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Research on long-term care insurance: status quo and directions for future research

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Abstract We provide a structured literature review of long-term care (LTC) insurance using main path analysis, a mathematical tool to identify the most significant paths in a citation network. We identify three major research areas (financing, demand, and insurability) and systematically evaluate them based on standard frameworks. We further review established and innovative (insurance) solutions for LTC financing. Our results illustrate the immense difficulties of insuring LTC both on the demand side (e.g., low value of consumption while in care, existence of substitutes) and supply side (e.g., lack of predictability and asymmetric information), explaining the marginal contribution of insurance mechanisms to LTC financing. Combined products that bundle the risks, and public–private partnerships that integrate LTC into the pension systems might help to overcome the insurability limitations. In addition, alternative financing methods that go beyond the idea of risk pooling (LTC bond, LTC put option, equity release) could help to improve the sustainability of LTC financing.

Keywords Long-term care · Long-term care insurance · Main path analysis · Citation network · Demand · Financing · Insurability · Literature survey

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Motivation and aim of the paper

The organisation and financing of LTC is arguably one of the most important societal tasks of the twenty-first century. Although significant uncertainties in terms of potential need, intensity and duration of LTC provide a powerful rationale for sharing this risk across individuals (Colombo et al. 2011), the market for long-term care insurance (LTCI) is very limited.[1] From the academic side, the low demand for LTCI remained largely unexplored until the late 1990s. However, the academic literature on LTC and insurance is now growing exponentially with more than 1200 articles in Web of Science alone (see Appendix 1). While a considerable amount of research on LTC has been published in medical or gerontological journals, a growing number of studies are documented in the fields of business and economics, calling for a structured and timely review of this emerging academic field.[2]

We provide a structured review of LTC in the context of insurance (see Fig. 1) using an identification technique—main path analysis—that to our knowledge has not yet been used in the insurance field. Based on the review results, we evaluate the literature using three established frameworks (Chen 2001; Outreville 2013; Berliner 1982) and compare our results with the findings from other insurance markets. Our review includes a summary of alternative insurance and financing models that we use to identify innovative insurance and financing solutions. Finally, we offer an overview of potential research topics from the perspectives of academics and practitioners to encourage future work on this important topic. The focus of the analysis is on the business and economics literature in the risk and insurance field.

To summarise our main results, there is a combination of ex ante (insurance) and ex post (public sector, family) funding mechanisms with some variations in all advanced economies. When it comes to private insurance, high premium loadings and limited coverage are needed on the supply side because of uncertainty with respect to probability, intensity and duration of LTC, and pronounced information asymmetries. On the demand side, only well-educated middle-income people with LTC experience and a pessimistic outlook tend to be interested in buying LTCI, which is a rather small group. Limited knowledge, low value of consumption while in care, and the availability of public and private substitutes all reduce the demand

[1] The statistics on LTC financing in OECD countries presented in Colombo et al. (2011) emphasise the low relevance of insurance. Private insurance as a source of LTC funding ranges from 0% (Netherlands, Czech Republic) to a maximum of 9.8% (Belgium). Social security, which might also use some insurance mechanisms is, however, important in some countries (90% in the Netherlands, 70% in the Czech Republic).

[2] There are a few previous literature surveys on LTC with a slightly narrower focus. The most comprehensive study is by Norton (2000), in which the taxonomy of LTC, supply, demand and demographic trends based on previous theoretical and empirical research are discussed. Cremer et al. (2012) and Klimaviciute and Pestieau (2018) review more recent publications, seeking a sustainable public LTC scheme that combines both market and family solutions. Pestieau and Ponthière (2012) study the vicious circle in the LTC market (i.e., the market for LTCI is thin because people may find most of the current LTCI products too expensive and at the same time, insurance companies provide LTCI with higher prices due to the thinness of its market) from both the demand and supply sides. Brown and Finkelstein (2011) discuss the LTC expenditure, the relevant nature of the private market for LTCI along with Medicaid in the U.S.

for LTCI.[3] Combined products that bundle risks, and public–private partnerships that integrate LTC into the pension systems might help to overcome the insurability limitations. In addition, alternative financing methods that go beyond the idea of risk pooling (LTC bond, LTC put option, equity release) could improve the sustainability of LTC financing.

The remainder of this paper is structured as follows. We begin with a description of our methodology and then present our data and identification results. Subsequently, we cluster the literature according to the three research topics. Finally, we discuss areas of future work from practitioners' and researchers' perspectives.

Methodology

We use main path analysis and text mining to identify the main research topics in the field of LTCI. Main path analysis is a methodological improvement on classical citation network analysis. Citation network analysis, introduced by Garfield et al. (1964), is a non-weighted directional graph representing the idea that knowledge flows from older to newer articles. Main path analysis, first suggested by Hummon and Dereian (1989), simplifies the citation network using predefined weighting indexes and has become state of the art for literature screening in a variety of fields.[4]

A citation network consists of nodes (articles) and links (arrows) between the nodes representing the citations between the articles directed towards the cited article. We produce our citation network and main path as follows. First, the data is exported from Web of Science to the HistCite (Garfield 2009) software to produce a citation network. Then, the resulting file is imported to the Pajek software introduced by Batagelj and Mrvar (1998) for path analysis. Figure 5 illustrates our citation network extracted from Web of Science. To extract the main path from such a citation network, a weighting index is needed for the links between the nodes. Hummon and Dereian (1989) and Batagelj (2003) present various weighting indexes along with a discussion of their pros and cons.[5] We follow Batagelj (2003) and use Search Path Count (SPC) as a weighting index of the links. This index counts the number of times a link is traversed through certain starting nodes (source nodes) to end nodes (sinking nodes).

Figure 2 illustrates a simple example of citation network based on the SPC index. Here we follow Ma and Liu (2016), Liu et al. (2016) and Lu and Liu (2016) and

[3] We discuss 20 factors whose impact on LTCI demand has been empirically studied. Of these, 12 are clear in their prediction and are in line with observations from other insurance markets. For the other eight factors, however, the literature is either inconclusive or contradictory.

[4] See, e.g., Liu et al. (2016) for an application to data envelopment analysis or Huang et al. (2017) for an application to 3D printing.

[5] Four measuring traversal counts discussed in the literature are Search Path Link Count (SPLC), Search Path Node Pair (SPNP), Node Pair Projection Count (NPPC), and Search Path Count (SPC). Although there are small variations in these indexes, Batagelj (2003) recommends SPC over other traversal counts.

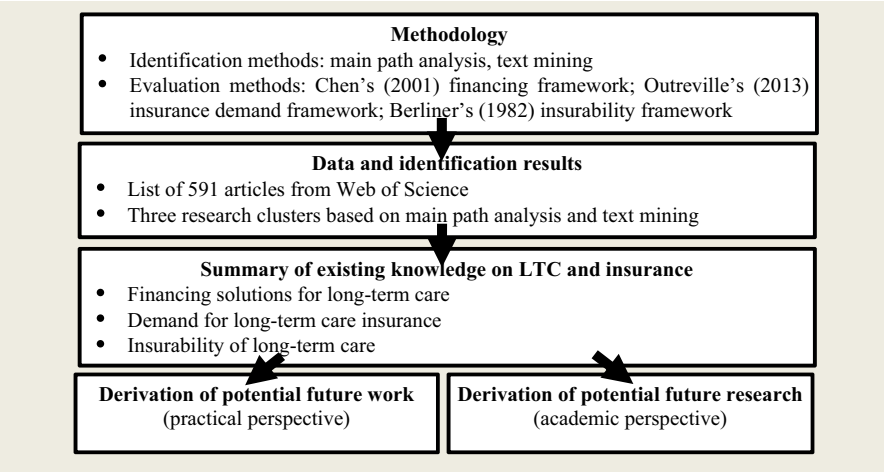

Fig. 1 Conceptual framework and research approach

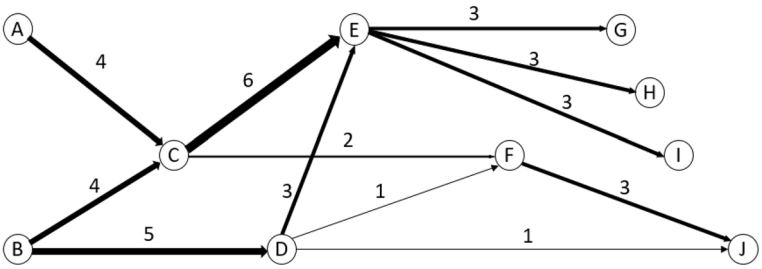

Fig. 2 A simple citation network with SPC index

choose the global[6] key-route main path analysis as our methodology for identifying the most important publications in the citation network. Global key-route main path finds the most significant link globally and searches forwards and backwards (until meeting a sinking or source node) to build the path. In the following example, nodes A and B are source nodes and G, H, I and J are sinking nodes. The global key-route main paths (the path with the highest traversal count globally) are identified as A-C-E-G, A-C-E-H, A-C-E-I, B-C-E-G, B-C-E-H and B-C-E-I. The thickness of the arrow is an indicator of the importance of the research indicating the traversal weight.

For more details on main path analysis, we refer to De Nooy et al. (2011). Building upon the identified networks, we analyse the underlying research topics with text

[6] We choose global rather than local search to connect the links in a way that delivers the largest traversal counts (see Liu and Lu (2012) for further explanation of this idea and a discussion of different approaches).

Table 1 Evaluation frameworks

Chen (2001) financing framework	Outreville (2013) demand framework	Berliner (1982) insurability criteria
Public sector: general governmental (excl. social security)	Economic factors: Price[a] Income Wealth Bequest motives	Actuarial criteria: Randomness of loss occurrence Maximum possible loss Average loss per event Loss exposure Information asymmetry
Public sector: social security Intergenerational model Intra-generational model	Social and cultural factors: Education and knowledge Preferences, experience and beliefs	Market criteria: Insurance premium Cover limits
Private sector: private LTC Stand-alone LTC policy Combined policy	Structural factors: Substitute for insurance Tax incentives	Social criteria: Public policy Legal restrictions
Private sector: out-of-pocket	Personal and demographic factors: Age and gender Marital status and number of children	

[a]Outreville (2013) and Berliner (1982) do not differentiate between subsidised price at point of utilisation or tax price, although they should. We refer to studies on the effects of changes in price on the demand for LTCI and we do not further differentiate between different price concepts

mining. We use the R package 'tm' (Feinerer and Hornik 2012) to identify the most frequently used words in titles, keywords and abstracts.

We then rely on three widely used frameworks to systematically evaluate the main results in the identified research fields (see Table 1). We begin by using Chen's (2001) financing framework to categorise standard LTC financing approaches and to identify innovative financing solutions that do not fit into the standard categories. Then, we follow Outreville (2013) and categorise insurance demand in four categories.[7] Finally, we address the insurability of LTC risk based on the Berliner (1982) insurability framework.[8]

Data and identification results

To ensure scientific quality, we limit our review to articles included in the Thomson Reuters Web of Science.[9] The Web of Science covers 18,000 journals in all academic disciplines. We conducted our search on March 8, 2018 using 'long term care' AND

[7] See, e.g., Eling et al. (2014) for an application to microinsurance demand.

[8] Biener and Eling (2012) and Biener et al. (2015) show applications to micro and cyber insurance.

[9] For identifying main research areas in LTC (applying main path analysis and text mining) we use the Web of Science database. However, in the later discussion we also include relevant studies and working papers from other sources.

'insurance' as keywords; publications from 1984 to February 2018 were retrieved by the search engine for further analysis, leading to 1280 articles with 'long term care' and 'insurance' in their title, abstract or keywords. Due to overlap with medical, gerontology and other journals irrelevant to our topic, we did not exclude these journals ex ante, because some articles relevant to economics are included in those journals (e.g., Cramer and Jensen 2006). Hence, to be more comprehensive in our selection, we examined each paper individually and included all studies on LTC and LTCI from a business, finance and economics point of view, resulting in 591 articles used for further analyses.[10]

The main path based on the 591 articles is shown in Fig. 3 and can be separated into three categories: insurability, demand and country-specific studies.[11] Early studies, beginning with Wiener et al. (1987), focus on restrictions, conditions and insurability of LTC. The group of studies beginning with Pauly (1990) deal with demand and market inefficiencies for LTCI, with a peak of research activity after 2000, especially with the contributions from Finkelstein and McGarry (2006) and Brown and Finkelstein (2007, 2008). Among the most recent works on the main path are country-specific studies and regional comparisons of LTC mechanisms (e.g., Doty et al. 2015; Nadash and Cuellar 2017). Text mining within the 591 articles (Table 2) also lets us identify five clusters: 'demand', 'financing', 'country-specific studies', 'demography' and 'insurability'. In the section 'Evaluation of results' we focus on demand and insurability, included in both the main path and text mining. As our overarching framework we take financing as the third research focus; demographic questions are not the focus of our research. Appendix 2 contains a review of country-specific studies and complete documentation of the results.

Evaluation of results

Financing of long-term care

Table 3 illustrates sources of financing LTC with their pros and cons as discussed in academic papers. We also present the relative importance of the different sources in terms of funding, emphasising the marginal role of insurance today. Our model of classifying LTC financing schemes follows Chen (2001)[12] who proposed the three-legged funding model for the U.S., consisting of social insurance, private insurance and personal savings. Mandatory social insurance with basic coverage serves as a safety net. Other voluntary coverages can supplement the base coverage

[10] A complete list of all articles and papers included in the review is available upon request.

[11] For clarity, each node on the graph mentions the family name of the first author along with the first letter of the family name of other authors followed by the year of publication.

[12] There are many ways to categorise LTC financing. Wittenberg et al. (2003) propose five categories: private savings, private insurance, private insurance with public-sector support, public-sector tax-based support, and social insurance. Costa-Font et al. (2015) distinguish ex ante (insurance) from ex post financing (public sector, family). We rely on Chen's (2001) categorisation because it allows us to make a statement on the empirical relevance using Colombo et al. (2011).

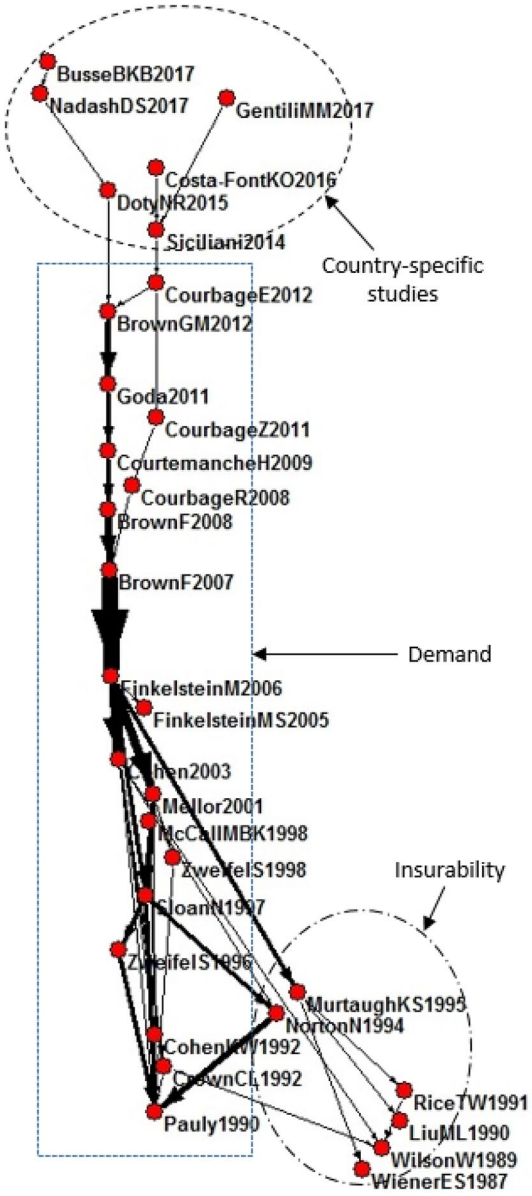

Fig. 3 Main path based on 591 articles

with funding from private sources. Chen (2001) suggests using trade-off principles to compensate for the inefficiencies in both private and public LTC funding. To improve the attractiveness of the private LTC products, he proposes combined (or hybrid) policies. Some of them are addressed comprehensively in the literature, such as life insurance or annuities with LTC riders (e.g., Kyle 2013). Combined products attempt to increase the use of LTCI, especially by addressing adverse selection. In

Table 2 Text mining results

Research area/cluster	Keywords (Frequency)
1. Demand	Market (214) Demand (159) Purchase (94)
2. Financing	Financing (194) Income (153) Financial (125)
3. Country-specific studies	Japan (171) Germany (112) Korea (70) China (59) United States (41)
4. Demography	Population (212) Age (202) Children (56) Demographic (53)
5. Insurability	Benefits (167) Coverage (164) Premium (68) Moral hazard (35) Underwriting (35) Adverse selection (34)

the public sector, Chen (2001) suggests collecting funds by employment-based contributions so that the majority of the population contributes to the financing and thus ensures the sustainability of the safety net.

Both ex ante and ex post funding mechanisms, with some variations, exist in all advanced economies. A system that relies exclusively on private insurance is not likely to work, because fluctuating income and unemployment will endanger its financial sustainability (Rothgang and Engelke 2009). However, by comparing comprehensive LTC financing schemes of social insurance such as those in Japan or Germany, Campbell et al. (2010) argue that reining in moral hazard effects (as done by private insurers) is also necessary for sustainability. There have also been diverging trends such as an increase in public coverage of LTC expenditure in France, Japan, Spain and Korea, but a decrease in relative terms in Germany, Sweden and the Netherlands.[13] Overall, it is empirically unclear what the optimal mix of financing should look like. It is also likely that there is not one optimal model; the best model might depend on economic, social, cultural and demographic factors. One simple example is that a pay-as-you-go financing scheme will work well in countries with growing populations and economies but not so well in countries whose economies are stagnating or even declining.

The private insurance market is small but growing. The number of insured in the U.S. rose from 1.7 million in 1992 to 7.2 million in 2014 (NAIC and The Center for Insurance Policy Research 2016, p. 9). In Germany, the number of private insurance

[13] Colombo et al. (2011, p. 79).

Table 3 Financing LTC expenditure

Source of funding			Pros (+) and cons (−) discussed in the literature	Empirical relevance[a]
Public sector	General governmental (excl. social security)	Tax-based sources (e.g., U.S. Medicaid)	+: Provides a safety net for those who are in need[b]. Income and wealth are taken into account (solidarity between rich and poor)[c]. Inclusion of entire population.[d] Immediate benefits possible (from day one) −: Labour income taxes may discourage work and decrease savings and consumption (negative purchasing power effects).[e] Vulnerable to government budget constraints;[f] reduced incentive to take care of the costs	52.3%
	Social security	Intergenerational model (pay as you go) Intra-generational model (capital funded)	+: Mandatory enrolment avoids adverse selection problems. Provides coverage for risks that are uninsurable in private insurance. Can adjust to changing circumstances. Democratic legitimacy of restrictions on coverage, e.g., extending or tightening the eligibility based on medical advancements[g] −: Intergenerational models ensure solidarity between generations but depend on demographics.[h] If limited to employees, non-employed have no coverage.[i] For intra-generational models immediate benefits are not possible, but models do not depend on demographics and diversification of risk	32.0%
Private sector	Private insurance	Stand-alone LTC policy	+: Covers individuals not eligible for public LTC; offers coverage expansion on top of public system; heritage protection; insurers have an incentive to manage costs −: Information asymmetry.[j] Costly medical tests and exclusion of high risks (e.g., older or chronically ill people).[k] Not affordable for many people because of high premium loadings.[l] Lapse risk when income/liquidity varies[m]	0.9%
		Combined policy	+: Combining LTC with annuities might mitigate adverse selection and lower administrative costs.[n] Annuities mitigate the risk of illiquidity during disability.[o] Use of available equity (e.g., reverse mortgage). Expanding coverage to population which is excluded from stand-alone LTCI −: Relatively complex products	
	Out-of-pocket		+: Prevents moral hazard and increases individual responsibility	13.5%

[a]Average percentage of funding based on Colombo et al. (2011) comparing LTC financing in 23 countries. The remaining 1.3% to complete 100% are other sources mentioned in Colombo et al. (2011). The funding from private insurance ranges from 0% (e.g., the Netherlands) to 9.8% (Belgium) with an average of 0.9%

[b]Feder et al. (2000)

[c]Ikegami and Campbell (2002)

[d]Glendinning et al. (2004)

[e]Kitao (2015)

[f]Yang et al. (2016). It can be considered as both an advantage and disadvantage because a regular political discussion is necessary

[g]Barr (2010). While democratic legitimacy of restrictions on coverage is mentioned as an advantage of social insurance, Rothgang (2010) mentions lack of adjustment (or late adjustment) of LTCI benefits as a weakness which may result in increasing copayments and encouraging delegitimisation of the insurance system

[h]Rothgang (2010)

[i]Yang et al. (2016)

[j]Frank et al. (2013)

[k]Comas-Herrera et al. (2012)

[l]Brown and Finkelstein (2007)

[m]Rothgang and Engelke (2009) and Konetzka and Luo (2011)

[n]Murtaugh et al. (2001)

[o]Weston (2012)

policies for LTC increased by 65% to 3.5 million from 2012 to 2017 (Brüss 2018; Nadash and Cuellar 2017). The low demand for stand-alone LTC policies has also motivated insurance companies to design combined products that bundle LTC with other risks. Getzen (1988) is one of the early researchers discussing long-life insurance to combine annuities, health insurance and LTC. Bundling different risks not only has the advantage of cost-effectiveness compared to separate purchases[14] but also addresses the insurability problems caused by asymmetric information. For example, by purchasing combined LTCI products that cover both the LTC risks and longevity risk, the problem of adverse selection can be mediated, and strict medical exclusions might be reduced.[15]

Panel A of Table 4 illustrates alternative LTCI policies. The products can be distinguished by (1) purchase time (at younger ages, during retirement, or at the time of LTC need), (2) timing of premium payment (at younger ages, during retirement, at the time of LTC need, or after death using whole life insurance or other assets such as real estate, collateral) and (3) coverage (complete or only part, in cash or in kind).[16] One of the latest innovations discussed in the literature is the variable life care annuity with guaranteed lifetime withdrawal benefits,[17] providing protection against shortfalls of income through guaranteed income streams and including an LTC rider.

Panel B of Table 4 depicts some alternative financing methods that go beyond the idea of risk pooling provided by insurance. The equity release uses the value of a house to finance LTC expenditure, but no risk pooling is done. The LTC bond is a pure savings product that is inheritable in case of non-use for LTC services, and the consortium[18] issues the right to future LTC services in exchange for payments today.

Demand for long-term care insurance

Table 5 categorises the research findings on LTCI demand using the Outreville (2013) demand framework in four major groups—economic, social and cultural, structural and demographic factors—for a total of 20 factors.[19] Twelve of the 20

[14] Murtaugh et al. (2001).

[15] Murtaugh et al. (2001) and Brown and Warshawsky (2013).

[16] There are some alternative products for traditional LTCI such as short-term care insurance (STCI or convalescent insurance) and critical illness insurance (critical care) which provide partial LTC coverage in terms of period (STCI is generally less than 1-year coverage) or limited risks (critical care covers only specified serious illnesses such as cancer or stroke).

[17] Hsieh et al. (2017).

[18] See Shilling (1991) for the formation, structure and operation of the consortium. In his study, he defines a consortium as a group of proprietary facilities that provides LTC.

[19] Some LTCI demand studies consider actual purchase decisions (e.g., Mellor 2001; Sperber et al. 2017), while others test demand and willingness to pay (e.g., Brau and Bruni 2008). Both approaches have their limitations and are included in our review. While studies with actual purchase decisions might be biased towards risks that are not excluded by insurance companies, studies that test the intention to purchase do not know whether it really reflects real-world behaviour. We also note that a few other demographic aspects were studied in the literature such as race, ethnicity and their effect on the ownership of LTCI (Headen Jr. 1992; Sloan and Norton 1997; Cramer and Jensen 2006; McGarry et al. 2013).

Table 4 Alternative insurance and financing models

Category		Definition
Panel A: Insurance models		
Annuity	Life care annuity	Combination of a deferred[a] or immediate[b] annuity with LTC disability coverage at retirement; pays retirement income along with increased benefit; the amount of annuity may be set according to the level of frailty.[c] The annuity can be paid when the insured is in need of LTC
	Enhanced annuity	Targets people who are entering or are already in a nursing home. Based on higher mortality assumptions and payment of single premium, the coverage offers an enhancement in the amount of annuity[d]
	Enhanced pension	Specific model of life care annuity offered at the time of retirement. It provides an increased annuity payment if LTC is needed; the premiums are collected by reduced annuity payments while the retired person is still healthy[e]
	Variable life care annuity with guaranteed lifetime withdrawal benefits (LCA-GLWB)	Combination of LTCI and a variable annuity with guaranteed lifetime withdrawal benefits. The guaranteed income component protects the insured against downside risk, and the LTC component protects against LTC expenses[f]
Life insurance	Accelerated life insurance[g]	Whole life insurance with monthly benefits paid to cover LTC expenses up to death[h]
	Life insurance with LTC rider	Pays the actual cost of LTC services up to a limit or a fixed indemnity charge. It is offered to people near their retirement age. It can be structured either as a reduced benefit amount from the cash value of the life insurance part of the policy or as an additional benefit requiring a single premium. Universal life policies may be a good option for this benefit[i]
	Lifestage LTC product	Term life insurance up to specific retirement age and change of cover to LTCI afterwards with the same premium and coverage amount[j]
Disability insurance	Combined disability coverage	A disability insurance policy that protects the insured against the shortfall in income caused by disability. The coverage may give the option to convert the disability insurance policy to LTC policy after retirement without the need for medical underwriting[k]
Combination of annuities and health insurance	Long life insurance	Covers costs of chronic illness (i.e., any cost related to nursing care in any facility or any medically necessary home health care) during retirement based on specific daily benefits for each of the coverages. In addition, it provides monthly payments after the age of 76, regardless of the health status of the insured. The premium is collected based on an initial lump sum paid at the beginning of retirement along with monthly premiums up to the end of long life contract[l]
Health insurance	Whole life health insurance[m]	Combination of permanent health insurance with LTC coverage, covering 'own or similar occupation' disability before retirement and LTC annuity paid based on frailty
Panel B: Financing models		
LTC bonds	Personal care savings bonds[n]	Regular bond which is liquidated in the event of LTC or death, but a small proportion of its value will be used for funding periodic cash prizes

Table 4 (continued)

Category		Definition
LTC put option	Consortium	Consortium of LTC providers issues securities to the public. They are put options, and their proceeds are to be used for financing LTC services
Equity release	Reverse mortgage[o]	Homeowner receives LTC coverage by taking out a loan (a lump sum or annuity payment) and has lifelong access to their home; the payments for the loan will be collected after the death of the insured or after selling the equity[p]
	Home reversion plan[q]	Selling (partly or in total) the equity in exchange for a lump sum based on private arrangements. The homeowner has the right to stay in the property as long as they live or until they move out

[a]Webb (2009)

[b]Murtaugh et al. (2001) and Spillman et al. (2003)

[c]Pitacco (1999)

[d]Ibid

[e]Ibid

[f]Hsieh et al. (2017)

[g]Freiman (2007), Mayhew et al. (2010) and Pitacco (1999): LTC cover as a rider benefit; that is the same concept as equity release (with life insurance as underlying equity)

[h]Pitacco (1999) and Spillman et al. (2003)

[i]Weston (2012)

[j]Own Your Future Minnesota (2015)

[k]Freiman (2007)

[l]Getzen (1988)

[m]Pitacco (1999) and Mayhew et al. (2010)

[n]Mayhew and Smith (2014) argue that the cash prizes offered by PCSBs are similar to lottery tickets which are more attractive to low-income people

[o]Ahlstrom et al. (2004)

[p]The idea is mentioned in earlier studies by Sawyer (1996) and Rasmussen et al. (1997). Mayhew et al. (2017) introduce similar products for the U.K. market called 'equity-for-insurance' and 'equity bank' products. The former product collects insurance premiums in exchange for the whole or a percentage of the equity value after the death of the homeowner. The latter provides the homeowner or their dependents with income or annuity during their remaining lifetime, and the debt will be paid after the death of the homeowner

[q]See Alai et al. (2014) and Hanewald et al. (2016)

Table 5 Main factors affecting LTCI demand

Category	Subcategory	Results with respect to LTCI demand
Economic Factors	Price	−: Cohen et al. (1992), Cramer and Jensen (2006), Schaber and Stum (2007)[a], Brown et al. (2012), and Wang et al. (2018)
	Income	+: Kumar et al. (1995), McCall et al. (1998), Mellor (2001), Cramer and Jensen (2006), Schaber and Stum (2007), Brau and Bruni (2008), Wang et al. (2018), and Courbage and Roudaut (2008): non-linear bell-shaped
	Wealth[b]	+: McCall et al. (1998), Mellor (2000, 2001), and Chatterjee and Fan (2017) 0: Kumar et al. (1995) −: Costa-Font and Rovira-Forns (2008): owning house or flat; Davidoff (2008, 2010): home equity.
	Bequest motives	+: Pauly (1990)[c], Cramer and Jensen (2006), Courbage and Roudaut (2008, 2011), Brown et al. (2012), Chatterjee and Fan (2017) 0: Sloan and Norton (1997), Lin and Prince (2016), and Sperber et al. (2017) −: Zweifel and Strüwe (1996, 1998), Eisen and Sloan (1996), Courbage and Zweifel (2011), Zweifel and Courbage (2016), and Lockwood (2018)
Social and Cultural Factors	Education	+: Kumar et al. (1995), Sloan and Norton (1997), McCall et al. (1998), Mellor (2000, 2001), Cramer and Jensen (2006), Chatterjee and Fan (2017), and Wang et al. (2018) 0: Costa-Font and Rovira-Forns (2008)
	Knowledge	+: Cohen et al. (1992): lack of information; Schaber and Stum (2007), and Zhou-Richter et al. (2010): adult children awareness; Gottlieb and Mitchell (2015)[d]: use of many information sources; Lin and Prince (2016): awareness of Partnership programme and financial literacy; McGarry et al. (2016): numerical literacy
	Experience	+: McCall et al. (1998), Coe et al. (2015): having family member or friend in need of LTC; Courbage and Roudaut (2008, 2011): experience of disability; Finkelstein et al. (2012), Tennyson and Yang (2014): previous caregiving experience 0: Cramer and Jensen (2006): experience of individual's own parents −: Kumar et al. (1995): previous caregiving experience
	Beliefs	+: Kumar et al. (1995): increased expectation of LTC cost; Sloan and Norton (1997)[e]: probability of being in a nursing home; McCall et al. (1998): belief of having no caregiver and independence from government in LTC expenditure; Brown et al. (2012) and Chatterjee and Fan (2017): need for care in future; Sperber et al. (2017): belief of autonomy; Finkelstein and McGarry (2006): belief about the likelihood of entering a nursing home; Pincus et al. (2017): promoting emotional frame; Schaber and Stum (2007): belief of higher risk
	State-dependent utility	−: Brown et al. (2012) and Brown and Finkelstein (2009)
	Intra-family moral hazard	0: Mellor (2001) −: Pauly (1990), Zweifel and Strüwe (1996, 1998), Zweifel (1996), and Sloan and Norton (1997)
	Current health status	+: McCall et al. (1998), Cramer and Jensen (2006), and Courbage and Roudaut (2008, 2011): having high risk factors of dependency[f] 0: Mellor (2001) −: Schaber and Stum (2007) and Costa-Font and Rovira-Forns (2008)
	Risk aversion	0: Finkelstein and McGarry (2006) and Costa-Font and Rovira-Forns (2008)
	Trust in insurers	+: Finkelstein and McGarry (2006): strong taste for insurance; Brown et al. (2012)[g]: trust in insurers; Chatterjee and Fan (2017): preference for risk management through other types of insurance

Table 5 (continued)

Category	Subcategory	Results with respect to LTCI demand
Structural Factors	Substitutes for LTCI: family resources	+: Courbage and Roudaut (2008) 0: Mellor (2001) −: Brown et al. (2012) and Costa-Font and Courbage (2015): financial support by family.
	Substitutes for LTCI: public insurance	0: Brown et al. (2012); Costa-Font and Courbage (2015): expectation of public payment for insurance −: Sloan and Norton (1997)[h], Brown et al. (2007), Brown and Finkelstein (2008), and Zweifel and Courbage (2016)
	Tax Incentives	+: Cramer and Jensen (2006) 0: Courtemanche and He (2009), Goda (2011), Nixon (2014), and Lin and Prince (2013): Partnership in Medicaid
Demographic Factors	Age	+: Schaber and Stum (2007) and Costa-Font and Rovira-Forns (2008): higher for middle age 0: Chatterjee and Fan (2017) −: Kumar et al. (1995) and Wang et al. (2018)
	Gender (women)	+: Kumar et al. (1995) and Chatterjee and Fan (2017) 0: Costa-Font and Rovira-Forns (2008)
	Marital status (married)	+: Kumar et al. (1995), Courbage and Roudaut (2008, 2011), and Brown and Finkelstein (2009) 0: Sloan and Norton (1997) and Cramer and Jensen (2006): results vary depending on different range of assets[i]
	Children	+: Courbage and Roudaut (2008, 2011) 0: Sloan and Norton (1997) and Costa-Font and Rovira-Forns (2008): household size −: Cramer and Jensen (2006) and Schaber and Stum (2007): family size

+ (−;0) denotes a positive (negative, insignificant) relationship between the change in a factor and LTCI demand

[a]They study the effects of group LTCI enrolment decision (and affordability of LTCI instead of price)

[b]Various categories of wealth are considered here such as net worth, asset, and net asset

[c]Pauly (1990) argues that individuals protect the bequest by buying insurance, such as LTCI and life insurance, and he believes the demand for LTCI would be higher among those who purchase (term) life insurance. However, Meier (1998) does not find any systematic correlation between demand for life insurance and the demand for LTCI

[d]Gottlieb and Mitchell (2015) define 'narrow framing' as people's tendency to make decisions in isolation

[e]They find self-evaluated probability of being in a nursing home in 5 years is significant. However, for a time frame of 10–15 years it is not

[f]These factors are defined as smoking, drinking alcohol and critical level of body mass index

[g]They find that lack of trust in insurers negatively affects the demand for LTCI

[h]For people over the age of 70 the correlation is negative, but for the cohort aged 51-64 it is not

[i]Married people with assets in the middle range have a positive correlation, otherwise negative

factors are clear in their prediction and consistent with observations from other insurance markets (see Outreville 2013; Eling et al. 2014). More income,[20] education, knowledge, experience,[21] beliefs about worse future conditions, whether economical or social, trust in insurance and providers and being a woman[22] all increase demand for LTCI.[23] An increase in price, substitutes for LTC (via public insurance), intra-family moral hazard and state-dependent utility negatively impact the demand for LTCI. Finally, risk aversion has an insignificant effect on demand.[24]

The other eight factors are inconclusive and sometimes even contradictory in their predictions. While higher wealth generally leads to more demand for LTCI, some studies report that home equity reduces the demand for LTCI.[25] This result is also linked to the inconclusive results for bequest motives. Lockwood (2018) argues that inconsistencies in retirees' saving and insurance choices match with models in which bequests are considered luxury goods compared to standard life-cycle models where people care only about their own consumption. He argues that bequest motives, by reducing the opportunity cost of precautionary efforts, decrease the value of insurance and might therefore explain a lower demand for late-life risks. Moreover, financial family support has a negative effect on the demand for LTCI.

Unobserved bad health status leading to more demand for LTCI is one of the fundamental information asymmetries in this market. A positive effect of health status documented in some studies might be due to potential empirical bias that LTCI policyholders are already filtered by exclusions from the insurers' underwriting process.[26] Courbage and Roudaut (2008) have addressed substitutes such as informal care from family. In their study of the French population, they cite altruism as a reason for the positive effect of informal care and the demand for LTCI. However, Mellor (2001) shows that caregiver availability does not discourage parents from buying LTCI.[27] Within the category of structural factors, it is also not clear whether tax incentives have a positive or insignificant impact on LTCI demand.[28]

[20] Courbage and Roudaut (2008) illustrate a non-linear bell-shaped effect of income on demand, emphasising that only a fraction of the population is interested in LTCI; poor people cannot afford it while extremely wealthy people can pay the potential costs out-of-pocket.

[21] Only Kumar et al. (1995) report a negative effect of experience on demand for LTCI. They state that most of LTCI policies available at the time of survey did not provide significant home health coverage.

[22] Costa-Font and Rovira-Forns (2008) explain their insignificant results by the fact that a part of the gender effect is captured by the effect of the individual's own disability risk perceptions.

[23] Our focus in this study is on the demand for LTCI in general. However, articles such as Meier (1999) focus on the postponement of purchasing LTCI by the young generation and its reasons.

[24] Costa-Font and Rovira-Forns (2008) attribute this insignificant effect to the fact that risk-averse people may prefer to protect themselves through other means such as protective savings and self-insurance.

[25] The same is observed for other measures related to home equity, such as having a larger home equity to wealth ratio (see Davidoff 2008).

[26] McCall et al. (1998).

[27] Other types of private insurance such as (the surrender value from) classical life insurance without LTC rider or critical illness insurance (for diseases that might result in LTC) might be interpreted as a third category of substitutes alongside public insurance and the family.

[28] Cramer and Jensen (2006) note that the demand for coverage is price-inelastic; a USD 1,000 decrease in the annual premium would cause an increase of only 0.01 (on a scale of 0 to 1) in the probability of an individual purchasing LTCI. It thus seems that premium subsidies or intense price competition may not

Costa-Font and Rovira-Forns (2008) report that middle-aged people have more demand for LTCI than other age cohorts. Chatterjee and Fan (2017) find an insignificant effect of age on LTCI demand. They argue that while many studies find demand increases with age, the insignificant effect may be due to the offsetting effect of health and perceived risk along with increase in premiums based on age. Moreover, Kumar et al. (1995) and Wang et al. (2018) find that the demand for LTCI decreases with age, perhaps because of the reduced expected value of coverage.[29] A more detailed study of potential non-linear and interaction effects might be needed to better explain the ambiguous results of age on LTCI demand.[30,31]

The effects of marital status and number of children are also mixed. While Courbage and Roudaut (2008, 2011) explain the positive relationship between being married and having children and LTCI demand by altruistic behaviour, Cramer and Jensen (2006) argue the opposite: that the negative effect of having children on LTCI demand may be attributable to expectations on the part of parents for their children to provide informal care as a substitute for formal care. Courbage and Zweifel (2011) theoretically prove the existence of a two-sided (bilateral) intergenerational moral hazard in which purchase of LTCI by parents decreases the child's incentive to provide informal care, and in the meantime, parents purchase less LTC coverage, expecting their child's efforts to keep them out of a nursing home. In a survey conducted in China, Xu and Zweifel (2014) find a similar two-sided intergenerational moral hazard on respondents' statements. However, they do not confirm the evidence of the effects of exogenous changes, such as more parental wealth and higher expected inheritance for the child on intergenerational moral hazard.[32] Overall, it seems that many of the inconclusive and contradictory results are explained by interactions among economic, social and demographic factors. More research might thus be needed to untangle those interaction effects in order to derive cleaner predictions for those factors.

Footnote 28 (continued)
stimulate the demand for insurance. Overall, it is not fully understood under which conditions premium subsidies or tax incentives are an effective and efficient tool for promoting LTCI demand.

[29] Kumar et al. (1995) state that as the probability of the LTC need increases, the utility value of purchasing fair (or constant load) insurance to meet that need falls, and self-insurance becomes more attractive. An additional explanation is the age variation in prices.

[30] Wang et al. (2018) also mention that higher demand in younger cohorts in China may be due to the strict one-child policy that was in effect at the time of their birth. They may feel a greater need for LTC coverage than their elders.

[31] Ambiguous results with respect to age are also documented in other insurance markets. These results, however, may reflect the U-shaped relationship as identified in Cohen and Einav (2007) and Halek and Eisenhauer (2001). Similar tests seem warranted in the LTCI market.

[32] While Courbage and Zweifel (2011) theoretically predict that more parental wealth and a higher level of expected inheritance induce intergenerational moral hazard, with the net effect leading to the purchase of less LTCI coverage, Xu and Zweifel (2014) argue that the lack of such predictions in China may be interpreted as the traditional Chinese view of the importance of filial piety, which means children do more to support their ailing parents, no matter how much LTC coverage their parents have.

Insurability of long-term care

Applying Berliner's (1982) insurability criteria to LTC risk, we now systematically analyse the problematic features of LTC risk and identify the major impediments to the development of the LTCI market (see Table 6).[33] We identify and discuss four problem areas.

Randomness of loss occurrence

There are two criteria for analysing randomness: independence and predictability. The need for formal LTC depends on many factors such as lifespan (with and without disability) and presence of family support (Kessler 2008), which do not seem critical to independence. Barr (2010) argues that LTC probability may not be independent, but rather interdependent. Because of technological progress and increasing life expectancy, there might be an upward trend in LTC probability due to multi-morbidity and dementia in later life. For instance, medical advancements have improved addressing cardiovascular disease, which will increase the life expectancy of elders who are now more prone to dementia. However, this effect is not trivial, because connecting future life expectancy and historical morbidity data neglects the finding that the morbidity of the future population might also be different.[34] While there are difficulties in describing morbidity and variations in the population morbidity,[35] some empirical studies conclude that there has been morbidity compression in recent years,[36] while others do not.[37] Moreover, conditions such as random fluctuations, lack of complete knowledge of relevant probabilities, long time dimensions and the dynamic nature of the environment affecting LTCI make LTC predictions difficult.[38] Not only are multi-state models more difficult to estimate and calibrate than single-state models (both conceptually and empirically), but there is a limited understanding of how the future of LTC might look.[39]

[33] The insurability model is defined from an insurance carrier point of view and analyses the risks at the aggregate portfolio level (not individually). It maps out the major factors that should be taken into account by practitioners (for product design) or policymakers (for institutional framework) to improve insurability. Although leading to some overlap in the demand factors, we believe that the consideration of both the Outreville (2013) insurance demand framework and the Berliner (1982) insurability criteria provides added value because they highlight the fundamental points from two different perspectives.

[34] An example is that future dementia might be overestimated just by connecting the number of elderly people in the future with today's dementia occurrences and neglecting changes in dementia occurrences.

[35] Crimmins and Beltrán-Sánchez (2011).

[36] Stallard (2016).

[37] Crimmins and Beltrán-Sánchez (2011).

[38] Brewster and Gutterman (2014).

[39] In a personal conversation, Christian Mumenthaler, CEO of Swiss Re, called LTC 'science fiction' insurance, because insurance companies have no idea what LTC will look like in 10 or 20 years. While insurance companies can limit the amount or coverage period, it is unclear whether this amount and time is sufficient.

Table 6 Assessment of insurability for LTC risk

Insurability criteria			Main findings	Assessment
Actuarial	(1)	Randomness of loss occurrence	Losses are independent (but may be interdependent) Long time dimension of the risk along with the dynamic nature of the environment affecting LTCI makes predictability difficult Actuarial basis for calculating LTCI premiums is not yet well developed in many countries Intertemporal risks such as inflation affecting cost of care cannot be diversified between age cohorts	Problematic
	(2)	Maximum possible loss	Possible portfolio loss may increase because of demographic factors and medical enhancements[a] Insurance companies protect themselves by limits on either payout[b] or duration of coverage[c]	Not problematic
	(3)	Average loss per event	The average loss for LTC may increase due to long-term nature of the risk and increase in medical costs, or decrease due to morbidity compression[d] Insurance companies prefer providing indemnity-based benefit rather than service benefits to better calculate the average losses[e]	Not problematic
	(4)	Loss exposure	Loss exposure may increase through ageing baby boomers It depends on the structure of population age cohorts	Not problematic
	(5)	Information asymmetry	Existence of both adverse selection and moral hazard Possible existence of intra-family moral hazard Insurers exclude the higher risk individuals by using medical scanning at the inception of cover.	Problematic
Market	(6)	Insurance premium	High loading needed because of uncertainty with respect to future losses and information asymmetry Low demand (only educated middle-income class people with experience and a pessimistic outlook are interested) Demand is rather inelastic with respect to price, indicating that subsidies may not be very effective	Problematic
	(7)	Cover limits	Intertemporal risk[f] encourages insurers to put limitation on their coverage Exclusion of people with pre-existing health conditions	Problematic
Society	(8)	Public policy	The coverage is consistent with societal values.	Not problematic
	(9)	Legal restrictions	Coverage is allowed in all jurisdictions	Not problematic

[a]Kyle (2013)

[b]Barr (2010)

[c]Comas-Herrera et al. (2012)

[d]Payne et al. (2007) study the impact of ageing on health care expenditure and find that the duration and severity of morbidity increase with age. However, Schut and van den Berg (2010) address the healthy ageing process that leads to longevity gains for the population. He states that the occurrence of this process is mixed. In addition, Stallard (2016) discusses comprehensively the compression of morbidity and mortality period based on empirical data

[e]Cutler (1996) illustrates this issue by describing indemnity payments that are fixed in amount (daily benefit) and time, comparing them to the real expenses of LTC services, which may exceed the daily benefits

[f]Ibid. The risks associated with long-term insurance policies arising from decreasing accuracy of predictions

While many studies use Markov models for pricing LTCI,[40] the research has focused on the future evolution of mortality and disability transition intensities.[41] The complex effects of the processes of ageing[42] (i.e., disability and cognitive impairment), death probabilities for both autonomous and disabled people, pathological information and longevity gains in the late twentieth century[43] and time spent in dependency[44] illustrate the need for comprehensive models for pricing LTC risks. More research is thus needed to improve the modelling and empirical basis for LTCI as well as the drivers of LTC probability, duration and intensity.[45]

Information asymmetry

Early studies by Cutler (1996) or Chen (2001) cite both adverse selection and moral hazard as the main insurability limitations. In the meantime, there is clear empirical evidence for adverse selection. For example, Oster et al. (2010) find strong evidence of adverse selection in LTCI analysing individuals' genetic information.[46] Zick et al. (2005) report that adverse selection exists for people who were diagnosed with Alzheimer's disease.[47] When it comes to moral hazard, Li and Jensen (2011) and Konetzka et al. (2014) discuss the effect of having LTCI on the likelihood of using nursing home care. The moral hazard issue in LTC can also occur as an intra-family moral hazard in which changes in caregivers' behaviours may affect LTCI demand and losses.[48] Various kinds of LTCI benefits, such as fixed versus proportional, may affect the kind and the intensity of intra-family moral hazard.[49] Insurance companies

[40] See Levikson and Mizrahi (1994), Pitacco (1995), and Haberman and Pitacco (1998) for early works.

[41] See Levantesi and Menzietti (2012) and Fong et al. (2015).

[42] Pritchard (2006).

[43] Biessy (2017).

[44] Fuino and Wagner (2018).

[45] The actuarial basis for calculating LTCI premiums is not well developed in many countries (the probability estimates of LTC are more accessible in the U.S. than in European and Asian countries), but is getting better (see, e.g., Fuino and Wagner 2018 for Switzerland). Furthermore, the cost of care that is covered by LTCI is exposed to intertemporal risk. Cutler (1996) argues that inflation affects all members of the insurance pool by gradual increase of the costs of services. Hence, it would be more difficult for an insurance company to pool such an interdependent risk. See Karlsson (2002).

[46] They use data from individuals at risk from Huntington disease (HD) and find that those who carry the HD genetic mutation are up to five times more likely to buy LTC than individuals from the population without that mutation.

[47] 17% of applicants who tested positive changed their LTCI coverage in the year following the test. This rate was 2% for people who tested negative, and 4% for those who did not receive the disclosure of their APOE (Apolipoprotein E). Studies of lapse behaviour in LTCI also discuss dynamic adverse selection, in which the insured may decide to cancel the policy when health improves. See Finkelstein et al. (2005) mentioning this inefficiency in the private LTCI market. Konetzka and Luo (2011) mention factors such as the characteristics of the individuals who cancel their LTC policies. They state that health status plays a small role in the decision to allow a policy to lapse. They also find little evidence of ex post adverse selection based on health status, and conclude that LTCI lapse is usually based on financial problems rather than changes in health risk. Basu (2016) also confirms the low economic conditions of the individuals as the factor affecting the lapse decision, and finds evidence of ex post advantageous selection.

[48] See Pauly (1990), Zweifel and Strüwe (1996), Zweifel (1996) and Zweifel and Strüwe (1998).

[49] See Klimaviciute (2017).

deal with adverse selection by medical screening and exclusions, especially for those with pre-existing health conditions.[50] Combined policies might help to resolve some of the information problems.

Insurance premium

Kessler (2008) mentions three problems that insurers face in pricing LTCI. The first is the substantial uncertainty in LTC cost projections, resulting in substantial uncertainty on future loss payments. The second risk is adverse selection, which requires insurers to set high loadings on the premiums. The third risk is moral hazard. Obviously, the insurability problems here are the natural consequence of the latter two aspects discussed above. Brown and Finkelstein (2007) consider the high premium loadings to be a signal of supply-side market failure. As discussed above (Cramer and Jensen 2006), subsidies or tax incentives reducing the effective price of LTCI are very likely not a general solution to the problem.

Cover limit

Insurance companies need limits on daily benefits and coverage period to protect against uncertainties[51] and inefficiencies such as adverse selection and moral hazard.[52] These cover limits also interact with factors such as public LTC. In addition, the tendency to provide an indemnity benefit rather than a service benefit may discourage individuals from purchasing private LTCI, because they are unsure whether coverage is sufficient.

To conclude, both supply-side and demand-side factors are used to explain the small market for private LTCI and thus reduced insurability. Among the supply-side explanations are high loadings on the actuarial fair price and rationed coverage (Brown and Finkelstein 2007) that result from significant actuarial uncertainties and asymmetric information. It seems, however, that supply-side constraints alone are not significant enough to be blamed for the small market size.[53] Limited consumer knowledge or rationality, state-dependent utility (i.e., a low value of consumption while in care), and the existence of potential substitutes for formal insurance are important demand-side explanations that reduce the insurability. Potential substitutes can be any informal financial or in-kind insurance provided by families, illiquid housing equity that may be liquidated to pay for care, or public insurance provided,

[50] See Hendren (2013) for existence of more private information for those who are rejected by an insurer.

[51] Barr (2010).

[52] Colombo et al. (2011).

[53] Brown and Finkelstein (2007, 2008). Focusing on the demand side, Ameriks et al. (2018) study the under-insurance in late-life risks by designing an idealised insurance product that does not have the defects of the LTCI policies available in the market. They then quantify the demand for their new product based on survey data and compare it with the demand for a normal LTCI product; their model predicts 59% of the sample will want to purchase their policy, while only 22% of the sample already has LTCI. This gap sheds light on unmet demand in the market.

for instance through Medicaid in the U.S. Information asymmetries have also been the centre of attention in many studies.[54]

Summary and directions for future research

Table 7 summarises our results and proposes avenues for further research. The list of research directions presented in Table 7 is based on a structured review of recent papers and the papers on the main path which is provided in Table 10 in Appendix 3. As one might expect for an applied research topic such as LTCI, the recommendations are intended for both academic researchers and practitioners. While the majority of research topics are addressed to researchers who must produce conceptual work and conduct empirical tests, most of the outcomes of such studies have implications for a practitioner audience.[55]

New methods and products are needed for financing the rise of LTC expenditure.[56] Some studies propose combined policies and other innovative ideas to compensate for inefficiencies such as adverse selection in the private LTCI market. Recent examples are reverse mortgages, variable life care annuities with guaranteed lifetime withdrawal benefits, and personal care saving bonds. While social insurance and tax-based financing may provide universal coverage to all of the population, in the long run the significant increases in public expenditure might call into question the sustainability of these types of funding.[57] Moreover, other effects of public financing of LTCI, such as crowding-out effects on private savings and informal care should be treated cautiously.[58] Recent studies have taken both information asymmetry and sustainability problems into account, and propose to embed LTCI costs in

[54] See Finkelstein and McGarry (2006), Webb (2009) and Sloan and Norton (1997).

[55] For example, the development of better data sets is mainly a to-do for practitioners, but if they exist they are an important input for research. At the same time, the development of better models for calculating risk and prices is a primary task for researchers, but if the models exist, they might be well applied in the industry. It is thus difficult, if not impossible, to identify which recommendations specifically address researchers or practitioners.

[56] De la Maisonneuve and Martins (2015) categorise the determinants of LTC expenditure in demographic and non-demographic drivers. In the demographic part, the transformation of the population towards older ages increases the number of old people. However, whether this leads to a higher number of people needing LTC depends on the development of disability rates among older generations (de Meijer et al. 2012). Disability trends seem to vary across countries; while some countries experience a decline in disability prevalence rates in elderly people (e.g., Denmark, Finland, and Italy), others experience stability (such as Australia and Canada) or even growth (Belgium, Japan, and Sweden); see Colombo et al. (2011). The dynamics of disability prevalence rates in different periods and countries is one of the major obstacles for predicting the effect of demography on future LTC expenditure and needs to be better understood. Non-demographic drivers such as the price of LTC (driven for example by productivity and labour costs), increase in demand for formal LTC (decline in availability of informal caregivers) and income effects (rise in real incomes leading to demand for higher quality services) are other factors determining LTC expenditure.

[57] Colombo and Mercier (2012) and Angelis et al. (2017).

[58] See Xu and Zweifel (2014) on the analysis of public expenditure in China, and Courbage and Zweifel (2015) on the effect of means-tested public provision on crowding-out effects of private savings and informal care.

Table 7 Summary of results and potential future research

Financing	Demand	Insurability
Panel A: Summary of results		
Mix of ex ante (insurance) and ex post (public sector, family) used in all advanced economies Contribution of private LTCI is marginal Combined insurance policies and alternative financing models might help to increase demand and improve sustainability	20 factors have been studied empirically with respect to their impact on LTCI demand 12 factors are relatively clear in their prediction and in general in line with observations from other insurance markets[a] The other eight factors are inconclusive or contradictory[b]	High premium loadings and rationed quantities needed because of uncertainty with respect to probability, intensity and duration of LTC and information asymmetries Reduced interest also on the demand side (low value of consumption while in care, existence of public and private substitutes)
Panel B: Potential future research		
Optimal mix of public and private funding	Impact of culture on formal and informal care	Morbidity data (more data with better quality, more countries)
Interaction with other parts of welfare (e.g. pension schemes)	Non-linear and interaction effects, e.g., with respect to income or age	Better models for calculating risks and prices
Wealth trajectories in retirement/life-cycle models	Role of taxes/premium subsidies	Alternative Risk Transfers (ART) to cover LTC risk
Non-linear LTCI policies	Two-sided altruism	Lapse of LTCI
Swap with cash flows depending on the survival of disabled people	Emotional framing versus rational framing	Risk preferences in the context of asymmetric information

[a]More income, education, knowledge, experience, future beliefs related to future worse condition, trust in insurance and providers and being female increase the demand for LTCI. An increase in price, substitutes for LTC, intra-family moral hazard and state-dependent utility reduce the demand for LTCI. Risk aversion has an insignificant effect on demand

[b]Wealth, bequest motives, health status, substitutes such as informal care from family, tax incentives, age, marital status and number of children are inconclusive or ambiguous

the Notional Defined Contribution (NDC) pension schemes as the optimal method of financing of LTC expenditure.[59] Implementation of such proposals may need further study on requirements and major obstacles to the transition from other methods of financing to new ones.[60] Blundell et al. (2016) compare retirement wealth trajectories in the U.S. and England. Their study addresses the importance of constructing a life-cycle model that explains different asset trajectories in various countries during retirement. While they mention the necessary ingredients of a model such as bequest motives, risk of health expenses and consideration of housing as a distinct asset, the literature on this field is still immature. Further research is needed, for example, to describe the determinants of housing wealth release during retirement.

Four categories of factors (economic, social and cultural, structural, demographic) influence the demand for private LTCI; social and cultural factors are the most frequently mentioned in the literature. The recent study by Gentili et al. (2017) gives new insights into cultural differences and their role in the demand for private LTCI along with public expenditure. They study the cultural differences in different regions of Switzerland and their effect on optimal coverage and public plans provided by the government. This study might be extended to other countries to examine the role of culture on demand for formal and informal care, as well as its effect on the optimal method of financing LTCI.

Some studies mention non-linear effects of the demand side. Using data from France, Courbage and Roudaut (2008) find a bell-shaped relationship between income and the demand for private LTC; in other words, demand is low for low- and high-income individuals but higher for middle-income individuals. This non-linear pattern could be studied in a cross-country setup. Next to country effects, interaction effects (e.g., with respect to age) might be considered in such a setup, for example to analyse a potential U-shape between age and LTCI demand (Cohen and Einav 2007; Halek and Eisenhauer 2001).

Brown and Finkelstein (2008) explore the interaction of public and private insurance in the U.S. They estimate the implicit tax for a median-wealth man to be 60% and for a median-wealth woman to be 75%. Implicit tax is the amount of premium that should be paid to private LTCI for similar coverage that would have been covered by Medicaid (meaning that the private policy replaces 60% of benefits otherwise covered by Medicaid; so the implicit tax is 60%). It would be worth using this criterion to compare the different tax-based systems of funding. This will improve our understanding of the relation between implicit tax and the demand for private LTCI, and the interaction between public and private activities in general. Moreover, the dynamics of changes in implicit tax due to recent reforms have the potential for future research. Given that it is in general not clear whether tax incentives have a positive or insignificant impact on LTCI demand and given that a lot of money

[59] See Pla-Porcel et al. (2016), Ventura-Marco and Vidal-Meliá (2016), Vidal-Meliá et al. (2018) and Pla-Porcel et al. (2017).

[60] See Meier (1996) for the analysis of moving from a private funding system to a social aid regime and from the latter to the compulsory insurance regime, and their effects on LTCI and savings.

might be used to finance tax incentives, more empirical studies should be done to analyse the real demand effect of tax incentives and their efficiency.

Altruistic behaviour between parents and children also deserves further attention. Cremer et al. (2016b) propose social LTCI utilising subsidies, payroll, and inheritance taxes. Their model might be extended to cases where parents leave no bequest or bequeath only when in good health. They also propose to study non-linear LTCI policies where LTC benefits are linked to the level of informal care provided by children. Cremer et al. (2017) study the role of private and public insurance in an uncertain family assistance setting. They analyse optimal conditions and properties of public LTCI in this environment. Their model can be extended in a way that adds heterogeneity by considering individuals with different wealth and probability of altruism.

The traditional models for framing the LTCI need to be improved. Pincus et al. (2017) show that emotional narrative frameworks can improve willingness to pay for LTCI compared to statistical evidence (i.e., level of probability). Further experimental research is needed to illustrate the cognitive and emotional drivers underlying the emotional frameworks and the influence of various emotions generated by communications. Also, the recent discussion on narrow framing and LTCI demand (Gottlieb and Mitchell 2015) might provide an alternative avenue to understand the decision-making process of individuals when buying LTCI. Experimental research might also provide clean tests in a controlled environment, for example, to more accurately analyse the effects of adverse selection and moral hazard, both of which are relevant for LTCI, but cannot be separated in most empirical research.

Longevity and morbidity risks have significant effects on LTC expenditure and insurability. However, the results of previous studies concerning these risks are inconclusive. As discussed above, some studies conclude that there has been morbidity compression in recent years[61] while others do not.[62] Other researchers focus on longevity[63] and disability[64] trends and their effects on LTC expenditure. These studies show that longevity, morbidity and disability change not only based on gender and age differences but also among age cohorts. It would be interesting to derive precise results on the effect of morbidity trends on LTC expenditure in countries other than the U.S. Moreover, further studies should be done on the dynamics of mortality and morbidity changes and the future predictions based on population growth.

Li et al. (2017) propose a new multiple state functional disability model that uses systematic trend and uncertainty of mortality and disability for transition rates. Their new model is suitable for pricing LTCI products based on uncertainties of transition rates. More studies are needed on the comprehensiveness of their model in morbidity compressions or expansions and its effect on LTCI pricing and risk management. Pauses or slowdowns in morbidity improvements and their effects should be

[61] Stallard (2016).

[62] Crimmins and Beltrán-Sánchez (2011).

[63] Lakdawalla and Philipson (2002) and Spillman and Lubitz (2000).

[64] See de Meijer et al. (2012) for trends in mild and severe disability; Stearns et al. (2007) and Freedman et al. (2013) on late-life activity limitations.

emphasised. There is also a lack of alternative risk transfers (ART) in the market for LTCI. While there are longevity securities, such as longevity bonds[65] and longevity swaps[66] for hedging the longevity exposure in annuity products, the financial market suffers from ART mechanisms for risks exposed to LTC.

The literature lacks comprehensive studies on possible ex post adverse or advantageous selection in the lapse of LTCI. Friedberg et al. (2017) mention unintended lapse as the major source of dynamic advantageous selection. Bauer et al. (2017) find the advantageous selection in both the decision to purchase and the decision to extend complementary LTCI coverage in Germany. Finkelstein et al. (2005) claim that the reason for immediate lapse could be a wrong purchase. Other studies have found a U-shaped lapse rate curve based on the duration of policy purchase.[67] More studies of lapses, the lapse rate curve, income shocks on lapse decision and the ex post effects of the lapse on LTCI portfolios are needed for better understanding, optimal design and improved risk management of LTCI policies. Also, the general information asymmetries inherent in the LTCI market need attention. Finkelstein and McGarry (2006) argue that heterogeneity of private information exists not only in risk types but also in risk preferences. They encourage further study of the effects of heterogeneity in risk preferences on the costs of asymmetric information about risk types.

The literature on LTCI thus still lacks empirical and theoretical research on numerous emerging areas. While more than a decade has passed since the introduction of combined LTCI products, more empirical research is needed to analyse their (in)efficiencies in terms of demand and supply. This could not only help practitioners to improve current LTCI products but also provide better insights for modelling the new ones. Moreover, there are a few theoretical observations that might need better empirical verification. Among them are crowding-out effects of various public provisions (as addressed e.g. by Courbage and Zweifel 2015), non-linear LTCI policies and separation of LTCI expenditure by quantity and inflation.

This paper focuses on alternative financing and risk management models, including insurance. Such a study should, however, not overlook other means of improving the sustainability of the LTC system, which might come from areas outside of financing. When it comes to the organisation of LTC, the introduction of new technologies to LTC can affect the cost development in this sector. Information, communication and technology can enhance communication among the actors such as citizens, informal and professional caregivers who provide LTC services.[68] The U.S. Center for Technology and Aging (2009) mentions seven focal areas of technology to help older adults remain independent and to make LTC more cost-efficient: (1) medication optimisation, (2) remote patient monitoring, (3) assistive technologies, (4) remote training and supervision, (5) disease management, (6) cognitive fitness and assessment technologies, and (7) social networking. New technologies, such as

[65] Bartkowiak (2012) and Blake et al. (2006).
[66] Chen (2016).
[67] Society of Actuaries (2011).
[68] ENEPRI (2012).

remote monitoring and virtual care, might significantly lower LTC expenditure, for example, by reducing the amount of labour needed in care provider facilities.[69] This may contribute to a lowering of the premiums for existing products as well as facilitating the design of new ones.

Appendices

Appendix 1: Increasing relevance of long-term care insurance

Figure 4 documents the exponential growth in the academic interest of the topic of LTCI by showing the number of papers (Fig. 4, left) and the number of citations (Fig. 4, right) from Web of Science. We depict the extracted records of total LTCI

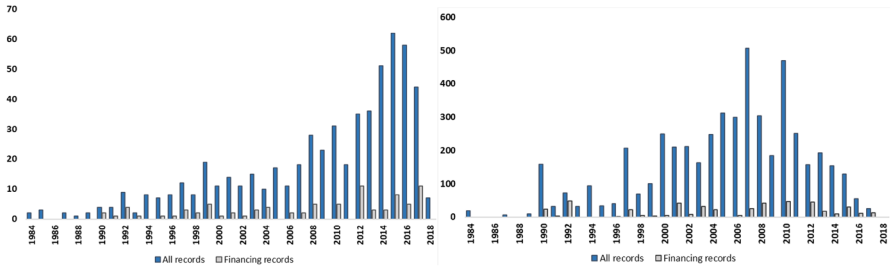

Fig. 4 Number of papers (left) and number of citations (right) in Web of Science

Table 8 Authors and journals with most publications in the data set

No.	Author	Records	Journal	Records
1	Costa-Font, J.	20	Gerontologist	51
2	Courbage, C.	13	Health Affairs	21
3	Pestieau, P.	13	Health Policy	21
4	Finkelstein, A.	8	The Geneva Papers on Risk and Insurance—Issues and Practice	20
5	Ikegami, N.	8	Journal of Risk and Insurance	15
6	Nadash, P.	8	Health Economics	14
7	Wiener, J.M.	7	Inquiry: The Journal of Health Care Organization Provision and Financing	13
8	Brown, J.R.	7	Journal of Health Economics	12
9	Cohen, M.A.	7	Social Policy Administration	11
10	Cremer, H.	7	Gesundheitswesen	9

[69] According to Argentum (2016), more than 1.2 million employees will be needed by 2025 to provide the required care for the growing ageing population.

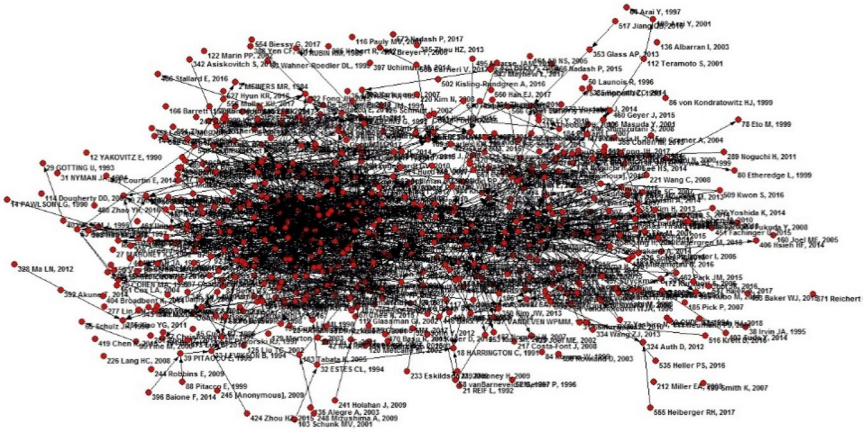

Fig. 5 Citation network of the 591 papers

literature along with the ones related to financing of LTCI for comprehensiveness of our results. The early peaks in the number of citations are 135 citations for the Pauly (1990) article and 67 and 64 citations for Sloan and Norton (1997) and Ikegami (1997). The three papers cited most often are by Van Houtven and Norton (2004), Finkelstein and McGarry (2006) and Ikegami and Campbell (2002) with 192, 187 and 152 citations, respectively.

We found 1280 articles based on search criteria of 'long term care' and 'insurance' from Web of Science and manually filtered out those unrelated to the insurance aspect of LTC. This left us with 591 articles for our citation network. Table 8 illustrates the authors and journals with the most publications in our database of 591 articles.

Appendix 2: Main path analysis

Figure 5 illustrates the raw citation network of 591 records exported from Web of Science.[70] Liu and Lu (2012) identify the following advantages of main path analysis. First, it simplifies the citation network with hundreds of nodes into a smaller number of nodes and links. This gives us a satellite view of the network. Second, it demonstrates the historical evolution of a topic via main contributions in the literature. Third, it shows which papers have attracted the most attention in the historical development of a topic. Although the citation count illustrates the direct effect of the articles on a certain topic, the main path analysis also considers the indirect effects.[71] Review papers are not included in the path because of the bias they could

[70] While most of these articles are empirical, approximately 106 are purely theoretical.

[71] The indirect effect is captured not only by the citation count but also by traversal weights between the nodes in the citation network.

Table 9 Main path studies

Article			Data			Citation Scores		
Author	Type	Main findings	Country	Source and year	Main Variables	LCS	GCS	Rank
Insurability and policy conditions								
Wiener et al. (1987)	Empirical	Evaluate affordability, coverage amounts and restrictions of available policies Find that LTCI policies are expensive and limited based on eligibility restrictions Recommend inflation adjustment of benefits for improvement of coverage	U.S.	31 private insurance policies -1986	Price, eligibility to purchase, coverage provisions, payment levels	2	6	164
Wilson and Weissert (1989)	Empirical	Focus on combinations of policy restrictions and exclusions Estimate likelihood of policy compliance Find two restrictions, prior hospitalisation and prior skilled care clauses as the major limitations of coverage	U.S.	National Nursing Home Survey (NNHS)-1985	Prior hospitalisation, mental illness exclusions, skilled or prior skilled-care requirements, deductible waiting periods, length of nursing home stay	6	9	128

Table 9 (continued)

Article			Data			Citation Scores		
Author	Type	Main findings	Country	Source and year	Main Variables	LCS	GCS	Rank
Liu et al. (1990)	Empirical	Compare insurability of LTCI with health insurance Study the important factors needed for designing and pricing private LTCI Find that population in need of LTC is very dynamic with higher levels of disability Implications for financing	U.S.	Supplement on Aging (SOA) of National Health Interview Survey (NHIS)-1984, National Long Term Care Survey (NLTCS)-1982–1984, (NNHS)-1985	Age, gender, ADL[a] difficulty by specific chronic condition, income, number of ADL, 56 health and functional variables, associated measures of acute and LTC service use both formal and informal, nursing home length of stay	3	18	69
Rice et al. (1991)	Empirical	Focus on current LTCI contracts in U.S. Examine their effects on out-of-pocket costs Confirm the restrictions mentioned in Wilson and Weissert (1989) and suggest two other restrictions, policy maximums and lack of inflation adjustment as major blocks	U.S.	NNHS-1985, LTC policies from 11 leading companies in 1988	Age, gender, marital status, nursing home length of stay, out-of-pocket costs paid by policies, policy restrictions	2	4	209

Table 9 (continued)

Article			Data			Citation Scores		
Author	Type	Main findings	Country	Source and year	Main Variables	LCS	GCS	Rank
Norton and Newhouse (1994)	Policy paper	Analyse U.S. LTC system Discuss four issues related to public LTC financing which are eligibility, benefits, financing, and reimbursements Suggest public LTC rather than private one	U.S.	–	–	12	25	46
Murtaugh et al. (1995)	Empirical	Focus on underwriting criteria of LTCI Discuss medical underwriting necessary to purchase LTCI Discuss efficiency of underwriting limitations on identifying high-cost groups	U.S.	National Mortality Followback Survey-1986, interview and NNHS-1985	Death certificate of residents aged 25 or older who died in 1986, nursing home use information, age, ADL limitation, major illnesses, lifestyle	17	22	54
Demand								
Pauly (1990)	Theoretical	Discusses rationality of limited tendency to buy private LTCI Argues existence of intra-family moral hazard Suggests intervention of government for LTCI market failure	–	–	–	94	135	5

Table 9 (continued)

Article			Data			Citation Scores		
Author	Type	Main findings	Country	Source and year	Main Variables	LCS	GCS	Rank
Crown et al. (1992)	Empirical	Study the affordability and potential market of private LTCI for various age cohorts Provide new estimates on significant potential market in the group of individuals aged 65–69 Discuss the role of public policy on the issue	U.S.	Survey of Income and Program participation, (SIPP)-1984, Consumer Expenditure Survey (CES)-1984	Age, asset, income, marital status, household expenditure data	6	12	94
Cohen et al. (1992)	Empirical	Study the differences between purchasers and non-purchasers of LTCI Mention various factors affecting the demand for private LTCI	U.S.	LifePlans Inc., Survey of purchasers and non-purchasers; U.S. Bureau of the Census, 1990	Age, gender, marital status, household income, liquid income, liquid asset, education, opinion about LTC	5	11	105
Zweifel and Strüwe (1996)	Theoretical	Study the existence of intra-family moral hazard Discuss the role of bequest in affecting intergenerational relationships	–	–	–	19	22	55

Table 9 (continued)

Article			Data			Citation Scores		
Author	Type	Main findings	Country	Source and year	Main Variables	LCS	GCS	Rank
Sloan and Norton (1997)	Empirical	Discuss the role of adverse selection, bequests and crowding-out on demand for private LTCI in U.S. Find no evidence of bequest motives	U.S.	Asset and Health Dynamics of the Oldest Old (AHEAD)-1993, Health and Retirement Study (HRS)-1992–1994	Variables related to expectations, adverse selection, bequest motive, Medicaid crowding-out, degree of risk aversion, income and wealth, expenditure risk, family structure, other demographic characteristics	48	67	3
Zweifel and Strüwe (1998)	Theoretical	Discuss the pros and cons of compulsory LTCI Argue that although by compulsory LTCI the adverse selection may be enhanced, the moral hazard between parents and children may increase	–	–	–	24	27	37
McCall et al. (1998)	Empirical	Study the factors affecting the purchase of Partnership programme Find out the determinants of purchasing Partnership LTCI	U.S.	Telephone survey of Partnership purchasers and random sample of population in each Partnership state-1995	Health status, opinions about LTC and LTCI, financial planning activities, demographic and social characteristics, income and assets	20	23	50

Table 9 (continued)

Article			Data			Citation Scores		
Author	Type	Main findings	Country	Source and year	Main Variables	LCS	GCS	Rank
Mellor (2001)	Empirical	Studies on substitutability of children as formal care for LTCI Does not confirm the existence of intra-family moral hazard Finds level of income, assets, and education as major factors affecting the demand for LTCI	U.S.	AHEAD-1994, Panel Study of Income Dynamics (PSID)-1994	Relationship of caregivers, age, education, income, net worth, health status, gender, marital status, colour, perspective towards receiving help, family size, having a daughter	32	38	27
Cohen (2003)	Empirical	Summarises the current knowledge available for private LTCI Discusses growing market for private LTCI and its effect on public expenditure, policyholders, their families and providers	U.S.	Health Insurance Association of America (HIAA)-1995–2000, Robert Wood Johnson Foundation (RWJ) and Department of Health and Human services (DHHS)-2000–2001	Annual sale, policy characteristics, age, gender, marital status, benefit package, wealth profile, education and awareness, daily cost of care, length of time receiving service, health status, availability of family support	7	17	75
Finkelstein et al. (2005)	Empirical	Discuss the dynamic inefficiencies of the market for LTCI by addressing the lapse patterns on LTCI Suggest the immediate lapses may be due to wrong purchase	U.S.	HRS-1995–2000, administrative data from a specific insurance company-1997–2001	Age, gender, number of limitations to IADLs[b], number of limitations to ADLs, and the presence of cognitive impairment	11	22	56

Table 9 (continued)

Article			Data			Citation Scores		
Author	Type	Main findings	Country	Source and year	Main Variables	LCS	GCS	Rank
Finkelstein and McGarry (2006)	Empirical	Study various dimensions of existence of private information market for LTCI Emphasise two types of people with private information that purchase private LTCI: high-risk individuals and people with strong taste for insurance	U.S.	AHEAD cohort of HRS-1995–2000	Age, gender, marital status, age of spouse, over 35 health indicators, limitations in ADL, limitations in IADL, cognitive impairment, average length of benefit period, wealth status, preventive activity, rating category, deductible, daily benefit, benefit period, escalation of benefit	41	187	2
Brown and Finkelstein (2007)	Empirical	Discuss the market failures for private LTCI Present the supply-side market failures of private LTCI Find out the supply-side factors are not the sole reason for LTCI market failures	U.S.	Weiss Rating Inc., 132 known insurance companies-2002, HRS-2000, MetLife Market Survey-2002, Society of Actuaries (SOA)-2002, NLTCS and NNHS	Market-wide premium and benefits, gender, marital status, age, termination probabilities	64	85	10
Brown and Finkelstein (2008)	Empirical	Analyse the effect of Medicaid on demand for LTCI Suggest reforms to reduce the implicit tax imposed by Medicaid to stimulate private LTCI	U.S.	MetLife Market Survey—2002	Average national daily care cost of nursing home and assisted living facilities, hourly costs of both skilled and unskilled home health care, age, wealth	51	88	9

Table 9 (continued)

Article			Data			Citation Scores		
Author	Type	Main findings	Country	Source and year	Main Variables	LCS	GCS	Rank
Courbage and Roudaut (2008)	Empirical	Study the LTCI purchase in France and the factors affecting the demand for LTCI The findings are altruistic behaviour, risk behaviours and experience of disability as reason for low demand for private LTCI	France	Survey of Health, Ageing and Retirement in Europe (SHARE)-2007	LTCI ownership status, age, marital status, education, income, inheritance, health status, life insurance ownership, recent hospitalisation, risk factors, having chronic conditions, having symptoms, mobility, ADL, IADL, family members, receipt or providing help to relatives, physical activity	26	29	34
Courtemanche and He (2009)	Empirical	Study the effect of tax incentives on the purchase of private LTCI Conclude even offering above-the-line tax deductions may have minor effects on expansion of market for private LTCI Estimate the price elasticity of demand for LTCI and discuss the effects of the taxes on government expenditure	U.S.	HRS-1996, 1998, 2000, 2002, 2004	LTCI ownership status, household income and wealth, mortgage payment, property tax, out-of-pocket medical expenses, demographics, and a detailed set of variables on health status	12	15	82

Table 9 (continued)

Article			Data			Citation Scores		
Author	Type	Main findings	Country	Source and year	Main Variables	LCS	GCS	Rank
Courbage and Zweifel (2011)	Theoretical	Discuss the two-sided intergenerational moral hazard in the purchase of LTCI, the one in which purchase of LTCI by parents protects the bequests from cost of nursing home care and the other one in which parents purchase less LTC coverage knowing that their children will keep them out of a nursing home	–	–	–	10	11	109
Goda (2011)	Empirical	Studies the effects of tax subsidy programmes on the number of people who purchase LTCI	U.S.	HRS-2006 (including AHEAD sample, War Baby (WB) sample and Children of the Depression Age (CODA) sample)	Demographics, health status, family structure, housing, employment, disability, retirement plans, net worth, income, and insurance coverage	10	12	101

Table 9 (continued)

Article			Data			Citation Scores		
Author	Type	Main findings	Country	Source and year	Main Variables	LCS	GCS	Rank
Brown et al. (2012)	Empirical	Survey to understand the effect of preferences and beliefs, likelihood of becoming disabled, formal care substitutes and features of the private market on demand for private LTCI. Explain the findings related to low demand for LTCI	U.S.	Survey field in RAND American Life Panel-2011	LTCI ownership, age, gender, education, ethnicity, preferences and beliefs, state-dependent utility, bequest motives, substitutes for insurance, substitutes for formal care; price and affordability, counterparty risk, trust in insurers	15	22	58
Courbage and Eeckhoudt (2012)	Theoretical	Study the optimal level of LTCI insurance and informal care and relation of these in the case where the child is also decision maker for the purchase of LTCI and informal care provider for their parents	–	–	–	3	5	202

Table 9 (continued)

Article			Data			Citation Scores		
Author	Type	Main findings	Country	Source and year	Main Variables	LCS	GCS	Rank
Country-specific studies								
Siciliani (2014)	Policy paper	Discusses the factors affecting expenditure growth of LTCI and relative projection in OECD countries Addresses the role of regulations imposed by government on quality of care the individuals receive Discusses public and private insurance in different countries	OECD	–	–	2	4	237
Doty et al. (2015)	Policy paper	Study the long-term services and supports in France and compare them with available policy in U.S. Provide solutions to American private LTCI based on French example	France	–	–	0	5	208

Table 9 (continued)

Article			Data			Citation Scores		
Author	Type	Main findings	Country	Source and year	Main Variables	LCS	GCS	Rank
Costa-Font et al. (2016)	Empirical	Focus on the LTC market changes during and after great recession in European countries Discuss the determinants of changing receipt of informal care during crisis	European Countries	SHARE, 2013	Receiving informal care, number of limitations to ADL, net worth, housing wealth, having one or more children live with the respondent, having one or more children live within 1 km of the respondent, cohabitation with a partner, unemployment change, education, demographics, born in country of interview	0	2	311
Gentili et al. (2017)	Empirical	Study the cultural differences and its effect on the market for LTC and other arrangements for the elderly in Switzerland	Switzerland	Statistics on socio-medical institutions (SOMED)-2007–2013, Home care survey (HCS)-2007–2013, Voting data from national referenda 2013, Public use sample (PUS) of Swiss census, SHARE-Wave 4, Release 5, Swiss Statistical Office (SFO)	Dependency level, age at entry, gender, place of residence, nursing home, share of people voting yes to amendment of Swiss Constitution, household characteristics, control variables at municipal and hospital level	0	0	574

Table 9 (continued)

Article			Data			Citation Scores		
Author	Type	Main findings	Country	Source and year	Main Variables	LCS	GCS	Rank
Nadash and Cuellar (2017)	Policy paper	Study the private LTCI in Germany Apply the example from German private LTCI to U.S. and France for better performance	Germany	–	–	1	1	383
Busse et al. (2017)	Policy paper	Focus on the evolution of statutory health insurance and LTC in Germany Discuss the challenges exposed to the German system	Germany	–	–	0	8	147

[a]Activities of daily living (ADLs) are the activities most people perform in daily life without assistance. The basic six ADLs are bathing, eating, toileting, dressing, transferring and continence

[b]Instrumental activities of daily living (IADLs) are more complicated tasks that are needed for living independently. They include doing laundry, cooking, shopping, using the telephone, cleaning, accessing transportation, taking medicines, and managing personal finances

introduce to the analysis.[72] Hence, after removing the review papers on the path, we list the top 40 routes based on global main path analysis, as depicted in Fig. 3.

The results show that the most important path is from Brown and Finkelstein (2007) to Finkelstein and McGarry (2006). Their relative Global Citation Scores (GCS) are 85 and 187, Local Citation Scores (LCS) are 64 and 41 and their GCS ranks are 10 and 2.[73] While there are papers with higher GCS and LCS in our database, the global key-route main path has chosen the above path as the most important in the evolution of knowledge. There are 31 papers on the main path, of which 21 are empirical, five theoretical, and five policy papers.[74] Table 9 illustrates the main path studies along with a summary of their findings.

Appendix 3: Review of future research

In this appendix we present potential future research that we extracted from the articles on the main path (from 2000 onwards) and conclusion part of all the recent publications (106 publications from 2016 to 2018) in our data set. We use this to derive directions for future research in the final section of the paper (Table 10).

[72] See Ho et al. (2017).

[73] Local Citation Score (LCS) counts the number of the times the paper is cited within the local network (extracted from HistCite Software). Global Citation Score (GCS) is the number of the times the paper is globally cited (i.e., citation count from all the articles available in Web of Science). We also provide the rank of the paper based on its GCS in our network.

[74] Table 9 also identifies the most important data sets used in the academic literature which are the U.S. National Nursing Home Survey (NNHS) mainly used in the 1990s by five main path studies, the U.S. Health and Retirement Study (HRS) used in six main path studies, and the Survey of Health, Ageing and Retirement in Europe (SHARE) used by three main path studies.

Table 10 Potential future directions based on main path and recent studies

Authors (year)	Title	Potential future research
Main path articles beyond 2000		
Finkelstein et al. (2005)	Dynamic inefficiencies in insurance markets: Evidence from long-term care insurance	The empirical relevance of effects of uninsured negative wealth or income shocks on lapsation Further study for finding the reasons behind immediate lapse after purchase of policy
Finkelstein and McGarry (2006)	Multiple dimensions of private information: Evidence from the long-term care insurance market	The necessary conditions related to effect of heterogeneity in risk preferences on the efficiency cost of asymmetric information about risk type
Brown and Finkelstein (2008)	The interaction of public and private insurance: Medicaid and the long-term care insurance market	The way private market will be affected by new Medicaid reform given the existence of market failures such as asymmetric information, incomplete commitment in contracting and non-diversifiable risks
Courbage and Roudaut (2008)	Empirical evidence on long-term care insurance purchase in France	Improve the results of the study by combining market data, such as characteristics of the products offered, and individual data, such as risk aversion behaviours
Courtemanche and He (2009)	Tax incentives and the decision to purchase long-term care insurance	Estimate elasticity of demand for LTCI using more refined measure of individuals' federal marginal income tax rates Study the efficiency of state-level incentives in promoting private LTCI market
Siciliani (2014)	The economics of long-term care	Study the relation between formal home care and institutional care Analyse the existence of Baumol's disease in LTC The role of technology on LTC costs (cost-saving or cost-augmenting) Study the effect of competition on quality Review systematically the availability, ownership structure and funding arrangements in various countries Empirically determine important factors explaining observed public–private mix Theoretical determination of optimal public–private mix Study the solutions for moral hazard problem in the design of future LTCI policies

Table 10 (continued)

Authors (year)	Title	Potential future research
Gentili et al. (2017)	The role of culture in long-term care arrangement decisions	Study the determinants of informal caregiving more comprehensively
Busse et al. (2017)	Statutory health insurance in Germany: A health system shaped by 135 years of solidarity, self-governance, and competition	Further study of the problems related to discontinuous care and oversupply in Germany's health system Analyse the long-term challenges raised by population ageing, growth in chronic disease, multimorbidity, migration, digitalization and existing urban–rural discrepancies
Recent articles 2016–2018		
Stallard (2016)	Compression of morbidity and mortality: New perspectives	Treat the recent pauses in morbidity improvements (as a new phenomenon disconnected from past trends or as a correction that restores long-term trend)
Cremer et al. (2016b)	Social long-term care insurance with two-sided altruism	Extend the context of two-sided altruism to the case where parents do not leave any bequest or they bequeath only when in good health Introduce private insurance with loading costs and possibility of non-linear LTCI polices
Blundell et al. (2016)	Comparing retirement wealth trajectories on both sides of the pond	Explore bequest motive differences in cross-country setting Estimate late-life health expense risk in England Study the factors that affect households not drawing on their housing wealth (such as consumption value of housing, the financial and emotional transaction costs of releasing housing wealth, the risk–return mix provided by housing) Constructing life-cycle model that could explain the asset trajectories in the U.S. and England
Brown et al. (2016)	Heterogeneity in state-dependent utility: Evidence from strategic surveys	Further research on whether state dependence in utility is multiplicative Assess the reliability of the measures obtained in this study by asking the same sample similar questions could help determine whether the responses reflect true measures of state dependence

Table 10 (continued)

Authors (year)	Title	Potential future research
Chatterjee (2016)	Reverse mortgage participation in the United States: Evidence from a national study	Improve the data set of those who have reverse mortgage Further study on awareness and demand for reverse mortgage products with better data set including a large number of reverse mortgage participants
Pla-Porcel et al. (2016)	Life care annuities (LCA) embedded in a notional defined contribution (NDC) framework	Adapt the designed actuarial balance sheet for NDC systems to include the new model with LTC and evaluate the impacts of the introduction of a minimum pension on the system's financial equilibrium The transition rules of moving from old financing system to the integrated NDC framework, the importance of including a minimum pension, permanent disability relationship with LTC, the necessary conditions for updating the annuity divisors and the required statistical data for computation of real dependency cost The design of yearly account statement including individual pension information about retirement and LTC rights, introducing automatic balance mechanism based on an actuarial balance sheet in order to take into account in the system the changing realities
Kreft and Doblhammer (2016)	Expansion or compression of long-term care in Germany between 2001 and 2009? A small-area decomposition study based on administrative health data	Investigate the future trends in the new care level 0 and the diversity causes in the mortality and morbidity effects Living conditions in countries and their overall change related to the trends in care need and mortality Further study to find the underlying mechanisms of health ageing for better understanding and dealing with the problems of an increasingly heterogeneous ageing society
Cremer et al. (2016a)	The design of long term care insurance contracts	Extend their model by also including welfare of caregivers in the design of social insurance

Table 10 (continued)

Authors (year)	Title	Potential future research
Fong (2017)	Old-age frailty patterns and implications for long-term care programmes	Study the reversibility of human ageing in ageing models Use richer data sets on health conditions and mortality rates to explore the possibility of recovery from frailty and the impact of population health trends on frailty Identify seasonality patterns by constructing longer time-series data
Pla-Porcel et al. (2017)	Converting retirement benefit into a life care annuity with graded benefits	Further research on the effect of ruling out the recovery assumptions in their proposed model in the specific case of an annuitant not being healthy in the initial state Separate the redistribution of resources when the unisex actuarial factor is included in computation of the initial benefit
Pincus et al. (2017)	Framing the decision to buy long-term care insurance: Losses and gains in the context of statistical and narrative evidence	Expand future research by focusing more on the type and strength of emotions generated by communications rather than rational uncertainty frameworks
Sperber et al. (2017)	How can adult children influence parents' long-term care insurance purchase decisions?	Study on defining specific communication channels and intervention activities
Biessy (2017)	Continuous-time semi-Markov inference of biometric laws associated with a long-term care insurance portfolio	Extend the one level LTC model proposed in the paper to consider several levels of LTC
Cremer and Roeder (2017)	Long term care policy with lazy rotten kids	Study the effect of crowding-out and altruism on a more disaggregate level and country-specific way
Cremer et al. (2017)	Uncertain altruism and the provision of long term care	Extend the model by adding heterogeneity in such a way that individuals may have different wealth and probability of altruism
Levantesi and Menzietti (2018)	Natural hedging in long-term care insurance	Study on developing non-parametric models in a multiple state framework to examine the effectiveness of natural hedging and also utilise different data set Introduce alternative risk management tools rather than natural hedging Study the possibility of constructing a swap written on the survival of disabled people and evaluating their hedge effectiveness

Table 10 (continued)

Authors (year)	Title	Potential future research
De la Peña et al. (2018)	Long term care pension benefits coverage via conversion factor based on different mortality rates: More money as age goes on	Extend the data on the different degrees or levels of dependence to obtain the transition probabilities from one stage to another Quantify the effect of this factor not only in the Spanish social security system but also in other countries such as France, Italy or Germany

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