Puzzles of Insurance Demand and its Biases:
A survey on the Role of Behavioural Biases and Financial Literacy on Insurance Demand[1]

Francisco Pitthan[2] and Kristof De Witte[3]

Abstract

Underinsurance for risks with high consequences is a social problem that keeps repeating itself every year in many parts of the world. This paper reviews the puzzles of insurance demand, and provides an overview of behavioural-economics based explanations on the concept of underinsurance. In particular, the study outlines heuristics and biases (among availability heuristics, myopia, narrow framing and others) that help to explain the existence of those puzzles. The results of the study indicate that heuristics and biases do motivate the chances of underinsurance through sub-optimal probability weighting or wrong probability estimation of insurable risks. Although the behavioural literature does provide compelling arguments for the factors that result in underinsurance, it has significantly fallen short in providing possible solutions for the puzzles. Since most biases and heuristics are motivated by either a lack of knowledge or misuse of financial concepts and products, the study proposes that one of the most systematic solutions to the behavioural-based problem of underinsurance is an outcome of financial literacy treatments, that aim at improving knowledge and use of finance.

Keywords: Insurance Demand; Underinsurance; Behavioural Finance; Financial Literacy; Financial Education

JEL-classification: G41, D80, D91, I22, G22, G53

1 Introduction

One of the intriguing puzzles in the economics of insurance literature is the underinsurance of risks with high consequences (Kunreuther et al., 2013). This underinsurance creates a strong social problem, as yearly and in many parts of the world, considerable losses hit humanity in the form of natural disasters, diseases, incapacities, terrorism, pandemics and accidents, which can be extremely costly, especially to developing countries (Heger et al., 2008).[4] Reviewing similar puzzles of insurance demand, the present paper provides an overview of behavioural-economics based explanations on the concept of underinsurance. In addition, the study

[1] We would like to thank the funding from Baloise Insurance Research Chair of Financial Well-Being.
[2] Leuven Economics of Education Research, KU Leuven, Leuven, Belgium (e-mail: francisco.donascimentopitthan@kuleuven.be).
[3] Leuven Economics of Education Research, KU Leuven, Leuven, Belgium; UNU-MERIT, Maastricht, the Netherlands (e-mail: kristof.dewitte@kuleuven.be).
[4] Following Heger et al. (2008), the Hurricanes that hit St Lucia in 1988 and Grenada in 2004 had damages of the order of 365% and 203% of their own GDP, respectively.

discusses possible solutions for the insurance puzzles and aims at exploring the role of financial literacy in the underinsurance of risks with high consequences.

Loss aversion is a compelling argument of how insurance can provide a welfare improvement for people, since the payment of an actuarial-fair premium (or a premium that is at least below the certainty-equivalent) to get fully insured against a loss is a utility improvement for loss-averse people. The concept of loss aversion was introduced in the prospect theory of Tversky and Kahneman (1979), where it was shown that people tend to prefer the avoidance of losses rather than the realization of a gain of the same amount. Ever since then, the concept of loss aversion has been popular in neuroscience (Tom et al., 2007)[5] and has been considered to prevail in broader society (Booij and Van de Kuilen, 2009).

In the insurance literature, the risky events that need insurance are usually categorized according to the degree of consequence and probability (e.g. natural disasters would be low-probability high-consequence risks, and bike theft would be high-probability low-consequence risks). By the expected utility theory, insurance for high-consequence risks would be preferred face to low-consequence risks (even for the same expected loss), but this is not what was verified in the literature, with the demand for high-probability and low-consequence risk being comparatively higher to low-probability high-consequence risks (Browne et al., 2015)[6], what gives rise to the insurance demand puzzles. However, despite the argument of loss aversion and of the expected utility theory, the study observes that many people are still uninsured in many dimensions, especially for high-consequence risks. The Munich RE's 2020 report shows that 2019 had losses from natural disasters of the order of $150 billion from which 65% rested uninsured, with a considerable part of the uninsured losses even coming from some developed countries.[7]

Since this underinsurance is also observed in high-income countries, with well-developed insurance markets (sometimes with subsidized premiums), this problem cannot be fully explained by undersupply of insurance markets (Kunreuther et al., 2013). Thus, the insurance demand literature focused on searching an on-going trend for gaining explanations for the insurance puzzles using insights from behavioural economics. The basic idea consists in the effects of biases and heuristics in the probability estimation and weighting of risks, which result in sub-optimal insurance decisions. Among the biases and heuristics that affect insurance demand, we distinguish between coarse chance categories (i.e., direct application of prospect theory, with huge boosts in probability weighting when consumers see a risk as possible or as certain); myopia (i.e., underestimation and underweighting of average probability due to few information and focus on surroundings); overconfidence (i.e., underweighting and underestimation of idiosyncratic probability, but right estimation of average probability); narrow framing and mental accounting (i.e., failure to consider interactions among decisions in different mental frameworks, sometimes also fail to account for iterations of the same event

[5] It was shown that, when faced with potential losses, the brain of subjects presented decreasing activity in gain-sensitive areas, with differences in the loss aversion being measured by a "neural loss aversion" in several regions, such as the ventral striatum and the prefrontal cortex.

[6] Using data from an insurance firm in Germany, Browne et al. (2015) found that only 13% of insurance policy owners had protection against natural hazards insurance, with the demand for bike theft insurance being greater.

[7] For instance, the report also discusses floods that hit the US mid-west in 2019, which had damages of $9.7 billion, with less than 1% of this being insured.

across time); idiosyncratic and social risk (i.e., higher demand for insurance of risks that are independent from the rest of the community, in comparison to social risk); availability heuristics (i.e., more importance to events that come easily to mind, due to recent or vivid memories); decisions based on experience and description (i.e., more weight to information received via external description in comparison to information based in life-experiences, which sometimes have a small sample); and affection (i.e., more weight to insure against losing objects with emotional attachment).

Although the insurance literature proposed many behavioural-based explanations for the demand puzzles, it still did not propose compelling solutions for those problems. Burns et al. (2010) propose the idea of giving the right and specific "remedy" to the main "symptom" of each one of the different biases, but with no widespread solution, since each bias would require different treatments. If we consider the biases and heuristics that affect insurance, most of them are motivated by a lack of knowledge or misuse of financial concepts and products, which can be directly linked to low levels of financial literacy. The role of financial literacy, which combines knowledge, attitudes, and skills to guarantee financial decisions that promote better financial well-being, is wrongly neglected as one of the main possible drivers and paths to mitigate the impact of behavioural biases in insurance decision making. Treatments of financial illiteracy through education or advisory were found to be particularly beneficial to improve insurance demand in communities suffering from underinsurance (Giné et al., 2013), yet, rarely any studies have focused on analysing the impact of improving financial literacy to reduce the effects of behavioural biases and heuristics in insurance demand.

This paper contributes to the literature in two distinct ways. First, it links the main puzzles of insurance demand to behavioural biases. As such, using insights from behavioural economics, we provide an explanation of these puzzles. Second, the study discusses the role of financial literacy in the inconsistencies in insurance demand. This will be conducive to addressing the gap present in the existing literature concerning possible solutions to the biases of insurance demand.

Other surveys also focused directly or indirectly on behavioural biases effects into insurance demand. Discussing the psychology of tail events, Barberis (2013) reviewed behavioural frameworks that considered the process of decision-making under uncertainty (which also include insurance), giving behavioural insights to explain the over and under assessment for estimating and weighting probabilities, which lead individuals into sub-optimal decisions. Considering the results of the exchange of models from the theory with experimental applications, Richter et al. (2014) discussed how behavioural models from the insurance literature either contribute or replace models from expected utility theory to answer its incongruences. Sum and Nordin (2018) surveyed the main heuristics, framing biases, and thinking systems that affected insurance purchasing. The work of Harrison and Ng (2019) showed the lack of theoretical coherence in many experimental works in the behavioural insurance literature. However, the current paper differs from previous surveys in its approach and objectives. Besides reviewing the insurance puzzles, the effect of biases, and heuristics in insurance demand, the study also focuses on discussing possible solutions to mitigate the behavioural problems that lead to suboptimal insurance levels. In addition to these different approaches, the paper is different from Barberis (2013) in the way that the current study focuses more explicitly on the concept of insurance demand and some risks with high probability. The

objective of the research framework is distinct from that of Richter et al. (2014), in the way that their study was solely based on the theoretical implications and while the current study focuses on a broader set of papers (they focus mainly on four papers from the same journal special edition). The paper states the implications of the behavioural biases and heuristics to insurance demand in a more explicit way, in comparison to broader arguments from Sum and Nordin (2018), discussing possible new avenues as well. Although Harrison and Ng (2019) review many current papers of insurance demand, they do not focus in the role of behavioural biases nor the possible financial literacy[8] and cognitive gaps which could explain insurance puzzles, instead, they discuss the different experimental and insurance decision settings with a theoretical motivation.

From a methodological perspective, the current study follows the methodology suggested by Higgins and Green (2011). In particular, the study began with searching in the Web of Science and ERIC web directories among titles, abstracts and keywords for the research terms related to insurance demand, behavioural biases, and financial literacy, using Booleans to find interactions between works of literature. Based on the search results from the databases, the papers were selected based on two comprehensive steps. Next, the selected papers' abstracts were screened and their titles were closely observed. This was done in order to ensure that the present does not deviate from its pre-defined set of objectives. Thirdly, to search for extra references, Web of Science and Google Scholar were used to check in the selected papers their citations and research that cited them.

The findings of the paper can be summarized as follows: although behavioural biases can explain the puzzles, the way to solve this demand problem is not necessarily through the behavioural literature, since no general solution was found, requiring different treatments for different biases. Beyond the most direct way of treating the puzzles by solving disinformation or by giving the proper "remedy" to each bias, the possible solution through the financial literacy approach might be a more broad and systematic direction, going in the root causes of most biases, with the possibility to apply financial literacy's educational and advisory methods in multiple environments.

The current paper unfolds as follows. Section two of this paper discusses the types of insurable risks, the decision making of insurance under expected utility theory, and its contradiction over the puzzles of insurance demand. Section three presents the methodology. Further, section four discusses the main behavioural-based explanations for the insurance demand puzzles. In section five, the role of financial literacy in insurance demand and its biases is discussed. Lastly, the final section provides the conclusion of the entire study.

[8] They make one mention to Clarke and Kalani (2012) which, among other objectives, checked the relationship of microinsurance demand with financial literacy. But we find that their measure of financial literacy was more related to numeracy (only one of their eight questions was related directly to financial knowledge or behaviour).

2 The types of risk, expected utility theory and insurance demand puzzles

This section discusses how economic theory considers the insurance demand for multiple types of risks and how it gives rise to puzzles when compared to empirical and experimental evidence. For this, a sub-section is separately dedicated to explain the main types of risk for a given event depending on the probability and consequence of it, followed by a sub-section that discusses the expected utility theory in view on insurance demand and its puzzles.

2.1 *Types of risks*

An on-going trend in the insurance literature has been comparing the demand levels of insurance premiums for risky events depending on multiple degrees of consequences[9] and probabilities (i.e. different degrees being called different types of risks). The observation of different insurance demand levels for a given type of risk in relation to what is predicted by the theory is what generates the demand puzzles. In this sub-section, the study aims to discuss the types of risks, since they serve as a basis to discuss the expected utility theory view on insurance demand and its puzzles. To simplify the exposition and to follow the most common types in the literature, a major focus is placed on two levels for both consequences and probabilities, the extremes 'high' and 'low'. As such, the study considers high-probability and high-consequence (HPHC), high-probability and low-consequence (HPLC), low-probability, and low-consequence (LPLC) and low-probability and high-consequence (LPHC) risk. Table 1 summarizes those four possible scenarios for a given risky event.

Table 1: Summary of different kinds of risks in terms of probability and their consequence.

	Low Probability	**High Probability**
Low Consequence	**LPLC:** Bike being hit by a meteorite or by a lightning (Not insurance worthy)	**HPLC:** Bike and cell phone theft; malfunction of electronics (Growing market)
High Consequence	**LPHC:** Natural disasters (e.g. fire, earthquake); terrorist attacks, pandemics (Most underinsured losses)	**HPHC:** Health issues, car damage, retirement, LTC dependency (Usually matured insurance market)

HPHC risks are usually related to risks with mature insurance markets that motivate health insurance, car crash insurance, house insurance and pension funds. Although most of those markets are matured, they still have a history of problems of asymmetry of information in the literature, started with the adverse selection and moral hazard seen in Arrow (1963), which is usually treated with deductibles, co-payments and market signalling. In contrast, there

[9] Consequences in terms of economic losses.

exist HPHC risks that remain underinsured, with undeveloped markets and sub-optimal demand, for instance, the Long-Term Care (LTC)[10] dependency risk.

The risks with HPLC have as main examples the risks of theft of some belongings (e.g. cell phones and bikes) and the risk of malfunction of electronics happening after the regular warranty protection. Both of these give rise to micro-insurance markets. The insurance for those risks is growing, especially in the developing countries. Partially, this can be associated with consequences to one's income being higher and while in some cases, the probability of theft is also higher. Examples can be seen in Gikonyo (2014) for Kenya, Akotey et al. (2011) for Ghana, and the review of Platteau et al. (2018).

LPLC risks are rare events with low consequences, such as the risk of having your bike being struck by lightning or of it being hit by a meteorite. These risks usually are not insurance worthy and do not have proper market development. The offer and marketing of insurance for one of those risks can be an indication of bad-intentioned insurance companies. They present no rationale for a proper insurance market. As a result, they are not addressed by the review of literature and so the study does not focus on this aspect.

Most of the recent literature focuses on LPHC risks, which can be exemplified by natural disasters (such as fires, earthquakes and floods), terrorist attacks, pandemics and other extreme events. These kinds of risks suffer from both under-developed markets and low demand, which can give rise to huge losses, big social problems and humanitarian tragedies. The insurance markets for those LPHC risks can also be heavily influenced by major events. For instance, after the 9/11 attacks in 2001, the demand for terrorism insurance increased and the perceived terrorism risk had seen a spike. In order to face this extra exposure, insurers decided to reduce coverage of existing insurance plans and to greatly increase insurance premiums (Kunreuther and Michel-Kerjan, 2004). The similar situation can be expected to happen in the insurance market for pandemics and other extreme events after the COVID-19 pandemic, which led many businesses to considerable non-insured losses.

Knowing about the main risks, one shall inquire what the economic theory has to proclaim about insurance demand, and thereby, this will be addressed in the next section. Besides, the study also exposes the contrasts of the theory with the results from the literature, which give rise to the main puzzles of insurance demand.

2.2 *The expected utility theory and the insurance demand puzzles*

Barberis (2013) points the over and under assessment of probability estimations and weights as one of the main motivations for the existence of antagonistic outcomes in the decision making of tail events.[11] This can be explained by different preferences but can also be heavily impacted by beliefs, heuristics and behavioural biases (e.g. the role of emotions from the affection bias and the over-optimistic beliefs from overconfidence). As insurance demand is within the same

[10] The OECD (2011) defines the term LTC as the special care and help that older people might need for day-to-day activities (e.g. washing, dressing, cleaning, cooking) as well as some types of medical assistance.
[11] Within an insurance framework, an example would be the decision to buy insurance for events with LPHC risks (e.g. natural disasters).

framework of decision making, it is also affected by different outcomes, causing underinsurance of some risks and over-insurance of others. This makes the appearance of some puzzles in insurance demand, in the way results from the empirical and experimental literature differ from the economic theory. One of them is the low insurance demand for LPHC risk in comparison to the high insurance demand for HPLC risk, that can also be motivated by biases. Seeing the great life-cycle welfare improvement of insurance against rare events with significant impact (e.g. disaster like flood, fire and earthquake) for risk-averse individuals, it is puzzling why the demand for LPHC risk insurance is so low in comparison to the one for HPLC risk insurance.

Concerning the view of the economic theory for the insurance demand of different risks, the expected utility theory proposes that risk-averse individuals (i.e. with concave utility functions) faced with the decision to get insurance against one of two risks A and B with the same expected loss, but where B has a higher variance (i.e. a mean-preserving spread of A), shall strictly prefer to insure against risk B, on strictly concave parts of the utility function, as seen in Browne et al. (2015). They discussed that the puzzle lies in the contradiction of the outputs from the theory and the results from the literature since this is often not the case in experiments and empirical data of insurance demand. Under the same expected loss and the same expense-loading in the premium, the demand for insurance against HPLC risks (equivalent to risk A) is greater than the one for LPHC risk (equivalent to risk B), which would contradict the expected utility theory, as seen from experiments of Slovic et al. (1977); Schoemaker and Kunreuther (1979); McClelland et al. (1993); Ganderton et al. (2000) and empirical data based on a Germany insurance company of Browne et al. (2015). The paper of Laury et al. (2009) replicates the experiment of Slovic et al. (1977) in gambles with and without real money, showing that individuals are much more sensitive to insure against LPHC risk in comparison to HPLC risk when gambling with money, arguing that previous results were due to the presence of confounds in the experiments (e.g. lack of monetary incentives). Although it comes from a different approach, which may motivate the investigation of the role of monetary loss or other “affect-poor” risks in the decision-making process, the results of Laury et al. (2009) may still be considered with care, because they diverge from the rest of the literature and the empirical data.

Additionally, consider still the possible risk C, which would have the same variance of risk A, but a higher average loss associated (i.e. a case of an HPHC risk). Using the expected utility theory approach, individuals should also prefer to insure against risk C in comparison to risk A. Considering that most HPHC have mature markets this is often the case, but still the study also observes exceptions, like the low demand for long-term care (LTC) insurance.

Since one of the main hypotheses of the expected utility theory is the rationality of individuals, the recent insurance demand literature has taken the behavioural and cognitive approach in order to search for reasonable explanations for these puzzles in insurance (i.e. underinsurance of LPHC risks, over-insurance of HPLC risks and underinsurance for some HPHC risks such as LTC). This literature is based on theoretical, experimental and empirical evidence that finds the explanation to this over or underinsurance of different risks based on the existence of at least part of the market that suffers from behavioural biases or that use heuristics

during their decision-making process. The next chapter explores the main developments of the behavioural biases of insurance demand literature.

3 Methodology

In order to have a more systematic analysis and selection of the current research in the context of insurance demand, behavioural finance and financial literacy, the study has followed the main guidelines from Higgins and Green (2011).

To present a robust and comprehensive survey, the study collected all evidence that fitted eligibility criteria of the paper for addressing the research questions. For this, the paper has selected and analysed the main results and pieces of evidence of chosen works based in experimental, quasi-experimental, empirical with observational data, theoretical, surveys, and correlational studies. Besides answering directly to the research questions, the previous section was designed to summarize the main insurable risks and puzzles of insurance demand, that serve as a basis for the subsequent discussions.

Considering our eligibility criteria, focus was placed on papers that discussed insurance products and markets with identified demand puzzles (i.e. over or underinsurance related to what is predicted from the models from expected utility theory). Well established insurance products with no recurrent aggregate demand deviations in comparison to expected utility theory in usual conditions were excluded from this study (e.g. health, house, and car insurance).

The search for relevant works was done from January 2020 till March 2020, restricting results to published papers before the year 2000 in the English language. Besides peer- reviewed papers, we also included books, thesis and working papers with relevant information and evidence to help outline the complete story. The search was restricted to the titles, abstracts and keywords from the works presented in web directories. Using the Web of Science and ERIC databases, our search focused in the combination of research terms from insurance demand (‘insurance demand’, ‘over-insurance’, ‘underinsurance’), behavioural finance (‘behavioural finance’, ‘behavioural economics’, ‘behaviour bias’) and financial literacy terms (‘financial literacy’, ‘financial education’), using Booleans to combine multiple work of literature. Other spellings of the research terms were also included, since some forms are more common in other variants of the English language.

The selection of papers was made in two steps as discussed earlier. First, the titles and abstracts of the researched papers from the web directories were analysed, selecting works related to their fitness to the mentioned eligibility criteria and the objective of this paper. The full text was verified in the case where the title and abstract were not sufficient to decide upon the selection of the work. Second, after selecting the papers from databases, we used Google Scholar and Web of Science to analyse their main citations and other works that cited them to choose additional studies that were not found in our previous search results. This led us to eventually add references outside the chosen publication date range, especially for theoretical papers used as a basis (e.g. Tversky and Kahneman, 1979) and first contributions to given literature (e.g. Slovic et al., 1977). Additionally, this process also guided us to one language

exception, being Piaget and Inhelder (1951), which was a pioneering study and helped to coin the chance categories terms. The searches from the web directories resulted in 465 references, which using our two selection steps resulted in 71 selected works.

4 Explaining insurance for irrational agents – The biases of insurance demand

This section investigates the main biases and heuristics that govern the decision-making process for the demand for insurance. The behavioural biases are chosen for their prominence in the literature to explain the over and underinsurance of different risks, based on their impact in either the probability estimation or probability weighting of people's insurance decision making. Although other biases than the discussed ones exist in the behavioural finance and decision making literature, they are not sufficiently relevant in the insurance demand literature to explain insurance puzzles.

4.1 *Coarse Chance Categories & Prospect Theory*

In the first paper of the prospect theory, Tversky and Kahneman (1979) showed that the behaviour of individuals depended on their reference point and the position in their value function, having different decisions in terms of gains and losses of their value function, rather than final wealth. The same framework is also influenced by loss aversion since even bets with positive expected wealth could be rejected for being a negative in the value function. This would mean that depending on the reference point and loss aversion the decision to buy an insurance premium. For instance, it can be seen as a risky asset with negative value. Tversky and Kahneman (1992) brought an augmentation of the theory, proposing the cumulative version prospect theory, that showed experimentally the existence of an S-shaped probability weighting function. This was done to weight probabilities in the decision-making process under uncertainty, which was conducive to explain the overweight of small probabilities and underweight of high probabilities. However, they found that this function is not well behaved near end-points, especially for really small probabilities, which could be either completely ignored or extremely overweight.

The bad-behaviour of the probability weighting function can be related, as noted by Burns et al. (2010), by coarse chance categories and the "possibility-effect", which comes as a direct result from prospect theory. Piaget and Inhelder (1951) related the perception of chance and probabilities by children from 4 to 12 years, which corresponded to categories of "it certainly won't happen", "it may happen" and "it certainly will happen", not that different from how adults may interpret uncertainty events, as from the 50% to 50% chance scenario of Fischhoff and Bruine De Bruin (1999) and by adults' poor understanding of probabilities from Reyna and Brainerd (2008). Bypassing certain idiosyncratic thresholds, an event. For instance, an event can have its label changed from "it certainly won't happen" to the label "it may happen", the so-called "possibility-effect", increasing drastically the weighting of this probability in the decision making of an individual. While small changes of probabilities that may lead to change the label of an event from "it may happen" to "it certainly will happen" can

also have a significant effect (the "certainty-effect"), small differences in intermediate probabilities might be understood as insignificant, as seen in the experiments of Tversky and Kahneman (1992).

Schmidt (2016) comes with a theoretical approach to the role of prospect theory in insurance demand, showing that it is sufficient to explain that low insurance demand for low probability risks (even with highly subsidized premiums) may face the high insurance demand for moderate or high probability risks (even with highly loaded premiums). Using American data, Hwang (2016) empirically found that loss-averse individuals have low-ownership of LTC insurance, which is consistent with prospect theory when individuals' have reference points for wealth levels. This is the case when they do not engage in insurance contracts and view insurance premiums as risky assets (i.e. generates no "return" in case of the insured bad event does not happen).

4.2 *Myopia and Overconfidence*

The biases of myopia and overconfidence are related to the under-estimation and under-weighting of bad outcomes. As noted by De Donder and Leroux (2013), they differ in the way the estimations are formed. Overconfident individuals have a good estimation of the average probability of loss for a given risk, but usually decide to not insure themselves because they are of the view that they have a lower probability (and lower confidence intervals) than the average of being affected, underweighting this risk in their decision making. On the other hand, myopic people, besides this underweighting, also underestimate the average probability of a bad outcome for a given risk. Myopia is also related to the preference for short-term benefits and for decisions that are closely related to their environment (either spatially, temporally, or emotionally), as seen in Maskell and Malmberg (2007) and Kunreuther et al. (2013). Nonetheless, myopic and overconfident individuals do not usually differ in their decisions, but differ in their thought process.

Earlier literature found evidence on the existence of myopia and overconfidence in insurance. De Donder and Leroux (2013) used a theoretical model to explain the low demand for LTC risk insurance with myopia, overconfidence, and procrastination biases. They found that the decision to not buy LTC insurance is compatible with overconfident and myopic individuals, but not with procrastinators. To explain, they would vote for their real need for insurance on public elections. Cremer and Roeder (2013) justify the social provision of public LTC risk insurance or the subsidize of private insurance with a model that considers myopia and actuarially non-fare loading-costs. In the paper of Galle (2012), it was depicted through a model that decisions benefiting public unemployment insurance are wounded by myopia, and that immediate incentive could make those decisions more common.

4.3 *Narrow Framing and Mental Accounting*

Narrow framing (Tversky and Kahneman, 1981; Kahneman and Lovallo, 1993) is a direct application of prospect theory, a bias heavily influenced by framing (i.e. how problems, choices. and data are presented), that suggests that individuals usually are more sensitive to negative

frames than positive ones.[12] Also, as a consequence of this sensitivity to framing, each decision or gamble is evaluated individually, in isolation from future opportunities, also neglecting other possible frames and the statistics of the past in evaluating current plans. For instance, many individuals under narrow framing faced with Samuelson's (1963) bet (50% chance of winning $200 against 50% chance of losing $100) would not accept it even when faced with multiple repetitions of the same bet. Brown et al. (2008) also suggests that framing matters for how to consider insurance annuities, either as a consumption (valuable insurance) or as an investment (a risky asset with payoffs in case of bad outcome), with individuals under the investment frame preferring non-annuitized insurance products. Using the prospect theory as its basis, Thaler (1985) reports that mental accounting consists of the idea that decisions are framed inside different "accounts" without considering interactions among multiple decisions or multiple "accounts". Mental accounting is also subject to framing, but in more general terms, since different decisions can be inside the same "account". Thaler (1985) suggests an application of this bias to "add-ons" in big insurance policies (e.g. health, house or car insurance). As that would be calculated inside the same account, individuals would consider them as a smaller-loss in comparison to buying them separately (e.g. a $5 premium increase to have dental insurance to an already existing $50 health insurance premium would seem more reasonable than a non-bundled $5 dental insurance under this bias).

Hsee and Kunreuther (2000) experimentally found that, depending on different frameworks and perception of gambles and accounts, the same monetary loss could have a different perceived value (non-fungibility of money) and individuals would be more willing to buy insurance. In contrast to this, Schwarcz (2010) substantially argues that the mental-accounting bias helps to explain the high demand for insurances against small financial losses (e.g. against bike theft), which would not be rationally related to the individual's full wealth, but considering separately into a different "account" would be reasonable for the individual. Ranyard et al. (2006) gave an experimental approach to insurance and credit decision processes, supporting the idea that people make those decisions regarding the "total mental accounts specific to the decision context encountered". Empirical data of Gottlieb and Mitchell (2019) suggest that individuals under narrow framing are less likely to insure themselves against LTC risk. This is because such individuals might fail to "evaluate the potential benefits of avoiding the losses alongside the costs of insurance", and thereby, being less eager to buy insurance.

4.4 *Idiosyncratic and Social Risk*

Using a theoretical and experimental approach, Friedl (2014) proposed the idea that individuals are more likely to insure against idiosyncratic risk (e.g. bike theft, extended warranties or cell phone insurance) as opposed to risks that are highly correlated between individuals (e.g. earthquakes, floods, fires), the so called "social risk". The idiosyncratic risk can also be related to loss aversion, since being the only affected by a bad outcome can have a greater impact on

[12] For example, Tversky and Kahneman (1986) show that people would be more impacted by a risk showing statistics that 10 out of 100 people, the "mortality frame" rather than saying that 90 out of 100 survived, "the survival frame". Differences in the mortality rate from 0% to 10% (in the "mortality frame") had more impact in subjects rather than differences in the survival rate from 90% to 100% (in the "survival frame").

one's utility due to shame and exclusion in comparison to social risk, that may have a relatively smaller impact on one's utility due to the shared sense of loss of the community.

4.5 Availability Heuristics

The availability heuristics are based on Tversky and Kahneman (1973, 1974), who proposed a concept about the assessment of the probability of an event by the "(…) ease which instances or occurrences can be brought to mind". Barberis (2013) notes that these heuristics can be explained as the overestimation of probabilities for events with vivid impact, either because it triggered some emotions or it had extensive media coverage. Moreover, it also explained the underestimation of probabilities for events with not such vivid images.

Keller et al. (2006) found experimental evidence on the role of availability for the perception of risk in flood areas when partial insurance was available, subjects that received the communication of past events in the area (frequencies, probabilities and photographs) had a greater perception of risk compared to control groups. Yin et al. (2016) portrayed through his study that after a first experience with a typhoon, individuals' demand is largely dominated by availability and so were more likely to insure against typhoon risk in the short-run, but if they experience a disaster multiple times the "gambler's fallacy" (Croson and Sundali, 2005) would dominate, which would result them in thinking that another typhoon would be less common.

4.6 Decisions based on experience and description

Hertwig et al. (2004) proposed and tested experimentally the idea, that, during decision making process, people usually overweight probabilities of rare events based on description available to them (e.g. when people have access to information sources with good descriptions of risks such as a book, a newspaper, television show) and underweight probabilities of rare events based on their experiences (e.g. when people base decisions regarding past events that happened with them or people close to them). They point out that the underweighting of events based on experience may be related to a small sample of previous experience with that given rare event.

Regarding the effects of decisions based on experience, Krawczyk et al. (2017) found through their experiments that a previous personal impact of a rare event has a greater effect on the weighting of insurance decisions in comparison to previous impacts on other people (i.e., the effect of other people's experiences would be discounted in comparison to own personal experiences). Cai and Song (2013) showed experimentally that even "hypothetical experiences" (e.g. a risk and insurance game) might play a role in increasing insurance take-up. The study found that such hypothetical experiences could have a stronger effect on individuals than what they have experienced in real life. For instance, an actual disaster in a neighbouring village that happened in the previous year could be less effective. While a hypothetical experience could be more effective due to being a more recent and personal experience. Outside the insurance

demand conversation, this bias was also linked in the climatic change literature[13], in decisions over non-rare events[14] and in the cognitive process behind those decisions.[15]

4.6 Affection

It is related to the difference in the perceived value of a loss due to the effects of emotions for a particular object or circumstance. Following Slovic et al. (2004), "affective responses occur rapidly and automatically", and thus, being a part of our experimental or intuitive system to comprehend risk, rather than our analytical system. Rottenstreich and Hsee (2001) distinguished how individuals face uncertain events based on their degree of affection, either by affect-poor events (with little to none emotional connection, usually based on purely monetary effects, e.g. a $100 coupon to pay a phone bill) or by the affect-rich ones (with huge emotional attachment, it can also be related to money, but while linked to emotions, like a $100 coupon for a fancy dinner or for a nice hotel at the beach). They showed experimentally (for instance by how much people would pay to avoid a monetary loss or to avoid an electric shock) how these events change the S-shaped degree of the probability weighting function from the prospect theory. It differs from a linear probability weighting function increasing in the probability estimation, with affect-rich events having a huge variation, greatly over-weighting small probabilities, under-weighting big probabilities and with less sense of variation in intermediate probabilities.

Besides the impact of mental accounting, Hsee and Kunreuther (2000) found that affection plays a significant role in the perceived value of a loss. Individuals would be more impacted by the risk of experience loss related to objects, in which they are emotionally attached and will portray a higher demand for insurance compared to the same monetary expected loss for other objects or circumstances. Keller et al. (2006) is of the view that the effects of the availability heuristics are intensified by affection (when subjects received affect-rich images that evoke fear for instance). However, the effects could not be disentangled to explain which is the main factor that increases risk perception among individuals. Petrova et al. (2014) conducted a study replicating the experimental findings of Rottenstreich and Hsee (2001) in an insurance setting, with consistent overweighting of small probabilities. However, the study found inconsistent results for higher probabilities as well as insignificant results for underweighting. Traczyk and Fulawka (2016) found experimentally the S-shaped effect of affect-rich events in insurance decisions, but decisions of high numerate people (i.e. good ability to understand and process statistical information) were found to be unaltered by affection.

[13] As to why people that make decisions based on experience underestimate the probability of global warming (Weber, 2016).

[14] Ludvig and Spetch (2011) experimentally showed the gap of decision-making process based on experience against the one based on the description for events with two equiprobable outcomes (i.e. with 50% probabilities).

[15] Lejarraga and Gonzalez (2011) discussed the effects of feedback in repeated decisions when both description and experience information are available.

5 A possible solution – The role of financial literacy

The literature on insurance demand has found compelling motivations for its puzzles through behavioural biases, but it lacks insights on how to mitigate them and how to solve the insurance demand problems. Most of the behavioural biases discussed in the previous section have as their main outcome either wrong probability estimations or sub-optimal probability weighting. Thus, this may lead consumers for insurance decisions that result in either over or underinsurance. This section discusses the role of financial literacy in mitigating behavioural biases, as many individuals are fully or partially motivated by financial illiteracy[16] such as improper knowledge, habits, or usage of risks and financial technologies, such as insurance.

As from Huston (2010), financial literacy should be conceptualized into two dimensions. First dimension concerns understanding (knowledge) and second, on the use (application) of personal finance and financial concepts. In a similar way, OECD/INFE (2011) defines financial literacy as "a combination of awareness, knowledge, skill, attitude, and behaviour necessary to make sound financial decisions and ultimately achieve individual financial well-being". The non-proper understanding component of the definition may be due to either a lack of knowledge of how some financial technologies work or when uncomplicated statistical questions (numeracy) or simple financial concepts are hard to grasp. The necessary degree of ability to understand those concepts leads financial literacy to be closely attached to cognitive ability, as seen from evidence from Lusardi et al. (2010) and Finke et al. (2017).

Financial literacy was found to affect considerably the decision making of individuals, since the absence of it (i.e. financial illiteracy) might result in sub-optimal outcomes. This refers to lacking sufficient financial skills to understand or apply concepts and technologies of investment, banking or credit. From the survey from Lusardi and Mitchell (2014), the effect of financial illiteracy has been linked to poorer investment decisions, a greater chance of falling in financial fraud schemes are a result of lower financial management skills, lower participation in financial markets and lower commitment to retirement planning. Beyond this, financial illiteracy is also related to big social problems like over-indebtedness among consumers (Gathergood, 2012).

By its effects on decision making, it is only natural to see that financial literacy also has a significant impact on the insurance demand of individuals. In a study conducted on rainfall insurance in India, Cole et al. (2013) observed that villages with previous experience with insurance, higher financial literacy, and better ability to understand financial concepts had a greater demand for insurance. Bryan (2019), using a randomized controlled trial for partial agricultural insurance policies in Kenya and Malawi, found that the undertaking of insurance was highly linked to the literacy and knowledge of the product technology in the regions. Although, the causality of financial literacy to motivate financial behaviour may be hard to estimate for the possibility of endogeneity (since the attitude and use of financial concepts or technologies also make part of the financial literacy) good evidence attested the relation contouring the problem using strong instrumental variables. These instruments consisted of a

[16] For a good overview of the topic, see De Beckker (2020).

number of newspapers and universities in regions of Russia (Klapper et al., 2012), and exposure to a new educational voucher in Chile (Behrman et al., 2012).

Not only financial literacy impacts insurance undertake, but it may also be a motivation behind many behavioural biases. Considering the biases and heuristics discussed, it can be clearly stated that most of them are motivated either by a lack of a proper understanding or by an inability to apply their financial knowledge into welfare optimal attitudes and behaviours. For instance, myopia and mental accounting are partially caused due to lack of knowledge. On the other hand, overconfidence and affection are biases that may lead to sub-optimal attitudes and behaviour, even for individuals with good knowledge. Thus, the improvement of one's financial literacy can also be a possibility to reduce the well-being of an individual and thereby, reducing the overall impact of behavioural biases in its decision-making process. Although, the literature has not reviewed causal studies or studies for insurance demand, the correlation between multiple behavioural biases and financial literacy was verified among investors in stocks and mutual funds (Ateş et al., 2016; Jonsson et al., 2017).

One of the main treatments that can be used to help reduce biases and improve financial literacy degrees is financial education, which would aim at improving financial decision making and financial well-being[17]. From Kaiser and Menkhoff (2020) meta-analysis, financial education has a significant impact to financial knowledge and to a lesser extent financial behaviour. Altman (2012) argues that the gains of financial education to better decision making can be limited by the errors, biases and automated processes of our brain. He suggests as additional treatment a number of policies aiming at letting the better solutions for financial illiterate individuals easier to make (e.g. provide better quality information presented in a non-complex way; develop institutional environment favourable to good decisions with an incentive structure that internalize externalities involved in financial decision making). Besides, the author notes that financial education with a more practical and specific decision-making environment can also improve the financial decisions of individuals.

Although previous literature of financial literacy did not venture directly in the solution of behavioural bias in insurance demand, it had proposed possible improvements to the underinsurance problem through treatment that reduces financial illiteracy. Giné et al. (2013) showed through their field experiments that financial literacy materials improve the insurance demand of farmers against drought risk, having social spillover effects to farmers that have not received any material (which does not happen when farmers only receive discounts for insurance premiums and no financial literacy materials). Tennyson (2011) surveyed data pointed out low average for insurance financial literacy, with higher financial literacy related to people with previous financial education or interest in personal finance. Gaurav et al. (2011) experimentally showed the positive marketing effect of financial literacy for the demand for insurance against rainfall risk in India. Lin et al. (2017) evidently associated better financial

[17] From OECD (2005), financial education can be defined as "the process by which financial consumers improve their understanding of financial products, concepts and risks and, through information, instruction and/or objective advice, develop the skills and confidence to become more aware of financial risks and opportunities, to make informed choices, to know where to go for help, and to take other effective actions to improve their financial well-being".

literacy with more demand for life insurance, but does not consider the behavioural motivations for LPHC underinsurance. On the other hand, Lin et al. (2019) incorporated the idea of anchoring bias for insurance demand, that can be limited to better insurance literacy. However, the research was focused only on survey data, without analysing treatment effects nor considered other biases.

6 Discussion and conclusion

Using a comprehensive review of the literature, this study elucidates how behavioural biases explain the insurance demand puzzles, and how financial literacy might mitigate those biases. The study was instrumental in guiding how behavioural biases, as well as cognitive problems and heuristics, explain inconsistencies in insurance demand. In particular, the role on the insurance of coarse chance categories and the prospect theory framework; myopia and overconfidence; mental accounting and narrow framing; preference for protection against idiosyncratic risk; availability heuristics; underweight of decisions based on experience; and the effects of affection were discussed in brief. Insights from these behavioural economics frameworks have the following implications for insurance puzzles.

The implications of the prospect theory and coarse chance categories to the insurance demand literature have two degrees, based on antagonistic forces. First, depending on the value function and idiosyncratic reference points, loss-averse people could be less inclined to buy insurance for low probability events (negative side of value function), but be more inclined to buy it for medium and high probabilities events (positive side of value function). Second, considering their probability weighting function in comparison to what would be observed in the weight using the expected utility theory[18], individuals would have a comparatively increased demand for insurance due to positive boost in the weighting of low probabilities that are suddenly seen as possible[19] ("possibility-effect"), with smaller comparative weight in medium probabilities. High probabilities seen as almost certain can also cause a comparative increase in insurance demand ("certainty effect"). Further research should compare empirically and experimentally, the antagonistic effects in terms of insurance demand for multiple risky events and degrees of loss aversion, estimating factors that trigger the possibility-effect as well as what indulge loss-averse people to consider insurance premiums as risky assets.

Although being different biases, myopic and overconfident people usually have similar underweighting of probabilities in their insurance decisions, resulting in underinsurance. But since their probability estimations are formed differently, further research can be conducted on investigating how treatment effects can be distinct for each of those biases. For instance, policies that share the real average threats of some risky event to the population could impact

[18] The expected utility theory weights probabilities as they were estimated since it does not consider a different probability weighting function like the prospect theory does.

[19] We note that for low probabilities not seen as possible the effect would be the inverse, having a comparative decrease in the demand for insurance. Moreover, for finding those events highly improbable (in the "never going to happen" label), individuals would usually reject insurance premiums for them.

the probability estimation and weighting of myopic people but maybe ineffective to overconfident individuals, which may need more tailor-made advisory about their own risks.

Considering the implications of mental accounting and narrow framing to insurance, those two biases can easily shift the decisions of consumers. As in the example of insurance add-ons, in which the same account or frame mentality can make consumers buy extra premiums related to their existing plans. In regard to this, the same kind of mental framework can consider one risk in complete isolation to other risks (or even by not considering iterations of the same risk), reducing insurance demand. Research can dive further into how this mechanism works for individuals with those biases, searching what could trigger them to see multiple mental accounts or frameworks in interactions with each other.

Idiosyncratic and social risk biases were conducive to understanding the high insurance demand for HPLC risks (usually linked to idiosyncratic risks like bike theft) and the low insurance demand for LPHC risks (usually linked to social risks like floods). To check for robustness, the existence of those biases can be investigated eliminating confound effects related to the kinds of risks, comparing the insurance demand of social and idiosyncratic risky events with similar types of probabilities and consequences.

In terms of impact towards the insurance market, the prevalence of availability heuristics tends to increase the probability weighting and the insurance demand of risky events that had a big impact in the community, vivid personal memories, plenty of media coverage or that happened recently. Future research should investigate the role of on-going campaigns of information (of threats, risks, and costs) about disasters in countries that suffer from underinsurance of LPHC risks while having a considerable prevalence of it.

The reliance to make decisions solely over experience might be one of the reasons for the underinsurance of low probability risks. Without sufficient knowledge of similar risky events happening inside their own community, consumers might be less inclined to buy insurance. As well as costly, the dependence on augmenting the time frame sample size of consumers to improve insurance demand is not enough, since many of those events have a low occurrence (e.g. once every ten or twenty years). The dissemination of description of events (either by media, public policies or companies) towards helping the underinsurance problem can also be harmful, since people that use description heuristics may over-insure beyond what is reasonable or of what they can afford. Further research in insurance demand should aim to investigate the thin line of the impact of description, looking for its benefits, costs, and limits.

The affection bias can be a double-edged sword towards insurance demand, which may cause over-insurance to events with big emotional connection, and underinsurance to events with none or low emotional connection. Although the insurance compensation for stolen objects with and without emotional attachment might be the same, the extra loss of losing the object with good childhood memories, for instance, may make people more eager to buy insurance premiums. As in the case of the availability heuristics, experimental and empirical research can verify if the impact of media can also transform affect-poor risky events in the face of the public into events with deep emotional connection, shifting insurance demand.

By focussing on the role of financial literacy in the insurance puzzle, the paper also provides routes for further research. In particular, the literature ignored the possibility to consider the behavioural biases and heuristics motivations for the insurance demand puzzles as issues arising from a certain degree of financial illiteracy. Financial literacy (i.e. the good knowledge and use of financial concepts and technologies) was found to have a significant role to play in decision making, with low levels of it (i.e. financial illiteracy) being linked with welfare-reducing financial decisions (e.g. low commitment to retirement funds, poor investment decisions) and social problems (e.g. over-indebtedness in society), with this also impacting insurance decision making. Although financial literacy improving measures were found in the literature to be able to reduce underinsurance, there are still no contributions to its effect on the behavioural biases of insurance puzzles. Since many biases and heuristics are motivated by either lack of knowledge or misuse of financial concepts and products (e.g. poor estimations of myopic people being motivated by lack of knowledge), it is natural to see the link with financial illiteracy, and measures that improve financial literacy could also end up mitigating behavioural biases that affect insurance demand. By this, the financial literacy approach can be seen as a possible new promising trend in the literature into solving the behavioural problem of insurance demand, which could promote better decisions and better financial outcomes to affected individuals.

The understanding of these behavioural motives, finding the root problems, as well as giving the right “remedies” to them can be a good way to approach the puzzles of insurance demand. In addition, the study strongly suggests that solving the personal finance knowledge and use issues that motivates many of those biases can be one of the main possible ways to mitigate the biases. For this purpose, the literature concerning financial literacy and education have much to add to answer the research questions of the insurance demand puzzles. The avenues of integrating those pieces of literature can certainly propose good fruits and developments to the insurance demand literature.

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