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# On-demand insurance: idea, development, impact on market equilibrium

*The article presents the definition, idea, development, and current state of a new business model known as on-demand insurance which has been in existence since the early 21st century. Moreover, the article does not only describe the premises behind the development of this new method of creating value for clients of insurance companies and the opportunities that appear in the market but also addresses the challenges that insurance providers can encounter. Based on the analysis and available source materials, the most interesting types of these insurance products and the entities that include such products in the portfolios were presented. In addition, some new regulatory challenges and trends were described.*

*The purpose of this study is to analyse the behaviour of the insurance market after the introduction of on-demand products in light of the classical definition of equilibrium in a competitive insurance market under conditions of information asymmetry.*

*The authors analysed the economic implications of implementing on-demand insurance, demonstrating its potential to enhance the overall welfare of the insured population by increasing utility for certain risk groups of clients.*

**Keywords:** insurtech, on-demand insurance, RS model, market equilibrium

**JEL:** G22, G52, D58

## Introduction

The rapid digitisation of various industries in the second decade of the 21st century has led to the emergence of on-demand services, particularly in sectors such as music, tourism, and media. In today's tech-driven and ever-evolving world, it is essential to provide products and services that

are tailored to meet the specific needs of consumers, marked by transparency and the ability to adapt flexibly to their lifestyles. Significant advancements in this realm have been evident since 2020, largely influenced by the constraints imposed by the COVID-19 pandemic.

In the case of insurance, there is a growing demand for universal access to insurance. People now expect to utilise digital technology to access insurance services at their convenience, whenever the need arises. The emergence of innovative insurance start-ups, as part of the insurtech, is driving transformative changes across various aspects of the insurance value chain, including risk and asset management, new products and services, and innovative distribution methods. Insurtech is commonly segmented into categories such as comparison portals, digital brokers, insurance cross-sellers, Peer-to-Peer insurance, on-demand insurance, digital insurers, Big Data, Internet of Things, and Blockchain[1]. In addition, a significant number of potential clients opt out of insurance coverage due to high premium costs associated with annual insurance contracts. They often feel that such extended coverage is unnecessary, knowing they are not at risk for the entire duration of the insurance term.

In light of the above, it is worth noting that insurance companies are actively responding to evolving client expectations by developing the concept of *on-demand insurance*. This new approach seeks to address emerging market needs. Can on-demand insurance substantially impact the traditional insurance market? What will the market look like once this type of product is introduced? These questions still lack a definitive answer.

The purpose of this study is to find the answer to the research question: 'Does on-demand insurance may increase the general welfare of the insured population?'. Additionally, the study will conduct an initial analysis of the insurance market's behaviour following the introduction of such products in light of the classic definition of Rothschild and Stiglitz equilibrium in a competitive insurance market under the conditions of information asymmetry (RS model).

In its structure, after the introduction part, the paper discusses a new business model in the insurance market by pointing to the essence of on-demand insurance and the development of the on-demand insurance market – all based on literature and a market trend review, and some use cases. The subsequent methodological part of the paper focuses on equilibrium in the competitive insurance market in the RS model and it discusses the state of the market before and after the introduction of on-demand products. The paper concludes with final remarks that encompass key findings, policy recommendations, and suggestions for future research.

## 1. A new business model on the insurance market

### 1.1. The essence of on-demand insurance

The emergence of on-demand insurance in the market addresses the specific needs of clients by offering protection only against the threats they face at a particular moment and additionally only for the period for which they are actually exposed to them. Zeier Röschmann, Erny, and Wagner suggest that the concept of on-demand insurance should be perceived as a technologically conditioned phenomenon of immediate conclusion of insurance for a period of protection personally

1. A. Braun and F. Schreiber, *The Current InsurTech Landscape: Business Models and Disruptive Potential,* University of St. Gallen, 2017, pp. 55–59.

defined or determined by technology, covering exposure to risk resulting from activity or ownership (a specific asset)[2]. The key idea behind this insurance model is to provide clients with the freedom to activate protection when needed without the need to engage with an insurance company or intermediary. Clients can self-activate coverage through mobile applications, for instance, by simply adjusting a slider. This allows individuals to secure insurance when starting activities such as biking on public roads, traveling overseas, or using electronic devices susceptible to damage or theft. Subsequently, clients also have the ability to terminate the coverage at their own discretion.

It is important to note that the term "on-demand insurance" is often erroneously linked with usage-based insurance (UBI), particularly in English literature. On-demand insurance is a broader concept, focusing on the start and duration of insurance coverage. In UBI, the main focus is on the behaviour of the insured or the use of the insured item, with the time of use being the only piece of information collected[3].

The concept behind on-demand products is based on a simple business model. It rests on the assumption that the insurance premium for short-term coverage of an asset (such as a smartphone or a bicycle) is higher than the proportionate (*pro rata temporis)* premium for a one-year contract. At the same time, the premium for each partial coverage period should be lower than the standard annual premium. If this balance is not achieved, there would be no rational incentive for the insured to opt for an on-demand product over an annual insurance policy. Determining the premium amount correctly involves the challenge of considering several factors that may not be relevant in the case of traditional insurance products.

Please bear in mind that the use of protection only at specific times impacts not just the insurance costs for clients. When it comes to this type of insurance, coverage is only provided when the asset is in use and at risk, which means that the exposure to risk is much higher throughout the coverage period compared to annual contracts. This means that risk realisation is not spread out over time. Additionally, allowing clients to enable or disable coverage presents a challenge for insurers in accurately predicting the total duration of coverage that the client will use during the specified period. Unlike traditional models, the premium is not calculated *ex ante* based on the client's declaration of the desired coverage period but is settled, for example, on an annual basis, after summing up the partial periods used in a given settlement period.

In addition, on-demand insurance could potentially lead to an increased risk of fraudulent claims as clients may be tempted to acquire coverage solely to report a loss that occurred prior to the policy's effective date. It is crucial to note that the rise in insurance risk may not only be attributed to heightened exposure or illegal activities but also to a significant increase in moral hazard. In the age of the burgeoning sharing economy (exemplified by companies like Airbnb, Uber, Blinkee, Lime, and Traficar) which is closely tied to on-demand insurance, the level of care for assets utilised by users might be lower compared to those owned directly by the policyholder.

We must also consider the issue of adverse selection. Akerlof emphasised decades ago that as long as clients have significant discretion in decisions related to insurance purchases, policy renewals, and coverage amounts, the problem of adverse selection will persist in the market (or

2. A. Zeier Röschmann, M. Erny and J. Wagner, *On the (future) role of on-demand insurance: market landscape, business model and customer perception,* 'The Geneva Papers on Risk and Insurance – Issues and Practice', 2022 vol. 47, pp. 604–606.

3. Ibidem., p. 608.

at least have the potential to arise)[4]. On-demand insurance products empower clients to make decisions in all these areas.

## 1.2. Development of the on-demand insurance market

Insurers opting in to incorporate on-demand products into their offerings, often through specialised entrepreneurs known as *insurtechs*, must contend with various limitations and consequences. However, since 2020 the number of companies offering this innovative insurance approach has significantly increased. These companies provide diverse interaction models between the insured and the insurer and cover a wide range of product lines, including motor insurance, bicycle insurance, electronic equipment insurance, housing insurance, fleet insurance, and business interruption insurance.

One of the first digital platforms enabling the conclusion of on-demand insurance was Trōv – an insurtech established in San Francisco in 2012. Clients were able to select specific insurable assets such as bicycles, cameras, or skis, and choose the start and end dates for coverage. Interestingly, Trōv is currently the largest insurance platform and, at the same time, the company that does not take over insurance risk[5], similar to how Uber is a major transportation company without owning any vehicles, and how Airbnb, a leading player in the hospitality industry, does not own any hotel rooms.

Trōv was initially launched in Australia, the UK, and Japan in collaboration with insurers like AXA, Samp, and Subcorp. More recently, Trōv has introduced a tenant insurance product in partnership with Lloyds Banking Group. Notably, Trōv's approach to the insurance distribution involves collaborating with various carriers to provide coverage under its brand. Thanks to this solution, the client always remains in the known distribution network.

Trōv has also embraced a new business model known as *embedded insurance* which essentially integrates insurance protection with the purchase of a specific product or service. This approach means that instead of selling insurance products separately, the insurance is seamlessly included as a native feature of the purchased product or service. For instance, using car share services automatically provides motor insurance for the duration of the vehicle's use, your new camera comes with built-in coverage against theft and damage, and the platform you use for business operations is insured by liability insurance. Embedded insurance is changing the insurance distribution model by offering insurers and their clients an extensive range of unique and specialised value propositions in real-time or at the point of sale[6].

An intriguing insurance platform to consider is Cuvva. Launched in 2015 in London, the company operates similarly to Trōv by offering insurance coverage for periods as short as 1 hour and up to 28 days. Cuvva focuses on providing short-term vehicle insurance in partnership with two

4. G.A. Akerlof, *The Market for 'Lemons': Quality Uncertainty and the Market Mechanism*, 'The Quarterly Journal of Economics', 1970 vol. 84(3), pp. 488–500.
5. T. Kemp, *In Conversation with Scot Walchek, CEO of Trov,* https://oakhcft.medium.com/in-conversation-with-scott-walchek-ceo-of-trov-71e6650d2398 (June 14, 2023).
6. S. Fischer, *Why Embedded Insurance is a Game Changer for Insurers and their Customers,* https://www.baloise.com/en/home/news-stories/news/blog/2019/why-embedded-insurance-is-a-game-changer-for-insurers-and-their-customers.html (March 14, 2023).

Gibraltar insurance companies: Collingwood and Mulsanne Insurance[7]. This type of insurance is addressed to vehicle owners or individuals in need of temporary coverage such as during test drives, private car rentals, or when moving. These short-term policies are designed to complement basic coverage such as third-party liability for vehicle owners, allowing for cost optimization while tailoring protection to specific situations.

American-Canadian Slice is different from its predecessors as it enables insurers and technology companies to create and market digital insurance products. Established in 2015, the company is among the pioneers in using artificial intelligence combined with *machine learning* (ML) to develop, deliver, and operate insurance products. This empowers insurers to offer flexible, on-demand insurance customised to client needs.

Similarly, the Sure platform centralises insurance processes in a single application, encompassing distribution, policing, and claims handling. This platform enables insurers to equip their insurance intermediaries (e.g., agents) with a suite of modern tools designed to streamline sales processes and enhance overall client service quality.

By Miles, on the other hand, is a platform that calculates vehicle insurance premiums based on the distance travelled. The company offers *pay-per-mile* insurance, an innovative form of on-demand insurance where the risk exposure is based on distance rather than time, measured in kilometres or miles.

Currently, at the beginning of the third decade of the 21st century, there is a growing variety of platforms offering on-demand insurance. Table 1 provides a summary of the most significant ones.

**Tab. 1. Examples of on-demand insurance offers (worldwide, 2011–2021).**

| no. | Name | Profile | Year* | Country |
|---|---|---|---|---|
| 1. | Metromiles | It offers *pay-per-mile* insurance, calculating the premium based on mileage data obtained from the mobile application. | 2011 | USA |
| 2. | Trōv | It enables insurers to create and market on-demand products in the embedded insurance formula. | 2012 | USA |
| 3. | Simplesurance | A platform that allows on-demand insurance for electronic equipment and bicycles. | 2012 | Germany |
| 4. | Amodo | It offers *pay-per-mile* insurance, calculating the premium based on mileage data obtained from the mobile application | 2013 | Croatia |
| 5. | Superscript | It offers short-term on-demand insurance for entrepreneurs. | 2014 | Great Britain |
| 6. | Vigo | It offers usage-based motorcycle insurance. It requires a mobile app and a tracking device installed in the vehicle. | 2014 | Slovenia |
| 7. | Slice | It enables insurers and technology companies to create and market on-demand products. | 2015 | USA |
| 8. | Lemonade | It offers home insurance using artificial intelligence (chatbot). The sale takes place via mobile application. | 2015 | USA |
| 9. | Cuvva | The platform offers short-term motor insurance. | 2015 | Great Britain |
| 10. | Getsafe | It focuses on short-term insurance of bicycles and household movables. The insurance is provided via mobile application. Currently, the offer also includes liability insurance and motor insurance. | 2015 | Germany |

7. P. Littlejohns, *What is Cuvva? Hourly car insurance for frequent drivers*, https://www.nsinsurance.com/news/cuvva-insurance-company/ (June 10, 2023).

| no. | Name | Profile | Year* | Country |
|---|---|---|---|---|
| 11. | Thimble | Through the mobile app, Verifly, it offers on-demand drone insurance with a coverage period of up to 8 hours. | 2016 | USA |
| 12. | Friday | *Pay-per-mile* motor insurance, calculating the premium based on vehicle mileage data. Unlike its competitors, it obtains data about the vehicle odometer reading based on client's declarations. | 2017 | Germany |
| 13. | Lings (Generals) | It allows you to insure selected assets (sports equipment, bicycles, drones, electronics) online against theft, damage, and destruction, for one day. | 2017 | Switzerland |
| 14. | UNIQA Insurance Ltd | It is activated as needed – the driver turns it on when he/she wants and pays for how much he/she drove. In addition, a flexible use and rational consumption according to the *pay-as-you-drive* principle is provided. | 2021 | Croatia |

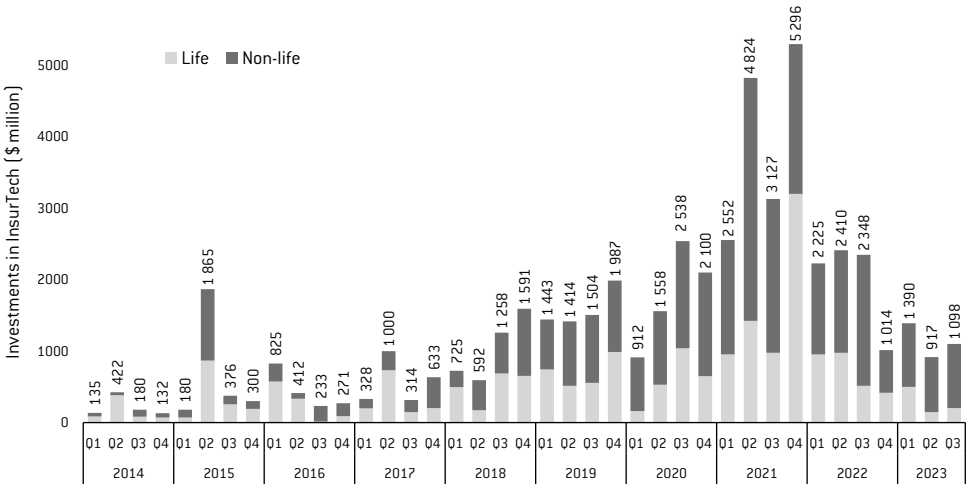
* – year of starting a business by the brand owner
Source: Own study.

A notable example is the *Smart motor vehicle insurance* offered by the traditional insurance company UNIQA Insurance Ltd in Croatia. UNIQA Smart motor vehicle insurance is the first fully digital motor vehicle insurance in Croatia that can be obtained through a mobile application. It can be activated as needed – the driver can turn it on when he/she wants and pays depending on how much they drive. In addition to allowing flexible use and cost-effective consumption based on the *pay-as-you-drive* principle, the Smart motor vehicle insurance also provides the user with the ability to monitor their driving, earn reward kilometres for safe driving, customise their coverage with no participation in a claim, and pay a lower premium than a "regular" motor vehicle insurance[8]. A similar example from the Polish market is Aviva which briefly offered hourly auto insurance under the brand TERAZ by Aviva.

The rise of on-demand insurance is evident from the growing number of established insurtech companies globally and their substantial capitalisation. In 2022, there were 521 global transactions involving the financing of insurtechs by investors, compared to 563 the previous year. However, there was a 50% reduction in capital, which was a consequence of the exceptionally high investment levels in 2021 driven by the COVID-19 pandemic. By the end of 2022, insurtechs had amassed approximately $8 billion in capital for future development, and by the third quarter of 2023, this figure had exceeded $3.4 billion, as depicted in Figure 1.

8. *Smart motor vehicle insurance – the first motor vehicle insurance that you pay for as much as you drive,* UNIQA Insurance Ltd., 2022, p. 16.

**Fig. 1. Quarterly worldwide investments in insurtech (2014–2023).**




Source: Global InsurTech Report, Gallagher Re, 2023, p. 47.

The emerging trend of on-demand insurance is gaining popularity, although it currently represents only 1% of the global premium[9]. Considering the early stage of its market lifecycle, this share can be deemed relatively high. Projections suggest that the global market for on-demand insurance products may reach $190 billion by 2026[10]. Nonetheless, operational scale stands as a potential barrier to the market's further development. Similar to traditional insurance, achieving desirable financial outcomes for insurers necessitates a substantial number of concluded contracts. However, evolving client needs driven by the widespread use of digital technologies could stimulate dynamic growth in this sector. For instance, the *Millennial generation*[11] born in the 1980s and 1990s exhibits a natural inclination towards digital technologies. With this generation already possessing assets and demonstrating an increasing demand for insurance, solutions such as on-demand insurance are meeting their needs. Research indicates that Generation Y accounts for nearly 50% of all digital technology purchases[12], underscoring their influence on the growing significance of on-demand insurance. Furthermore, the demographic shift towards a larger proportion of Millennials and the ongoing development of the sharing economy, facilitating short-term asset lending, contribute to the market demand for insurance products with premiums payable only for the duration of the loan period[13].

9. *Will on-demand insurance become mainstream?*, KMPG 2017, p. 1, https://assets.kpmg/content/dam/kpmg/uk/pdf/2017/09/will-on-demand-insurance-become-mainstream.pdf (April 12, 2023).
10. D. Garth, *The future of insurance in an on-demand world*, https://www.insurance-canada.ca/2019/08/23/future-insurance-on-demand-world/ (May 20, 2023).
11. Other common terms are *Generation Y* or *Digital Generation*.
12. Ch. Colby and K. Bell, *The On-Demand Economy Is Growing, and Not Just for the Young and Wealthy*, 'Harvard Business Review', 2016, https://hbr.org/2016/04/the-on-demand-economy-is-growing-and-not-just-for-the-young-and-wealthy (June 14, 2023).
13. M. Eling and M. Lehmann, *The Impact of Digitalization on the Insurance Value Chain and the Insurability of Risks*, 'The Geneva Papers', 2018 vol. 43, pp. 359–396.

In addition, it should be borne in mind that because the contracts are short-term, the total premium paid by a single client to the insurance fund is lower than it would be for an annual period. To mitigate the higher risk associated with these products, the insurer may need to increase the amount of capital set aside for technical provisions. This adjustment can directly affect the insurer's financial results for a specific period.

An important driver of on-demand insurance is the Digital Finance Strategy for the EU, aiming to foster a competitive EU financial sector that provides consumers with access to innovative financial products while ensuring consumer protection and financial stability. This initiative aligns with the EU's ambition for a recovery that embraces the digital transition. Digital financial services have the potential to modernise the European economy across various sectors, positioning Europe as a global digital player[14]. Additionally, FinTech plays a crucial role in the Capital Markets Union by facilitating the deepening and broadening of EU capital markets through the integration of digitisation and data-driven solutions to transform business models[15]. The concept of open insurance is also pertinent to the on-demand insurance agenda. Key use cases for on-demand insurance include improving access to public registers and facilitating better interaction between businesses and technology providers. This may involve collaboration with Internet of Things (IoT) providers such as those offering health or motor telematics as well as providing white-labelled insurance products that can be integrated into other digital business models[16].

## 2. Equilibrium in the competitive insurance market in the RS model

### 2.1. General assumptions of the RS model

To assess the potential impact of introducing on-demand insurance products in a competitive market, let us consider a scenario based on Rothschild and Stiglitz's assumptions[17]. In this scenario, there is a screening game in the market, involving two potential outcomes (no loss and loss) and a state-contingent insured's wealth: $w_1$, representing no damage to the insured property $w$, and $w_2$, representing damage resulting in a non-negative loss of $X$. In this market, there are at least two risk-neutral insurers vying for profit $\pi$ by offering individual contracts C, denoted by the pair $\{r, q\}$, where $r$ is the actuarial premium and $q$ is the potential compensation. These insurers operate under the Cournot-Nash model, treating their competitors' actions as independent and unchanging. Additionally, they have the ability to restrict the number of contracts purchased by each insured, which can lead to the premium not necessarily being proportional to the compensation amount.

14. *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on a Digital Finance Strategy for the EU*, European Commission 2020, COM(2020) 591 final.
15. *Communication from the Commission to the European Parliament, the Council, the European Central Bank, the European Economic and Social Committee and the Committee of the Regions*, *FinTech Action plan: For a more competitive and innovative European financial sector*, European Commission 2018, COM(2018) 109 final.
16. *Open insurance: accessing and sharing insurance-related data*, Discussion paper, EIOPA 2023, p. 15, doi: 10.2854/013491.
17. M. Rothschild and J. Stiglitz, *Equilibrium in competitive insurance markets: An essay on the economics of imperfect information*, 'The Quarterly Journal of Economics', 1976 vol. 90(4), pp. 629–649.

In the market, a group of insured individuals exists who are denoted as N characterised by the same strictly concave and doubly differentiable von Neumann-Morgenstern utility function $u(w)$, where $u'(w) > 0$ and $u''(w) < 0$. This function assigns a specific level of satisfaction for each wealth amount of the insured individuals, with a preference for higher wealth values. Each insured individual possesses assets with an initial amount of wealth denoted as $w_0$ and is subject to a potential loss $X$ (where $0 < X < w_0$). Furthermore, each individual belongs to a homogeneous risk group (profile) denoted as $i$ which categorises the insured based solely on their probability of filing an insurance claim $p_i \in (0,1)$. Each insured individual is aware of their group assignment and the corresponding probability $p_i$ which is predetermined and independent of the individual.

Given the additional assumption that the insured, under conditions of full coverage with parameter $q_i = x$, derives identical utility from the property, regardless of whether a loss occurs, the function of the insured's expected utility when purchasing the contract $C_i$ can be expressed as $\bar{u}_i(C_i) - p_i \times u(w_0 - r_i - X + q_i) + (1 - p_i) \times u(w_0 - r_i) \geq 0$.

The insured individuals are risk averse, meaning they seek to minimise potential losses through insurance contracts ($\bar{u}_i(C_i) - \bar{u}_i(E) \geq 0$, where $E$ represents no insurance). When they are indifferent to multiple contracts, they will choose the one preferred by the insurer. It is essential to limit the set of contracts, denoted as $\omega$, offered by insurers to those that satisfy the condition $w_0 - r_i \geq w_0 - r_i - X + q_i > 0$ in order to eliminate the problem of moral hazard.

Insurers lack *ex ante* complete knowledge of the profile of each insured person[18] but hold expectations about the representation of different groups of insured persons in the overall population. This lack of full risk-related information about the client results from *information asymmetry* in the insurance market. This situation arises when one party to the contract (the insured or the insurer) possesses more information of common value about the insured risk than the other party, leading to incorrect insurance decisions. Akerlof's initial presentation of this concept used the example of the used car market[19]. The results of his considerations were quickly extended to the insurance market and formed the basis for the assertion that if all insurers lack complete information about the risks of each individual insured person, market equilibrium may not exist, and if it does, it may not be effective. Information asymmetry is recognised as one of the causes of market failure and leads to adverse selection and moral hazard as its consequences.

In addition, insurers are constrained by the requirement that the policies they offer cannot result in a positive profit. If a competitor attempted to introduce a policy with a positive profit, other market participants could respond by offering a policy with a slightly lower premium and higher compensation, still ensuring profitability. This dynamic would lead to the attraction of all clients within a specific group, a phenomenon known as *cream skimming*.

In such a market, there is an attempt to achieve a separating equilibrium whereby different groups of clients are offered different policy terms. Rothschild and Stiglitz assert that in a competitive insurance market, the equilibrium consists of a set of contracts such that, when clients make

18. A situation in which not only the insurer but also the insured do not know the probability of causing damage by them was considered, among others, in: T.R. Palfrey and C.S. Spatt, *Repeated Insurance Contracts and Learning*, 'The Rand Journal of Economics', 1985 vol. 16(3), pp. 356–367; D.A. Malueg, *Repeated Insurance Contracts with Differential Learning*, 'The Review of Economic Studies', 1988 vol. 55(1), pp. 177–181; M. Boyer, G. Dionne and R. Kihlstrom, *Insurance and the Value of Publicly Available Information*, in: Studies in the Economics of Uncertainty, T.B. Fomby, T.K. Seo (Eds.), Springer, New York, 1989.

19. G.A. Akerlof, op. cit., pp. 488–500.

choices that maximise their expected utility: a) no element of the equilibrium set yields a negative expected profit, b) no contract outside of the equilibrium set could yield a non-negative profit[20].

## 2.2. The state of the market before the introduction of on-demand products

### 2.2.1. Competitive insurance market assuming two client risk profiles

The traditional RS model posits the presence of two homogeneous groups of insured individuals in the market: those with low $(i = L)$ and high $(i = H)$ risk, where $p_H > p_L$. The proportion of insured individuals from group $H$ is $\gamma = \frac{n_H}{N}$ and $L$ respecti vely $1 - \gamma = \frac{n_H}{N}$, signifying that the overall population's average risk is $\tilde{p} = \gamma p_H + (1 - \gamma)p_L$. For a state of separating equilibrium to be attained in a competitive insurance market under conditions of information asymmetry, a contract with reduced coverage must be offered to the low-risk insured group, resulting in a loss of utility for this group. This is because a potential contract, providing full coverage to group $L$ (satisfying the equation $w_1 = w_2$), would not only be most preferred by group $L$, but would also be strictly preferred by group $H$ over $C_H$ due to the same coverage, but at a lower premium. Since insurers cannot assign specific risk profiles to individual insureds, $C_L$ would be purchased by representatives of both groups. In practice, this situation may lead to adverse selection as group $L$ is overly burdened with an additional premium to compensate for losses caused by insured individuals with the $H$ profile. Therefore, $C_L$ cannot be part of the equilibrium set as zero profit would only be achieved if it were purchased solely by individuals with the probability of loss $p_L$. A potential contract catered to group $L$, which could establish equilibrium, cannot be preferred by group $H$ over $C_H$.

Accepted assumptions enable the formulation of the following problem:

$$\max_{r_i, q_i} p_i \times u(w_0 - r_i - X + q_i) + (1 - p_i) \times u(w_0 - r_i)$$

s.t.

$$(1 - p_i)r_i - p_i(q_i - r_i) = 0$$

$$u(w_0 - r_H) \geq p_H \times u(w_0 - X - r_L + q_L) + (1 - p_H) \times u(w_0 - r_L).$$[21]

The problem solution can be illustrated graphically by identifying contracts on the positive quadrant of the coordinate system. The values on the axes correspond to the insured's asset values in both states: $w_1$ and $w_2$. Point $E$ with coordinates $(w_0, w_0 - X)$ represents no insurance, while the coordinates of point $C_i$ $(w_0 - r_i, w_0 - r_i - X + q_i)$ represent the state of the insured's wealth in both the cases of no damage and when damage occurs, if the insurance contract $C_i$ has been concluded. The line $\pi_i = 0$, passing through point $E$ and with a slope of $-\frac{1 - p_i}{p_i}$, represents all contracts that, with a claim probability of $p_i$, yield an expected zero-profit $\pi$ for the insurer. This is given by the equation $w_2 = w_1 - X + q_i$, where $w_1 = w_0 - r_i$, $r_i = p_i q_i$[22].

In Figure 2, the solution to the maximisation problem is the set $\omega^* = \{C_H, C_L'\}$. Although $C_L'$ is part of $\omega^*$, the purchase of it results in reduced utility for group $L$ due to underinsurance, when compared

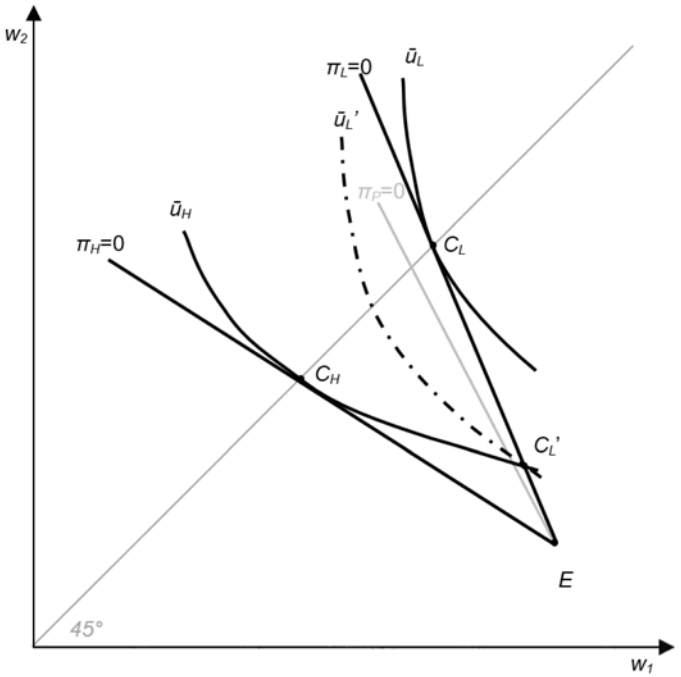
20. M. Rothschild and J. Stiglitz, op. cit., p. 633.

21. This limitation is directly related to the self-selection mechanism.

22. $r_i = p_i q_i$ means a fair premium determined based on the expected value of the claim.

to the full coverage provided by $C_L$. It can be inferred that this decrease in utility as well as a more general loss of welfare are a direct outcome of the information asymmetry present in the market.

**Fig. 2. Market equilibrium with two client risk profiles.**




Source: Own elaboration based on M. Rothschild and J. Stiglitz, op. cit., p. 633.

It is important to note that the existence of the $\omega^*$ set does not necessarily ensure market equilibrium. For instance, if one insurer were to offer a contract $C_P$ lying above $\bar{u}_L'$ and has a zero--profit line $\pi_P = 0$ (common to all insureds), which closely aligns with the line $\pi_L = 0$ (this could occur if the proportion of *H*-profile insureds is relatively small or if the differences in probabilities are insignificant), $C_P$ could disrupt the potential equilibrium by attracting both groups and generating positive profits concurrently.

### 2.2.2. Competitive insurance market assuming four client risk profiles

The above analysis can be expanded by introducing an additional factor – risk exposure denoted as $t_j \in (0,1)$ which represents the proportion of the year during which the asset is exposed to risk. For simplicity, we will categorise the exposure time as short $(j = S)$ or long $(j = E)$. The probability of an insured party reporting a claim can be expressed as $p_{ij} > p(t_j, \varepsilon_i) \in (0,1)$, where $\varepsilon$ represents factors other than exposure that influence the probability, $i \in \{L,H\}$, $j \in \{S,E\}$, and $p(t_E, \varepsilon_i) > p(t_S, \varepsilon_i)$.

In situations where the insurer does not attempt to observe the exposure and clients are categorised into basic risk groups $(L, H)$ based solely on the final $p_i$ value, the exposure is assumed to be automatically included in the value of $p_i$. It is also assumed that $p_{HS} > p_{LE}$, meaning that insurers in group *L* cannot achieve the same probability of claim as group *H* simply by increasing the length of exposure.

This approach results in the creation of not two, as in the original RS model, but four (see Table 2) homogeneous groups of insured individuals. These groups differ in the probability of a claim which is influenced by the duration of exposure and other factors impacting the level of probability directly.

**Tab. 2. Four profiles of the insured resulting from the identification of exposure to risk.**

| | | $\varepsilon$ | |
|---|---|---|---|
| | | $H$ | $L$ |
| $t$ | $E$ | group: $HE$<br>$p_{HE} = p(t_E, \varepsilon_H)$ | group: $LE$<br>$p_{LE} = p(t_E, \varepsilon_L)$ |
| | $S$ | group: $HS$<br>$p_{HS} = p(t_S, \varepsilon_H)$ | group: $LS$<br>$p_{LS} = p(t_S, \varepsilon_L)$ |

Source: Own elaboration.

Insurers try to offer separate contracts $C_{ij}$ for each of the risk groups and the function of the expected utility of the insured, when purchasing a contract intended for him, is $\bar{u}_{ij}(C_{ij}) = p_{ij} \times u(w_0 - r_{ij} - X + q_{ij}) + (1 - p_{ij}) \times u(w_0 - r_{ij}) \geq 0$.

In order to establish a separating equilibrium, policyholders in risk groups other than $HE$ should be provided with contracts offering a more limited scope of coverage, resulting in reduced utility for these groups. This approach is still driven by insurers' desire to mitigate adverse selection and maintain a zero-profit condition. Therefore, the problem to be solved can be framed as:

$$\max_{r_{ij}, q_{ij}} p_{ij} \times u(w_0 - r_{ij} - X + q_{ij}) + (1 - p_{ij}) \times u(w_0 - r_{ij})$$

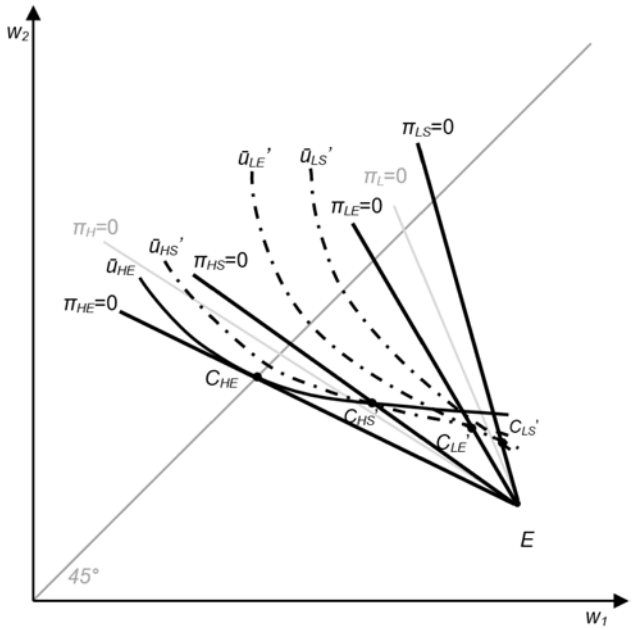
s.t.

$$(1 - p_{ij}) r_{ij} - p_{ij}(q_{ij} - r_{ij}) = 0$$
$$u(w_0 - r_{HE}) \geq p_{HE} \times u(w_0 - X - r_{HS} - q_{HS}) + (1 - p_{HE}) \times u(w_0 - r_{HS})$$
$$u(w_0 - r_{HS}) \geq p_{HS} \times u(w_0 - X - r_{LE} - q_{LE}) + (1 - p_{HS}) \times u(w_0 - r_{LE})$$
$$u(w_0 - r_{LE}) \geq p_{LE} \times u(w_0 - X - r_{LS} - q_{LS}) + (1 - p_{LE}) \times u(w_0 - r_{LS}).$$

In Figure 3, it is evident that the solution is the set $\omega^* = \{C_{HE}, C_{HS}', C_{LE}', C_{LS}'\}$.

These contracts not only lead to a deeper reduction in utility for members of the original $L$ group (now divided into $LE$ and $LS$ groups), but also result in a decrease in utility for the $HS$ group. This means that some of the insured who were previously part of group $H$ and had the benefit of full insurance with a fair premium may now face limitations. In order to still maintain the zero-profit condition after the separation of the $HS$ group, the contract offered to these insured individuals must not provide higher utility for the $HE$ group compared to the $C_{HE}$ offered to it.

**Fig. 3. Market equilibrium with four client risk profiles before the introduction of on-demand insurance.**




Source: Own study.

The act of separating additional risk groups results in a decline in welfare among the insured population due to the progressive reduction of utility in groups other than the one with the highest probability of a claim.

## 2.5. The introduction of on-demand insurance to the market

Let us consider a scenario where insurers, alongside their annual contracts $C_{ij}$, introduce on-demand contracts $D_{ij}$, where $t_j$ gains the common knowledge value (the exposure is fully observable by insurers). The expected utility function from acquiring $D_{ij}$ can be defined as $\bar{u}_{ij}(D_{ij}) = p_{ij} \times u(w_0 - t_j r_{ij}^d - X + q_{ij}^d) + (1 - p_{ij}) \times u(w_0 - t_j r_{ij}^d) \geq 0$, where the index $d$ denotes the premium and indemnity provided for on-demand insurance. It is noticeable that the fair premium on an annual basis $r_{ij}^d$ was adjusted in this case to take into account the duration of the exposure $t_i$. For the same level of probability $p_{ij}$, the annual fair premium for on-demand products $r_{ij}^d = \frac{p_{ij} q_{ij}^d}{t_j}$ with a coverage period shorter than one year will be higher than the corresponding annual premium for traditional products $r_{ij} = p_{ij} q_{ij}$. This is due to the necessity for insurers to maintain premium adequacy and ensure a consistent level of compensation regardless of the type of product chosen. In the case of on-demand insurance, the required premium amount must be collected from short-term contracts rather than annual ones. Hence, there is a relation whereby the shorter the period for which a given asset is insured, the higher the insurance premium per unit of time.

The slope of the zero-profit line varies for each set of products. For standard one-year products, the slope is directly correlated with $p_{ij}$ and increases as the probability decreases. On the other hand, for on-demand insurance, the slope of the zero-profit line is determined by $\frac{p_{ij}}{t_j}$. This makes

the slope not only less steep than that of annual products, but also potentially different in order due to taking into consideration the exposure when determining the fair premium. Assuming a constant $\varepsilon$, the zero-profit line for $t_S$ will be less steep than for $t_E$, causing the line for the contract $D_{LS}$ to be positioned to the left of the line for the contract $D_{LE}$ (as illustrated in Fig. 4).

The problem to be solved in this case takes the form:

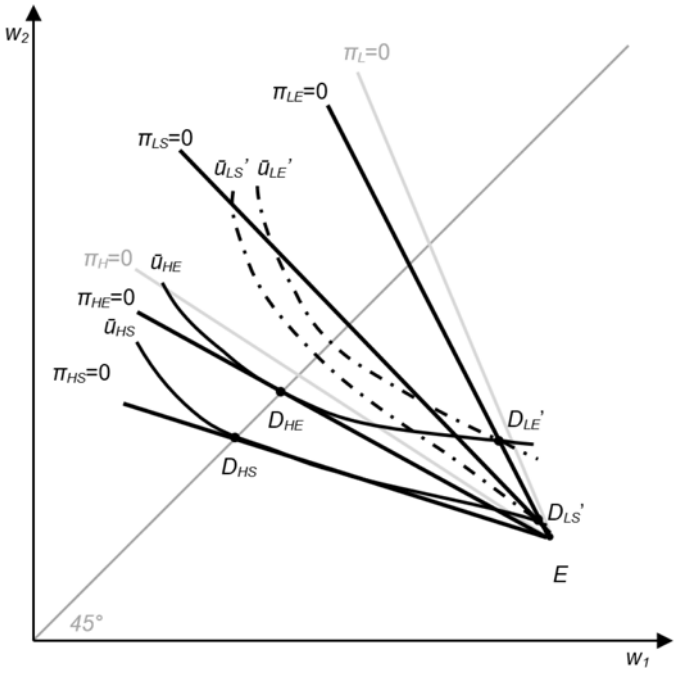
$$\max_{r_{ij},q_{ij}} p_{ij} \times u\left(w_0 - t_j r_{ij}^d - X + q_{ij}^d\right) + \left(1 - p_{ij}\right) \times u\left(w_0 - t_j r_{ij}^d\right)$$

s.t.
$$\left(1 - p_{ij}\right) r_{ij}^d - p_{ij}\left(q_{ij}^d - r_{ij}^d\right) = 0$$
$$u\left(w_0 - r_{Hj}\right) \geq p_{Hj} \times u\left(w_0 - X - r_{Lj}^d + q_{Lj}^d\right) + \left(1 - p_{Hj}\right) \times u\left(w_0 - r_{Lj}^d\right).$$

Policyholders from the *HE* group will be presented with the option of $D_{HE}$, the policy that provides full coverage at a fair premium, similar to $C_{HE}$. As a result, they are indifferent about the products available to them. Furthermore, because insurers have full knowledge of the duration of the exposure, policyholders cannot select insurance targeted at profiles with short exposure. In this scenario, they will stick with $C_{HE}$ which is preferred by insurers due to the higher premium it yields. In their efforts to maximise the utility derived from insurance, the *HE* group strictly prefers $D_{LE}$, the policy that also offers full coverage, but at a lower premium. Consequently, the contract introduced to the market for policyholders from the *LE* group cannot offer greater utility to the *HE* group than $D_{HE}$. This contract, termed $D_{LE}$', provides a lower level of protection than $D_{LE}$, albeit with a fair premium. Thus, the introduction of on-demand products does not improve the *LE* group's situation because, regardless of the product chosen, they will experience a loss of utility due to information asymmetry in the market. Similar to the *HE* group, members of the *LE* group will continue with yearly insurance which is preferred by insurers.

The situation of the *HS* group differs slightly as they may now obtain full coverage with a fair premium following the introduction of $D_{HS}$. Consequently, the members of this group can enhance their position and achieve the first-best allocation by eliminating the issue of underinsurance that existed with the previous $C_{HS}$ coverage. Although $D_{HE}$ would be more cost-effective in terms of the insurance premium per unit of time, members of the *HS* group are unable to opt for it due to it being fully observable by the insurer. On the other hand, they strictly prefer $D_{LS}$ over $D_{HS}$, meaning that a policy designed for the *LS* group would not provide the *HS* profile with greater utility than $D_{HS}$. As a result, the *LS* group will be offered a policy $D_{LS}$' similar to $D_{LS}$ but with a lower level of coverage, albeit still at a fair premium. Similarly to the *LE* group, the introduction of on-demand insurance will not alter the position of the *LS* group which will experience decreased utility regardless of the type of product selected. Therefore, they will continue with the $C_{LS}$' coverage.

**Fig. 4. Market equilibrium with four client risk profiles after the introduction of on-demand insurance.**




Source: Own study.

After the introduction of on-demand products, the equilibrium set will be $\omega^* = \{C_{HE}, D_{HS}, C_{LE}', C_{LS}'\}$. If the competitive insurance market remained in equilibrium according to the definition of Rothschild and Stiglitz, the introduction of on-demand products will enable policyholders with high risk and short exposure to obtain full coverage at a fair premium. This will increase the utility derived by this group from insurance and enhance the welfare of the entire insured population.

## Final remarks

If there are four distinct groups of insured individuals in a competitive market, each differentiated by their probability of experiencing a loss based on factors such as the duration of the risk exposure and other relevant characteristics, the introduction of on-demand insurance will result in the establishment of a new set of equilibria. Contracts within this set have the potential to increase the overall welfare of insured individuals, particularly those in the high-risk, short exposure group (*HS*) due to the potential for the increased utility. This is because insurers, in response to market asymmetry, may need to limit coverage for groups other than those with the highest probability of reporting damages. However, insurers implementing on-demand products can mitigate the negative impact of information asymmetry by leveraging common knowledge and full observability of risk exposure.

Despite the introduction of on-demand insurance, the position of low-risk clients remains unchanged, regardless of the duration of exposure. Contracts offered to them still need to have narrower coverage to avoid attracting high-risk policyholders and causing a loss for insurers.

According to market analyses, on-demand insurance currently holds a relatively small market share. However, it has been suggested that insurers will likely need to allocate resources towards the development of this product in order to maintain a competitive edge in the near future[23].

The rise of on-demand insurance is being driven by key factors such as the EU Digital Strategy and regulatory initiatives that support FinTech and insurtech. On-demand insurance and insurtech have the potential to impact client risk behaviour, enhance customer experience and sustainability, generate new business prospects, and add value to insurance core processes[24]. These potential outcomes could serve as the valuable areas for future research.

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## Ubezpieczenia na żądanie: idea, rozwój, wpływ na równowagę rynkową

*W artykule została przedstawiona definicja, idea, rozwój oraz obecny stan nowego modelu biznesowego, który w ostatnich kilku latach pojawił się na rynku – ubezpieczeń na żądanie. Zostały w nim scharakteryzowane przesłanki stojące za wypracowaniem tego nowego sposobu kreowania wartości dla klientów zakładów ubezpieczeń, szanse jakie pojawiają na rynku, ale też i zagrożenia z jakimi zakłady muszą mierzyć. Na podstawie analiz i dostępnych materiałów źródłowych zaprezentowano najciekawsze rodzaje tych ubezpieczeń oraz podmioty je oferujące.*

*Celem niniejszego opracowania jest analiza zachowania się rynku ubezpieczeniowego po wprowadzeniu produktów na żądanie, w świetle klasycznej definicji równowagi na konkurencyjnym rynku ubezpieczeń w warunkach asymetrii informacji.*

*Autorzy dokonali analizy ekonomicznej konsekwencji wdrożenia na rynek ubezpieczeń na żądanie wykazując, że są one w stanie zwiększyć ogólny dobrobyt zbiorowości ubezpieczonych ze względu na możliwy wzrost użyteczności dla wybranych grup ryzyka klientów.*

**Słowa kluczowe:** insurtech, ubezpieczenia na żądanie, model RS, równowaga rynkowa

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