mechanism”. Sub-group 2 covers the bottom right quadrant with low to moderate technical risk / R&D funding requirements and moderate to high age

specialization and will be titled “self-help and compassion”. Sub-group 3 covers the remaining quadrant of moderate to high age specialization and moderate to high technical risk / R&D funding requirements and has been labeled “public intervention”.

The “classic market mechanism” sub-group comprises age-based innovations with all levels of technical risk and equally diverse R&D funding requirements. Products and services in this sub-group are rather similar to non-age-based consumer products in appearance and functionality. Many of the innovation designs in this sub-group have been designed for use independent of age – appealing to users of most ages – or have been unobtrusively adapted so as to ensure age-friendliness. From a user perspective, there are two direct consequences of this similarity to non-age-based consumer goods: First, the elderly users’ potential autonomy enhancement derived from the use of these innovations is somewhat limited, although it can be expected to be higher than that derived from a non-age-based product. Therefore, these innovations target aging customers that still command a relatively high level of autonomy. Second, visual similarity with other consumer products and services conceals the age-based nature of the innovation (e.g. marketing age-based product characteristics as “comfort features”), reducing potential risks of age stigmatization for the user. From a provider perspective, low age specialization offers the benefit that existing advertising and sales channels may in many cases be used for communication and distribution. Moreover, experience from related non-age-based innovations may serve as a guiding post to the provider in order to forecast profitability and risk. Therefore, this sub-group of age-based innovations offers ample business opportunities for private and corporate for-profit innovators that seek a calculable return on their investment. Examples of age-based innovations in this sub-group include cell phones designed for elderly people, age-friendly cars (e.g. the Volkswagen Golf Plus³⁵), and travel offers for elderly people that feature the availability of a medic throughout the journey.

The sub-group termed “self-help and compassion” is characterized by innovations with moderate to high age specialization. In other words, products and services in this sub-group differ strongly from non-age-based consumer products in appearance, functionality, or both. They are designed to clearly appeal to aged users and would not be purchased and used by users without age-associated deficiencies in individual autonomy³⁶. From a user perspective, innovations in this sub-group typically offer moderate to high benefits in sustaining or restoring individual autonomy, providing significantly higher advantages than non-age-based consumer products. As a consequence, these innovations mainly target users that have already suffered from a substantial age-associated decline in individual autonomy. Furthermore, the strong autonomy enhancement of these innovations often means that the age-friendly nature is very conspicuous, creating potential stigmatization risks for the user – users without deficiencies in individual autonomy would likely not use these innovations. In a way, autonomy-enhancing innovations with high age specialization may be perceived as negative status symbols, as they reveal their users’ impaired individual autonomy. From a commercial

³⁵ During the first half of 2011, 69% of Golf Plus models sold in Germany were bought by persons above the age of 60 (Senioren kaufen VW und Mercedes 2011).

³⁶ In some cases, non-aged users whose individual autonomy is otherwise reduced (e.g. disabled people) may also use these innovations. Cf. Helminen 2011.

perspective, innovations in this sub-group offer several major challenges. Relevant users can be very hard to reach through conventional advertising and communication channels due to their advanced autonomy decline (e.g. mobility, senses, or cognitive capabilities)³⁷. Distribution via regular consumer goods channels may be significantly restricted due limited market size, a costly and difficult sales process, and the innovations' non-prestigious appearance. In the light of these commercial challenges, this sub-group is of limited attractiveness for purely profit-seeking innovators. Instead, many innovators derive non-financial benefits – either as self-helping user innovators³⁸ to address their very own needs and problems or as “compassionate” innovators innovating for loved ones. As a consequence, however, technical complexity of these innovations is limited, because these types of innovators rarely command large R&D budgets. Example innovations from this sub-group are rollators, stair lifts, and reverse mortgages.

The sub-group “public intervention” covers the top-right quadrant of moderate to high technical risk and R&D funding requirements and moderate to high age specialization. In other words, innovations in this sub-group may be quite radically new both from a technical and a commercial perspective, potentially requiring not only substantial R&D efforts but also the development of a suitable business model for innovation commercialization. Similarly to the innovations in sub-group 2, these innovations typically offer moderate to high benefits in sustaining or restoring individual autonomy. As a consequence, their potential users are largely limited to those who have already suffered from significant age-associated decline in individual autonomy. Technologically these age-based innovations are more sophisticated than those in the previous sub-group, often requiring costly and prolonged R&D efforts with significant risks of failure. Commercially, this sub-group also affords formidable challenges. In addition to hard-to-reach customers suffering from markedly reduced individual autonomy, innovations belonging to this sub-group typically come at very high prices in order to cover previously accumulated R&D expenses. As a consequence, stakeholders engaging in this sub-group face daunting financial risks, related to both technical development and to profitable commercialization. Therefore, stakeholders innovating are mainly organizations that are wholly or partly financed with public funds (e.g. research institutes, universities, private companies that receive public funding or tax breaks), motivated to innovate in order to address the societal challenge of an aging population rather than to make a short-term profit³⁹. Due to the important role of public funding as a catalyst for innovation this sub-group shall be called public intervention. Example innovations from this sub-group include the hybrid assistive limb suit (HAL suit)⁴⁰ and the Paro assistive social robot⁴¹.

³⁷ It may be considered a vicious circle that these innovations are meant to restore the individual autonomy, which target customers partly lack in order to purchase them.

³⁸ For user innovation cf. e.g. Hippel 1976 and Herstatt, Hippel 1992.

³⁹ There may also be some large private for-profit corporations that can afford sizeable research efforts, which do not immediately yield a profit but may serve other purposes (e.g. a demonstration of the company's technological capability). From an outside-in perspective it is often difficult to assess whether these companies also benefit from public grants for their research efforts.

⁴⁰ Cf. e.g. Sankai 2006.

⁴¹ Cf. National Institute of Advanced Industrial Science and Technology (AIST) 9/17/2004 and Institute for International Studies and Training (IIST) 2010.

Expert Interview Series

Building on the aforementioned typology six propositions were developed, designed to investigate and test the hypothesized adoption and diffusion characteristics in the different quadrants. These propositions were then at the center of an expert interview series aimed at testing their validity.

P1: Many diversified B2C companies do not engage in innovation in product/service segments with a high level of age specialization due to a perceived misfit with their corporate image, limited compatibility with their existing technical, marketing and distribution capabilities, or because they consider the segments as too commercially unattractive.

P2: Supply side challenges can result in a bottleneck for the early adoption of age-specialized innovations created by innovators with limited marketing and sales capabilities, access to financing, or other operational requirements, such as user innovators, start-ups, or other SMEs.

P3: Initial adoption of age-specialized innovations with low to moderate technical risk is driven by the regional sales focus of the innovator at the outset of commercialization, which is typically on the home country market. This home market adoption lead is time-limited and may later be overruled by better lead market conditions found in another country.

P4: Public intervention plays a major role in the development of age-specialized and technologically challenging innovations. Age-based innovations resulting from public intervention are strongly aligned with domestic needs and preferences due to political, financial, and ideological incentives of public stakeholders to focus on their constituents.

P5: The domestic emphasis of age-based innovations resulting from public intervention delays international adoption and increases the risk of idiosyncratic innovations.

P6: Early adoption and lead market development of age-specialized and technologically advanced innovations are influenced by public sector stakeholders in the role of buyers.

For the expert interview series, theoretical sampling was used with the final sample including 12 interviewees (41%) at the level of CEO, managing director, or company founder, 13 interviewees (45%) with business unit or project responsibility (e.g. vice president, head of marketing), and four interviewees (14%) with other job functions. In terms of industry branches the final sample included six interviewees working in telecare and personal services, six in the field of assistive robotics and consumer electronics, six as age-specialized consultants, four in the mobility aids industry, three in age-specialized furniture and household goods, and four in other branches of industry⁴².

⁴² Age-specialized retailers, finance (reverse mortgages), media.

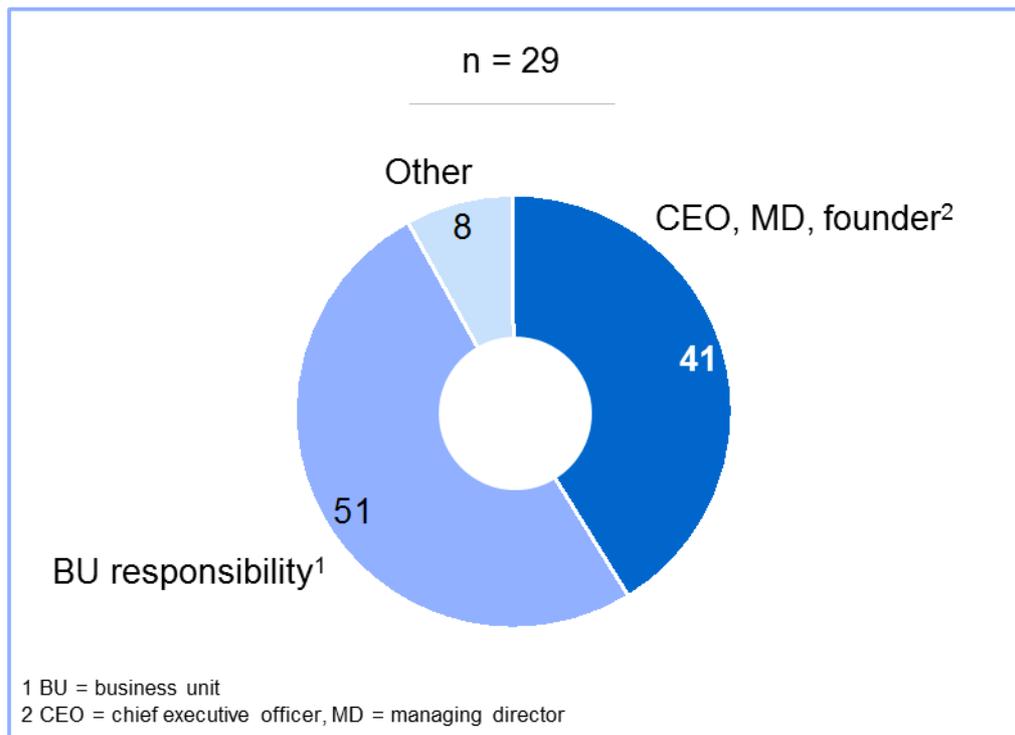


Figure 6: Expert interviewees by job function, in percent

The interviews followed a semi-structured interview guide with 27 question items. Interviews were recorded, transcribed, and coded using MAXQDA 11 software. Based on the thematic coding approach a coding system⁴³ for text analysis was developed, consisting of 59 coding categories (gross)⁴⁴. After subtraction of twelve categories solely needed to differentiate between sub-categories⁴⁵, the coding system comprises 47 coding categories (net). Categories were ordered in a four-step hierarchy. A total of 752 codes were assigned to text segments, corresponding to an average of 16.0 coded segments per coding category (net). Eventually, propositions P1, P2, P5, and P6 were supported in the interviews, whereas propositions P3 and P4 were partly supported.

Results and Discussion

As a necessary prerequisite for any investigation, this study initially set out to establish – or prove false – the existence of lead markets within the context of age-based innovations⁴⁶. While lead markets may have implications on a larger economic scale, a demonstration of lead market existence required a nearly microscopic approach: International adoption and diffusion patterns needed to be understood not only at the level of a product or service category but – even more specific – on the level of various innovation designs potentially competing within that category⁴⁷. A meticulous methodology not relying on statistical averages but rather focusing on genuine phenomenological data was needed. Consequently, a case study approach was chosen. In order to increase robustness of results, multiple cases in

⁴³ The terms “coding system” and “code system” are being used interchangeably in this study.

⁴⁴ See appendix for complete code system.

⁴⁵ No text segments were assigned to these twelve categories.

⁴⁶ “RQ 1: Do lead markets exist within the field of age-based innovations?”

⁴⁷ See Beise 2001.

different product and service categories were studied with this methodology. On a very basic level, it could be shown that international adoption of foreign innovation designs does occur within the field of age-based innovations, a straightforward but important precondition for any possible lead market phenomenon. Furthermore, it could be demonstrated in several instances that adoption and diffusion had indeed been subject to time delays between different countries. In other words, adoption and diffusion did not occur in a temporally homogeneous fashion across geographies, but some countries had systematically been leading ahead of other lagging countries within the respective age-based product or service category. Thus, applying Beise's definition of lead markets⁴⁸ the answer to research question 1 (RQ1) is patently affirmative. It should be noted that this proof of existence of lead markets is limited to those age-based products and services that have been analyzed⁴⁹.

Heartening as these first results may have been, they spoiled any hope of identifying a single country as consistently being lead market for age-based innovations: Even among the four analyzed product and service categories – arguably a modest number within the large and heterogeneous field of age-based innovations – four different lead markets on three continents materialized in the course of the analysis⁵⁰. Therefore, the answer to research question 2 is negative⁵¹. This finding has far-reaching implications: If there is no single lead market for the entirety of age-based innovations, any further quest aimed at the identification of underlying determinants is ineffectual. From the vantage point of managerial practice this means that there is no simple shortcut to locating the country best suited for testing and commercializing novel age-based products and services.

On closer inspection, the case studies revealed a surprising common element: They indicated that each respective country of invention and initial commercialization also took the lead in innovation adoption and diffusion. Early diffusion occurred much more locally than expected, at times starting in direct geographic proximity of the innovator. In Beise's taxonomy this would be quite expectable for innovations categorized as idiosyncratic, in other words, tailored to domestic needs and preferences but not perfectly compatible with those found within other countries (Beise 2001). For lead market designs with internationally successful adoption, however, it would be expected that they are adopted first in the market with optimal lead market conditions – irrespective of provenance (*ibid.*). However, the countries of invention did in fact not always provide ideal market conditions. Therefore, the finding that provenance seems to influence early adoption of age-based innovations was not only surprising but also to some extent in disagreement with extant lead market theory. In a way, this insight was pivotal for the remaining work in this dissertation project.

⁴⁸ “Lead markets have the characteristic that product or process innovation designs adopted early become the globally dominant design and supersede other innovation designs initially adopted or preferred by other countries” (Beise 2001, p. 10).

⁴⁹ It does not make any statements about the existence of lead markets for each and every existent and thinkable age-based innovation.

⁵⁰ Identified lead markets: USA for stair lifts, Central Scandinavia for rollators, UK for reverse mortgages, and Japan most likely (still emerging) for assistive social robots in eldercare.

⁵¹ “RQ 2: Is there a single lead market for all age-based innovations or do various countries take lead market roles in the different product and service categories within this field?”

Theoretically, it could be possible that differences in market conditions for the adoption and diffusion of age-based innovations are so miniscule between different countries that the influence on adoption would be small. In that case, adoption spreading domestically first and internationally later might be quite thinkable. However, the results of the integrated analysis indicate otherwise: Substantial country-specific differences in lead market advantages could be identified, clearly separating country markets with high lead market potentials for age-based innovations⁵² (especially Japan, Germany, and the United States) from less promising ones. Thus, at this point the domestic adoption advantage seen in age-based innovations remained puzzling. Fortunately, findings from the market participant study (MPS) aided in the development of propositions that could then be tested to resolve this puzzle. The MPS primarily aimed at gauging the innovation providers' view on lead market existence, location, and underlying factors⁵³. In addition, however, it offered an inside view into the challenges faced by innovation providers in achieving innovation adoption. In particular, it hinted at age-related problems with accessing customers and markets, e.g. in terms of company-to-customer communication⁵⁴ and with regard to establishing efficient sales and distribution organizations⁵⁵. In combination with earlier evidence from the case studies, these findings contributed to the fundamental hypothesis that problems on the supplying side of the age-based market – the companies and organizations involved in innovation, production, and sales – might be a bottleneck to innovation adoption and might contribute to a domestic adoption advantage. When dominant strategy is to commercialize innovations in the country market with optimal adoption conditions (the lead market) but we find innovating organizations in age-based innovations consistently opt for their – in terms of lead market conditions often sub-optimal – home market, there are two possible explanations: Either these innovating companies lack capabilities (“supply side capabilities”, e.g. capabilities in marketing, sales, distribution, or financing) or they lack motivation to serve the most promising country market from the outset⁵⁶. Instead, they turn to their domestic markets. This puzzle leads directly up to research question 5⁵⁷.

The issue described above does not appear to apply to all age-based innovations equally. It was visible in highly age-specialized innovations aimed at the exclusive use by elderly people. However, it was not observed in less age-specialized innovations that target a wider age group. Furthermore, it became apparent that – within the highly age-specialized innovations – very different types of stakeholders were involved in innovation, depending on the level of technical challenge and R&D funding requirements. In order to reflect these differences a typology of age-based innovations was introduced. Three sub-groups were

⁵² It thus offered an answer to research question 3: “Which countries are at present most likely to become lead markets for age-based innovations and for what reasons?”

⁵³ “RQ 4: Which countries do providers of age-based innovations identify as lead markets and to which factors do they attribute lead market development?”

⁵⁴ E.g. difficulty in reaching elderly individuals for marketing purposes or product improvement

⁵⁵ E.g. constrained usability of channels for elderly customers

⁵⁶ As could be shown in the expert interview series, companies often have some awareness that there may be more promising country markets than their home market, so lack of awareness does not appear to be a plausible explanation for their domestic market selection.

⁵⁷ “RQ 5: Is extant lead market theory applicable to the entire field of age-based innovations and sufficient to explain lead market location, or which additional explanations are necessary in order to explain lead market development given the market conditions in this field?”

identified, categorized along the dimensions of age specialization and of technical risk / R&D funding requirements (Figure 5, p. 19). And indeed, stakeholder types dominating innovation within these different sub-groups tend to be equipped quite differently with supply side capabilities and act upon different motivations, as was proposed and eventually substantiated within the expert interview series (EIS):

- Sub-group 1: In the two quadrants with relatively low age specialization⁵⁸, we find age-diversified – that is, developing and selling both age-based and non-age-based innovations – B2C companies. These companies are typically well-equipped in terms of supply side capabilities (e.g. existing sales and distribution networks) and are profit-seeking, selecting markets based on attractiveness for their business. As could be shown in the EIS, these companies eschew the more age-specialized market segments for a variety of reasons, e.g. negative image spill over, insufficient market size, or scarce profits. Companies are typically able and willing to prioritize the most promising country markets with their innovations, in line with extant lead market theory.
- Sub-group 2: In the quadrant with relatively high age specialization and relatively low technical risk / R&D funding requirements innovating companies typically comprise start-ups, entrepreneurs, often user innovators or compassionate innovators. Many of these have limited supply side capabilities at their disposal (e.g. financing constraints, no existing sales networks, limited access to indirect sales networks). Moreover, motives for innovation activities may range from charitable to profit-seeking – from the desire to help a close relative to the objective of reaching high sales volumes and profits. In this sub-group, adoption and diffusion of innovations may substantially suffer from constrained supply side capabilities – in particular on the international level – and from lack of a clear profit orientation.
- Sub-group 3: In the quadrant with relatively high age specialization and relatively high technical risk / R&D funding requirements (sub-group 3) public stakeholders (e.g. universities, research institutes), public-private-partnerships and public funding play major roles in age-based innovation. Supply side capabilities may vary. In terms of motivation many stakeholders are more incentivized (e.g. through research grants) to focus on technical invention and advancement than on actual market diffusion. Frequently, marketability and especially affordability appear to be less relevant than technical aspects. Moreover, public and publicly-financed stakeholders are often expected to devise solutions to national problems (e.g. effects of population aging within the country providing the research funding) rather than create products and services that prioritize global diffusion success.

It is important to assess these findings in the context of extant lead market theory. Lead market theory primarily relies on market conditions as determinants of lead market potential and therefore on the development of lead markets (Beise 2001): Countries scoring – individually or cumulatively – high in demand advantage, price/cost advantage, transfer advantage, export advantage, and market structure advantage are expected to first widely

⁵⁸ Products and services in this sub-group typically address both elderly and non-elderly users; age-based functionality is often not obvious at first sight.

adopt a lead market design that is later met with international success through adoption in lag markets (*ibid.*).

This approach may indeed be applicable under many circumstances. However, within the field of age-based innovations, the author has identified two sub-groups of products and services – sub-groups 2 and 3 – where this principle does not appear to hold as expected: Innovations that later turned out to be internationally adopted lead market designs had not been initially adopted in the market with best conditions but rather in the innovator's country, spreading domestically first. In other words, countries, which were *ex ante* no exceptional lead market candidates in terms of market conditions (e.g. formalized as lead market factors) developed into first adopters of age-based innovations that would later become internationally successful (lead market designs); these countries must therefore by definition be labeled lead markets. They cannot be described as idiosyncratic markets, since the designs adopted there were later adopted internationally. Neither can they be described as lag markets, because they factually led the adoption process. For these countries, attaining lead market status had less to do with market conditions than with the fact that they were host to innovators insufficiently capable or willing to serve the most promising country markets first and instead resorted to a domestic sales focus that was met with successful domestic adoption, later followed by international adoption. This means that lead market designs may originate from unexpected locations that are not necessarily in line with predictions of high lead market potential.

This finding does not in any way dispute the general importance of market conditions for innovation adoption and lead market development as described by Beise and – for example – applied by Rennings and Cleff to various innovation categories. Neither is it a backflip to earlier, more country-of-invention-oriented lead market definitions, such as Yip 1992. Instead, it does add a facet to the generally demand-oriented concept of lead markets: Scenarios do in fact exist where innovating companies either lack the capabilities or the willingness for a strategic market selection that prioritizes countries based on lead market potential. For various reasons, company focus is on the domestic market first, even if it offers less than optimal demand conditions. Thus, the finding is not in disagreement with lead market theory but sets a limit to its applicability: In order for lead market theory to hold true, providers of innovations need the capability and willingness to prioritize countries with optimal demand conditions.

In Beise's seminal work on lead markets⁵⁹, much effort is put into the analysis of demand conditions and the identification of lead markets. However, there is little focus on limitations and constraints existing within individual innovating companies and potentially having an effect on adoption and diffusion⁶⁰. Instead, it seems that there has so far been a tacit assumption that innovating companies are invariably able and willing to deliberately choose the markets they serve, following a rational economic logic. In the vast majority of cases this approach may hold true. However, we have seen in the context of age-based innovations that both insufficient supply side capabilities and a departure from purely profit-seeking motives –

⁵⁹ Beise 2001

⁶⁰ A brief chapter on "Conditions of Lead Market Existence" (Beise 2001, pp. 126–128) lists market-related and demand side pre-conditions for lead market development. However, potentially limiting supply side factors are widely disregarded in this context.

be it due to locally rooted charitable aims or due to national public objectives – may lead to an initial domestic commercialization that is unwarranted by extant lead market theory. Thus, in these cases the innovator’s provenance influences the location of initial innovation availability to customers and – often – initial customer adoption. After all, a country may only become lead market if it has the opportunity to adopt an innovation before other countries do. If the innovator is located abroad and not capable or not willing to prioritize international sales, no potential import countries can become lead market. Even high lead market potentials are ineffective under such conditions.

Implications and Outlook

The application of lead market theory to the field of age-based innovations has demonstrated that innovators need to be both capable and willing to prioritize their diffusion-related activities based on country-specific demand conditions. If this is not the case, early adoption and diffusion will not be in line with expectations based on lead market theory (i.e. starting in the markets with optimal demand conditions and highest lead market potential) but will occur much more locally and domestically, in the innovator’s vicinity (Figure 7).

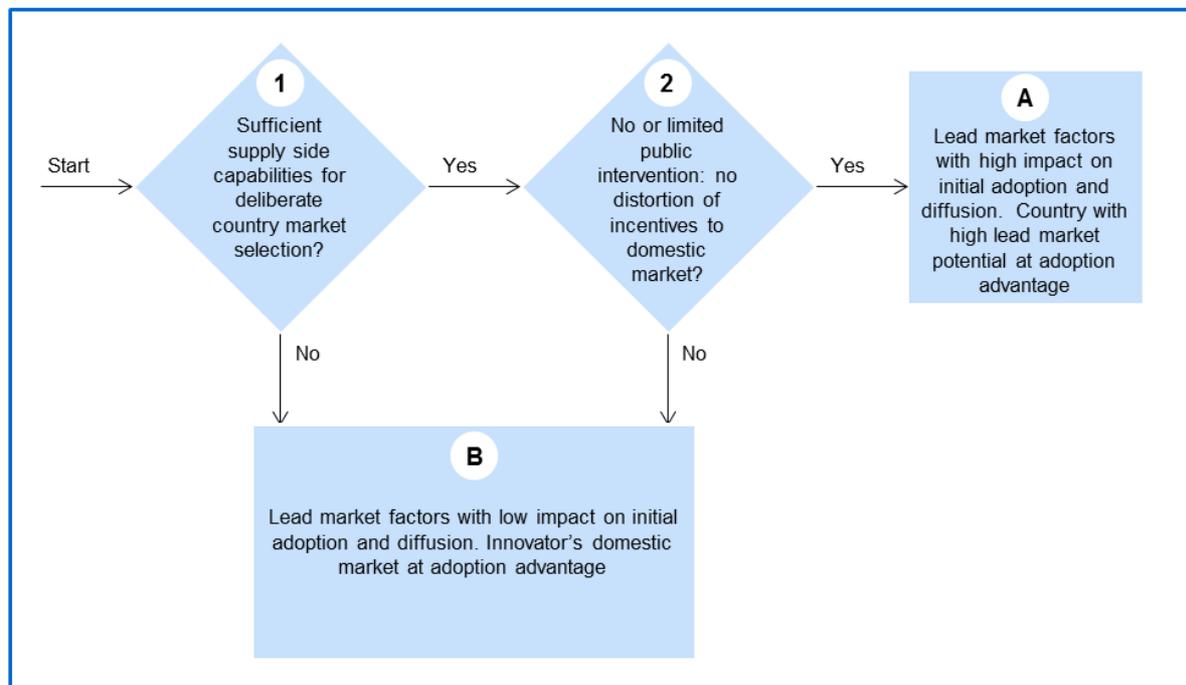


Figure 7: Prerequisites for the applicability of lead market theory

This observation has likely also relevance for lead market theory beyond the field of age-based innovations: There is no evidence that the observed phenomenon is causally linked to the nature of age-based innovations as such. To the contrary, it appears that the market structure of highly age-specialized innovations (e.g. limited market size and profit expectations) leaves innovation to certain types of stakeholders. It is based on the characteristics and motivations of these innovating stakeholders that the issues of supply side capabilities and domestic focus come to bear. Therefore, it may be assumed that the observed phenomenon is not limited to age-based innovations but may also occur in other markets with similar conditions. These conditions include:

1. Limited or no innovation activity by entities with
 - (a) sufficient supply side capabilities for the deliberate prioritization of country markets based on demand conditions
 - (b) and which are exposed to a functioning market mechanism that does not artificially set incentives for domestic over international sales activities

in combination with one or both of 2 and 3:

2. Existence of innovators with insufficient supply side capabilities (e.g. start-ups, entrepreneurs, user innovators, compassionate innovators) for the deliberate prioritization of country markets, resorting to domestic marketing and sales activities
3. Existence of innovators partly or fully insulated from a functioning market mechanism (e.g. organizations with full or partial tax funding, universities, research institutions), incentivized through public intervention to innovate primarily for domestic purposes (e.g. by their organizational mission or financially through domestically-targeted subsidies) rather than for country markets with optimal demand conditions

In the case of age-based innovations, all three conditions are fulfilled. With regard to 2 and 3, the former is more prevalent in the field of relatively low-tech age-based innovations (sub-group 2) whereas the latter can primarily be seen in costly high-tech age-based innovations (sub-group 3). In general terms, however, the fulfilling of either condition 2 or condition 3 should be sufficient in order to create a domestically-focused diffusion scenario as described.

Therefore, a number of opportunities for further research arise. In particular, the supply side challenges observed with regard to innovation diffusion in age-based innovations should receive additional scrutiny. In particular, other product and service categories, in which supply side challenges have effects on innovation adoption and diffusion should be identified and their characteristics compared. It should be suspected that the phenomenon will occur in a range of product and service categories, where innovators collectively experience limitations in international market access, constraining them from initially serving the most promising country markets. Furthermore, the causes of supply side challenges should be studied in more detail. At this point, evidence suggests that deficiencies in marketing capabilities, access to sales and distribution networks, and insufficient access to financing are important elements of supply side challenges for innovation diffusion. However, it is not certain, whether this list of causes is exhaustive. Neither is the relative impact of these constraints to innovation diffusion known.

Second, the effects of public intervention in innovation development on international innovation diffusion should receive further examination. There is now evidence from the age-based field that public intervention in the development of age-based innovations may result in delayed international diffusion compared to privately-conducted innovation projects. However, the reasons are not yet entirely clear. It seems likely that organizations involved in publicly-funded innovation projects (e.g. universities) are incentivized differently and – given the structure of public grants – technical achievement may be more relevant to them than innovation diffusion, let alone international innovation diffusion. There is also evidence that public intervention has a bias toward domestically-focused designs, which optimally address domestic preferences at the cost of exportability. Further study at the organizational level (i.e.

within relevant organizations) may help answer these questions and shed light on the associated decision-making processes. In addition, innovation diffusion in other industries with strong public influence on innovation development (e.g. defense, public infrastructure) should be analyzed in this context.

Additionally, the phenomenon that has been labeled compassionate innovation⁶¹ should receive additional attention. Is it limited to age-based innovations due to the unique constellation of users with progressively declining autonomy – and therefore ability to innovate – on the one hand and limited attention by manufacturer innovators on the other hand? Or can the phenomenon be observed in other areas as well? Furthermore, the defining characteristics of compassionate innovation should be subject to additional examination, especially in comparison with user innovation and manufacturer innovation.

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⁶¹ Particularly prevalent in the bottom-right quadrant (high age specialization, moderate technical risk / R&D funding requirements) of the typology matrix (Figure 5)

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