The true value of the internet of things for the financial sector

The impact of IoT, artificial intelligence (AI) and information asymmetry on competitive financial markets

EY

Building a better working world

Contents

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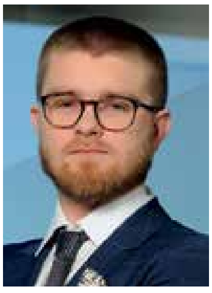

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Introduction

The most fundamental role that the financial services industry plays in the world economy is that it moves money from entities with excess funds to those with a need for funds.

Simple? It is not, and here's why. Most transactions on the financial markets are made based on the assumption that we are able to predict the future.

Unfortunately, as the saying attributed to Niels Bohr goes, "Prediction is very difficult, especially about the future."

For management science, with its roots in the work of F. W. Taylor,[1] development is based on the underlying belief that the systems we are trying to manage are ordered. It is only a matter of time and resources before the relationships between cause and effect will be discovered.

The reality, though, is different. In the marketplace, with numerous participants and multiple transactional relations between them, we have not managed, at least up to now, to develop tools that model the behavior of such systems — based on cause impact analysis and predictions of future state.

The development of information technologies modified the way financial institutions analyze data and support decisions. However, they have not changed the way they acquire source data about the world around us. Therefore, prediction models are — still — mostly based on sets of historical data, processed using statistical methods.

The rapid evolution of digital technologies resulted in many business executives bursting with excitement on learning details about new technologies, such as sensors, long-life tiny batteries and radio transmitters.

Financial institutions are spending billions analyzing the potential of new technologies, commonly called the Internet of Things (IoT), for their operations. However, most of the solutions are built around consumer IoT devices that do not differ particularly from the solutions developed for the retail sector (e.g., face recognition, voice analysis for call centers, customer service bots, new smart forms of identification, and authentication and payment).

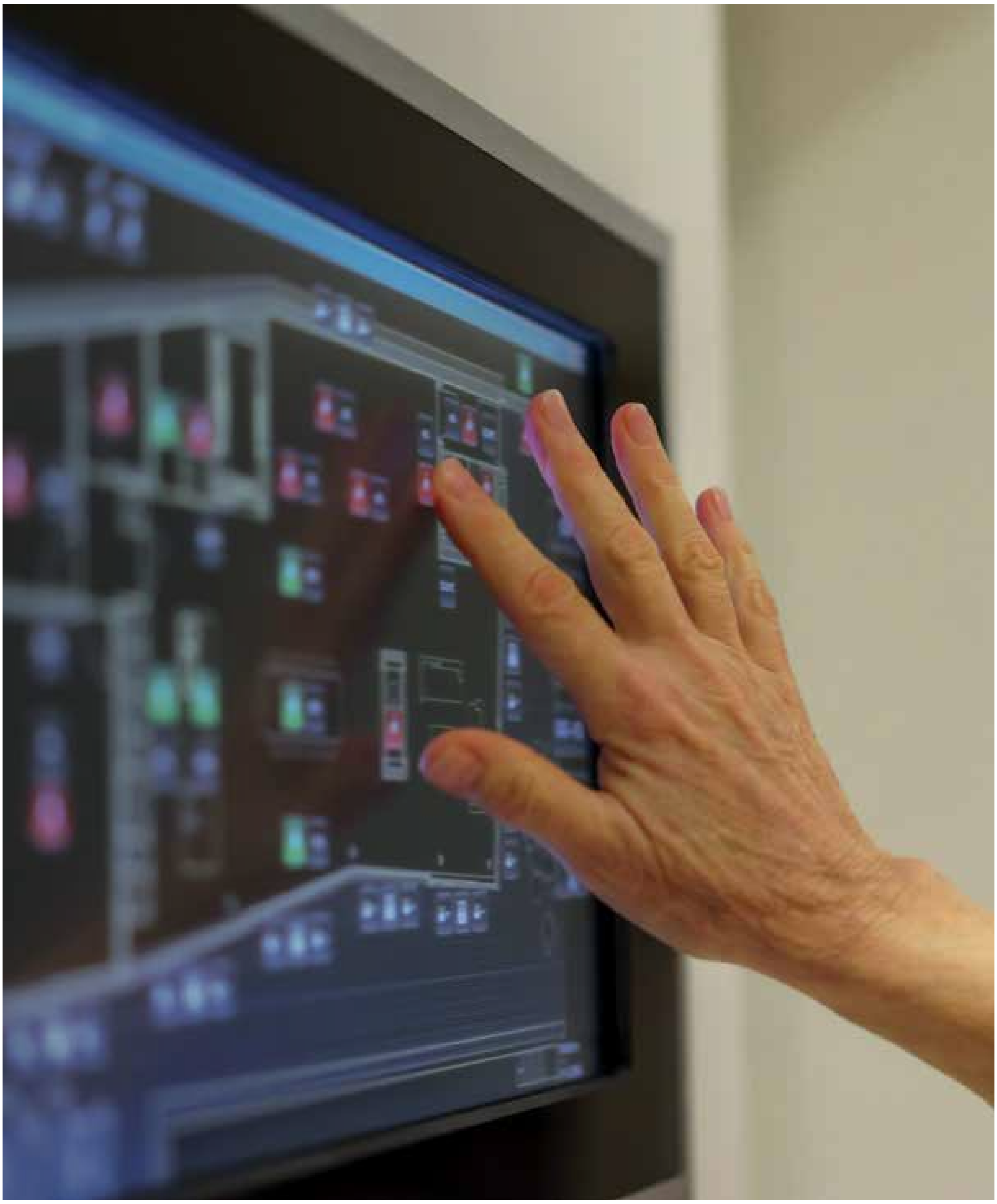
Like many other industries, **traditional financial institutions are focusing on small incremental improvements in the efficiency of their current operating model, losing sight of a breakthrough change in the very basis of their business. Instead, they could be managing the uncertainty, risk and asymmetry of information brought by the IoT.**

The purpose of this paper is not to elaborate on the shiny new technical capabilities of IoT devices, new connectivity technologies or discussions about the benefits of cutting edge processing. Instead, we want to explain how countless networked devices, through their interactions and convergence with artificial neural networks as data processing tools, will fundamentally change the core characteristics of financial institutions, in the future. What is more, we will show how bumpy the road leading to the world of the "new normal" can be.

The purpose of this paper is not to elaborate on the shiny new technical capabilities of the IoT. Instead, we want to explain how countless networked devices will fundamentally change the core characteristics of financial institutions, in the future. And we will show how bumpy the road toward the "new normal" can be.

[1]Frederick Winslow Taylor (20 March 1856–21 March 1915) was an American mechanical engineer who sought to improve industrial efficiency. He was one of the first management consultants.

The IoT



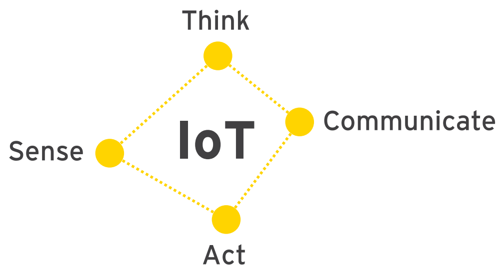
Let's start with the basics. The IoT is the technology that enables physical objects to be connected to the digital world. Various IoT devices provide information about geographical position, internal state, environmental conditions and the interactions between multiple objects. To be more precise, IoT devices do not provide information – they provide the results of objective observations, and thus data.

(The subtle difference between information and data will be explored later.)

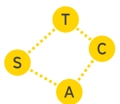
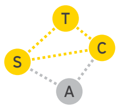
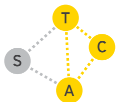
The massive deployment of sensors will result in unprecedented capabilities for gathering objective data about the world around us.[2] However, it is not obvious how these data will affect decision-making processes, operating models and risk profiles.

The massive deployment of sensors will result in unprecedented capabilities for gathering objective data about the world around us.

Table 1. What constitutes the IoT?



IoT devices variations

	Connectivity	Store and analyze	Sense	Actuate or visualize
	✓	✓	✓	✓
	✓	✓	✓	✗
	✓	✓	✗	✓

Source: own study.

[2]In 2018, it is expected that this will be over 400 zetabytes (ZB); in 2013 this figure was 113ZB. (1) (2)

Statistics as the foundation for financial markets

The effective management of uncertainty is the basis around which the financial sector functions. Regardless of whether we are talking about insurance, loans or trading securities, the accurate prediction of future events determines the profitability of a business. At the same time, the financial sector plays a vital role in the development of the economy by supporting entrepreneurs in risk management, i.e., bearing risk that would not be acceptable at the individual level.

But this intermediate role is not granted forever. If industries find more effective ways to manage money transfers between parties safely, they will immediately switch to those methods. The rapid development of computer infrastructure supporting the bitcoin platform[3] — financed only by private investors — shows that such a switch is highly probable.

For the financial sector, therefore, it is critical to keep transaction margins at a level that allows these transactions to remain competitive in relation to other solutions. For years, the science that allowed forecasting and management of profitable margins was statistics, fueled by the collection of data about past events. Normal distribution, regression to the mean, standard deviation and often very complex risk management models supported the financial sector in everyday business.

It might be assumed that the zetabytes of additional data created by the IoT will make financial activities more predictable, as models will be based on objective measurements. However, in this study, we will try to show that for the traditional financial industry, the increase in popularity of the IoT may be a destabilizing factor, undermining the basis of operational models and decision-making mechanisms.

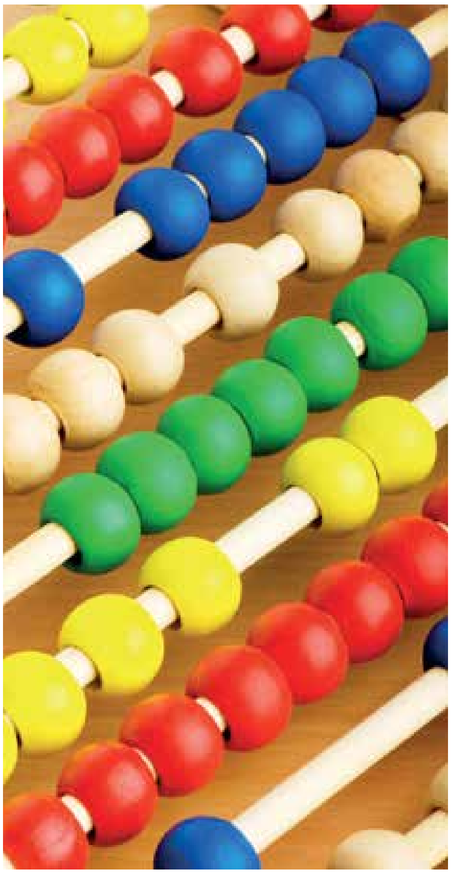
You cannot find statistical order where, previously, chaos did not exist. From the time of Galton,[4] it has been known that statistical methods are appropriate where we are dealing with independent events. The IoT creates a mechanism for interrelation of events. The system does not become ordered in the sense of cause and effect, but it ceases to be chaotic. The domain of complexity appears.

[3]Currently, in terms of computer power, this infrastructure is hundreds of times more powerful than any other computing platform. (11)

[4]Francis Galton (16 February 1822–17 January 1911) was an English statistician, produced over 340 papers and books. He also created the statistical concept of correlation and widely promoted regression toward the mean. (12)

Normal distribution, regression to the mean, standard deviation and often very complex risk management models supported the financial sector in everyday business.

Ackoff's pyramid



Understanding the true impact of increased data availability on the quality of decision-making requires clarification of some concepts. As Rusell Ackoff writes, (3) people talking about learning processes often use terms such as data, information, knowledge, understanding and wisdom interchangeably. By not defining these concepts, we lose the hierarchy of their value for making decisions and the impact involved in transforming one into another through the use of analytical, statistical predictive models.

To avoid these problems, in this study, we will use the definitions determined by Ackoff:

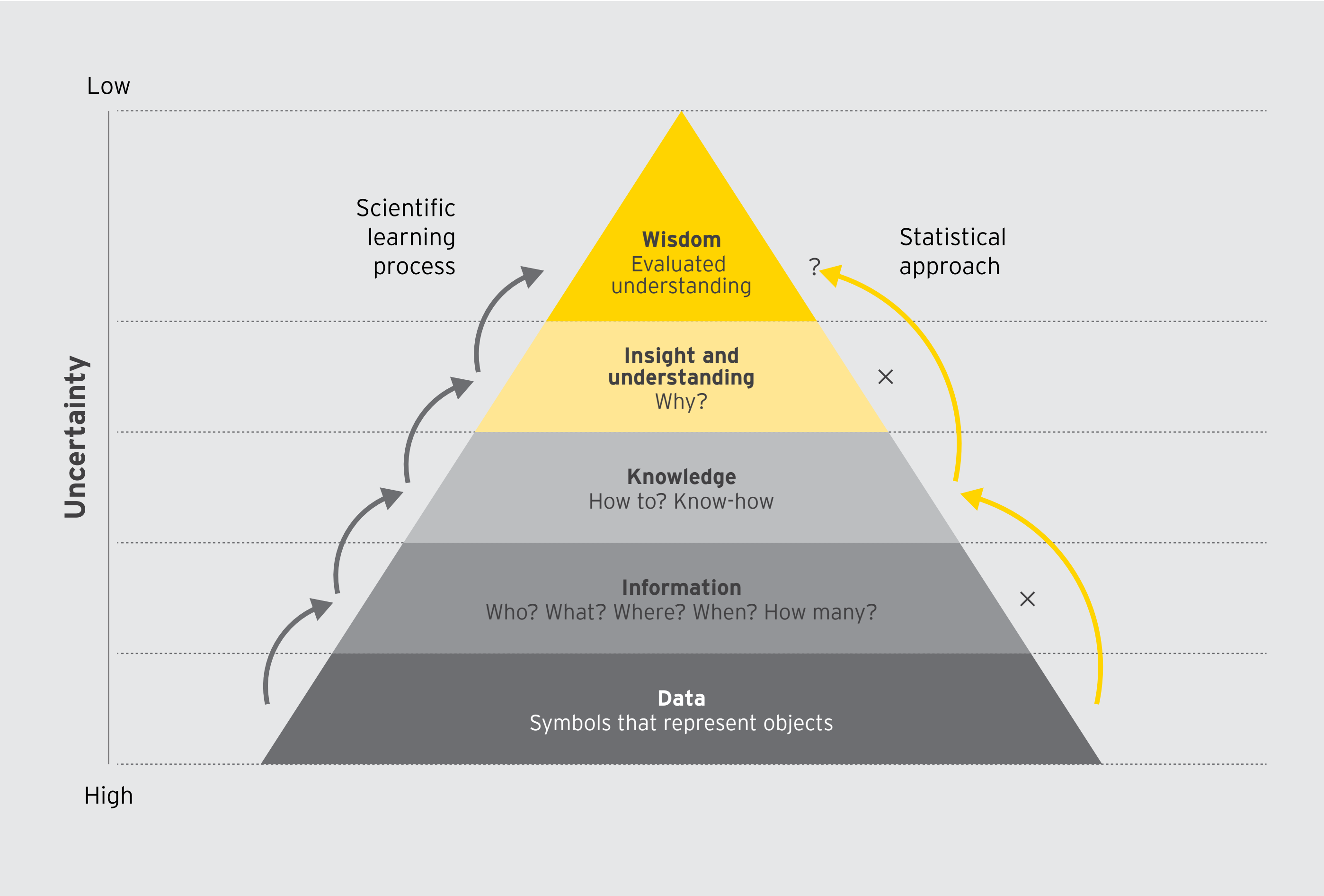
- **Data** consist of symbols that represent objects, events and their properties. Data are products of observation – the IoT is directly responsible for the availability of data.
- **Information** is contained in descriptions, or in answers to questions that begin with such words as who, what, where, when and how many.
- **Knowledge** is contained in instructions. It consists of know-how, for example, knowing how a system works or how to make it work in a desired way. It also makes maintenance and control of objects, systems and events possible.
- **Understanding** is contained in explanations, e.g., answers to "why" questions. We do not learn how to do something by doing it correctly because we already know how to do it. The most we can get out of doing something correctly is confirmation of what we already know. However, we can acquire knowledge from doing something incorrectly, but only if we can determine the cause of the error and correct it.
- **Wisdom** is the ability to perceive and evaluate the long-term consequences of behavior.

The above hierarchy of concepts creates a pyramid, as shown in Figure 1.

By not defining these concepts, we lose the hierarchy of their value for making decisions and the impact involved in transforming one into another through the use of analytical, statistical predictive models.

Understanding the true impact of increased data availability on the quality of decision-making requires clarification of some concepts.

Figure 1. Ackoff hierarchy in the form of a pyramid, with two alternative transformation paths depicted.



Source: own study.

Ackoff's pyramid

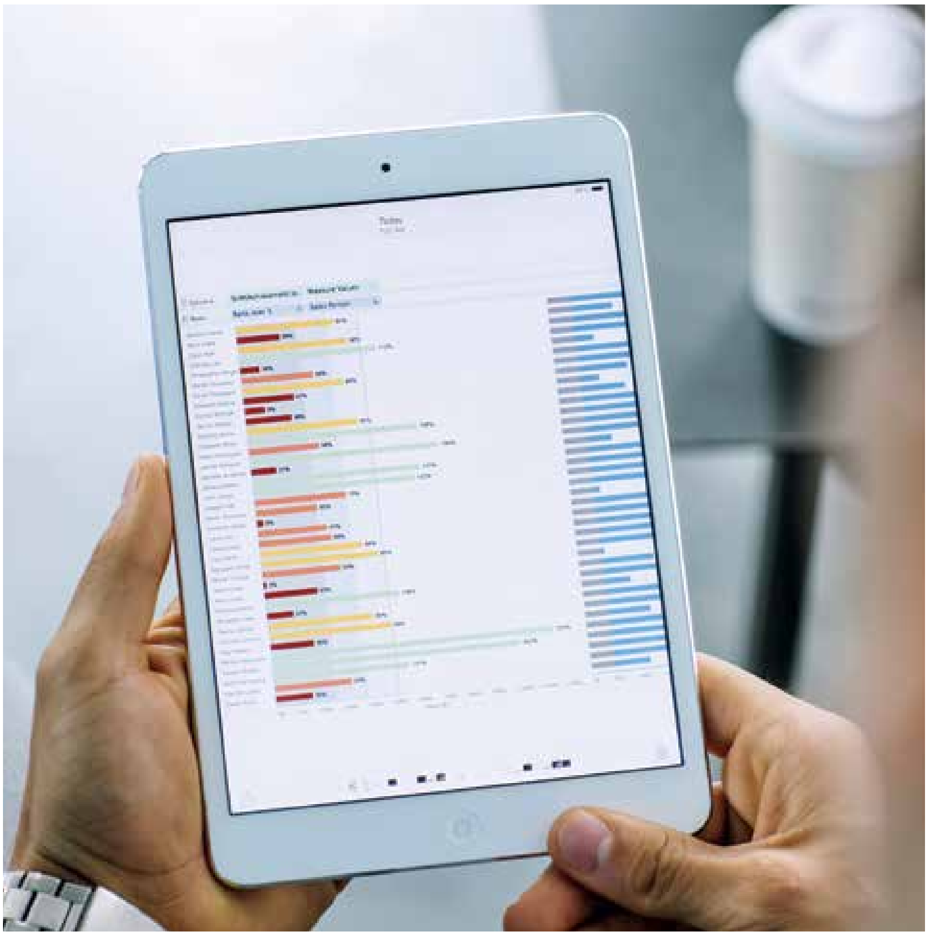
We intuitively assume that decision-making processes are based on the step-by-step transformation of data. We assume that the increase in the amount of data should translate directly into better **information**, adding to the instructions **(knowledge)** more appropriate to the situation, as well as **understanding** and, finally, reducing the uncertainty through the prediction of future events **(wisdom)**.

However, in reality we act differently when using statistics as the basis for making decisions. We collect data about past events and formulate instructions **(knowledge)** based on commonly accepted patterns (such as the normal distribution shown in Figure 2).

The statistics do not provide us with **information** (at least as it is defined by Ackoff), but only with the interpretation of past events as a signpost for what we believe will happen in the future.

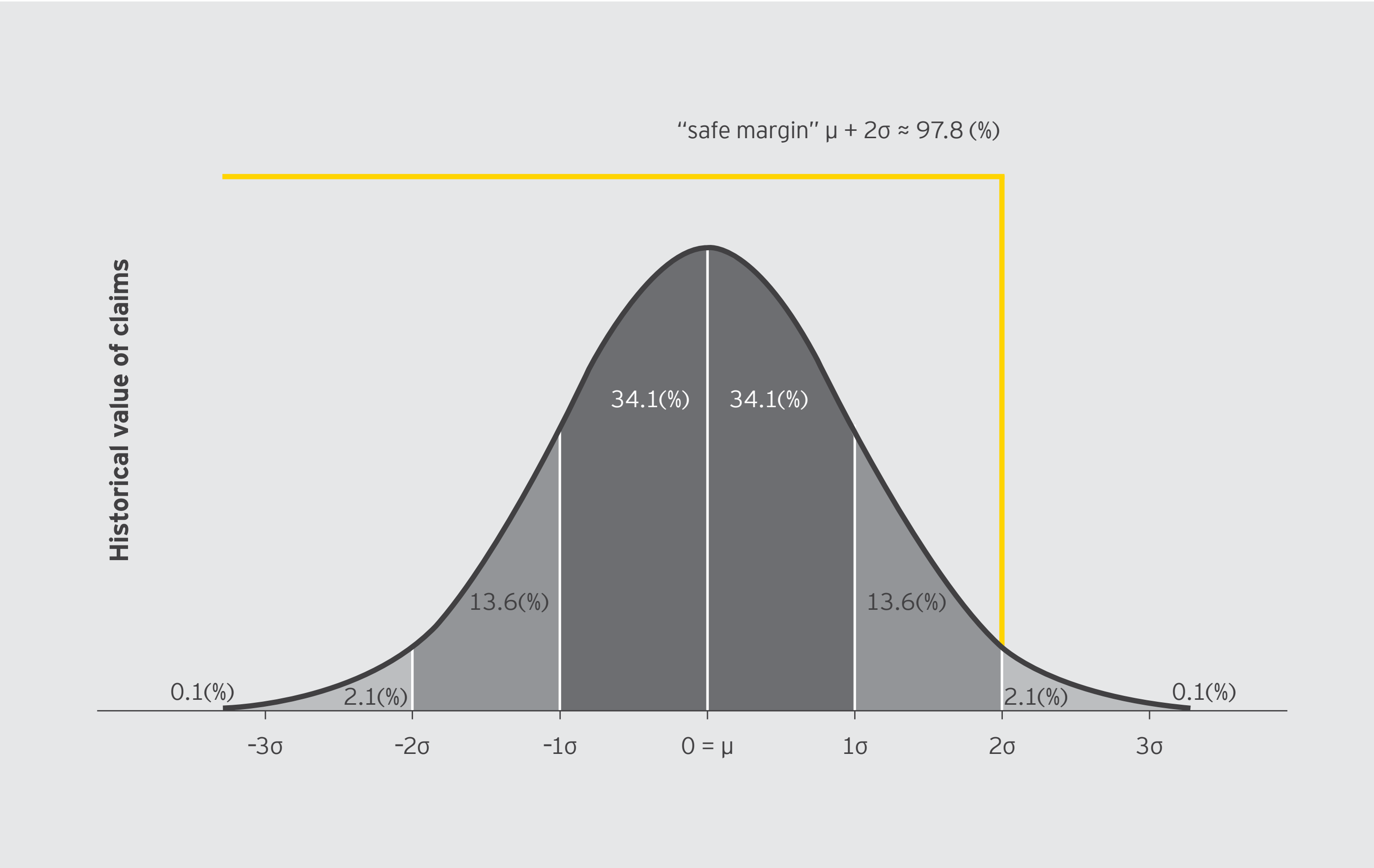
Despite the known limitations of this approach (it's enough to mention black swans here), most traditional institutions from the financial sector, in particular insurance providers (hereafter referred to as TradCo), build their decision models on this (normal distribution) basis.

If the distribution in Figure 2 illustrates the distribution of damage in the past, then the value 0 on the x-axis indicates the expected value **μ**. According to the normal distribution, 97.8% of all the insured will suffer damage lower than the expected value, plus two standard deviations **σ.**



Therefore, if all entities have similar historical data about past claims, they can set a "safe" risk margin and, on this basis, determine the insurance rate that will give them a profit on their operations.

Figure 2. Standard normal distribution of claims.



Source: own study.

The statistics do not provide us with information (at least as it is defined by Ackoff), but only with the interpretation of past events as a signpost for what we believe will happen in the future.

IoT's impact on information asymmetry

The popularization of IoT devices has enabled the introduction of a new type of insurance known as **usage-based insurance (UBI)**[5] also known as pay as you drive (PAYD), **pay how you drive (PHYD)** and **mile-based auto insurance.** With this kind of insurance, the final cost depends upon the type of vehicle used, measured against time, distance, behavior and place. This differs from traditional insurance, which attempts to identify and reward "safe" drivers, giving them lower premiums or a no-claims bonus.

The condition for obtaining such insurance is the installation of a device capable of monitoring the geographical location of a vehicle, both on the move and at a standstill.

Let's try to imagine the long-term consequences of the emergence of a new company on the market (NewCo) offering only usage-based-insurance, i.e., all clients are covered by monitoring. A fairly obvious conclusion[6] is that, in the first place, drivers who want to reveal their cautious driving style to the insurer will migrate to NewCo. Less careful (faster) drivers who use their cars in "unsafe" (high traffic) regions will remain with TradCo.

[5] As highlighted in the introduction to this paper, our goal is to identify familiar solutions, but to present them from a future-looking perspective. We believe consequences that are unnoticeable today will come into sharp focus tomorrow as the number of sensors increase, similar to what happened with platform-based businesses.

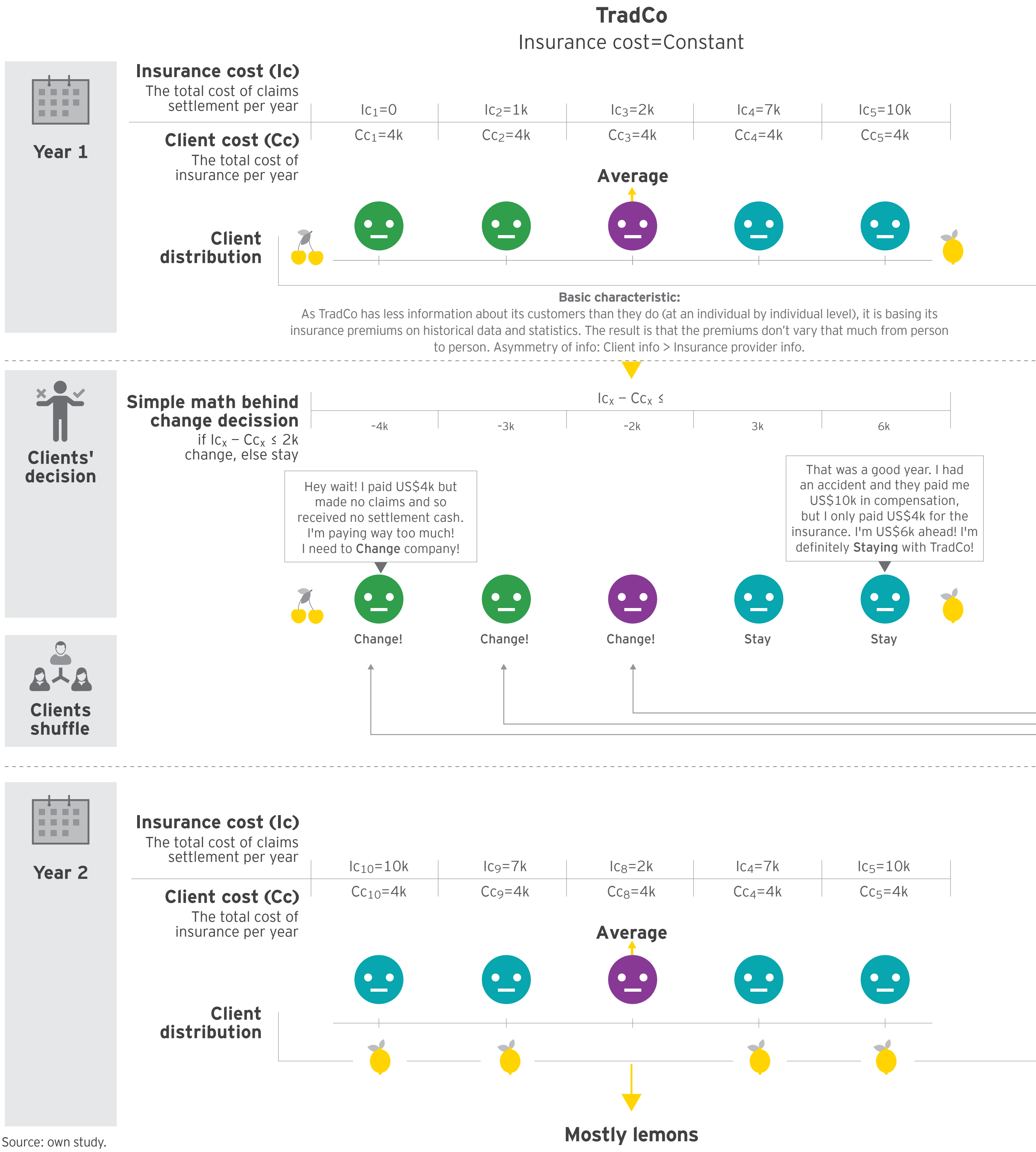
[6] This is particularly the case if we consider that both factors, behavior (speed) and place (traffic complexity), have an impact on the accident risk and the extent of the claim.

Figure 3. Accident risk in relation to behavior (speed) and place (traffic situation complexity).

Source: M. Taylor, A. Baruya and J. V. Kennedy, *"The relationship between speed and accidents on rural single carriageway roads,"* TRL Limited, 2002. (4)

The condition for obtaining such insurance is the installation of a device capable of monitoring the geographical location of a vehicle, both on the move and when at a standstill.

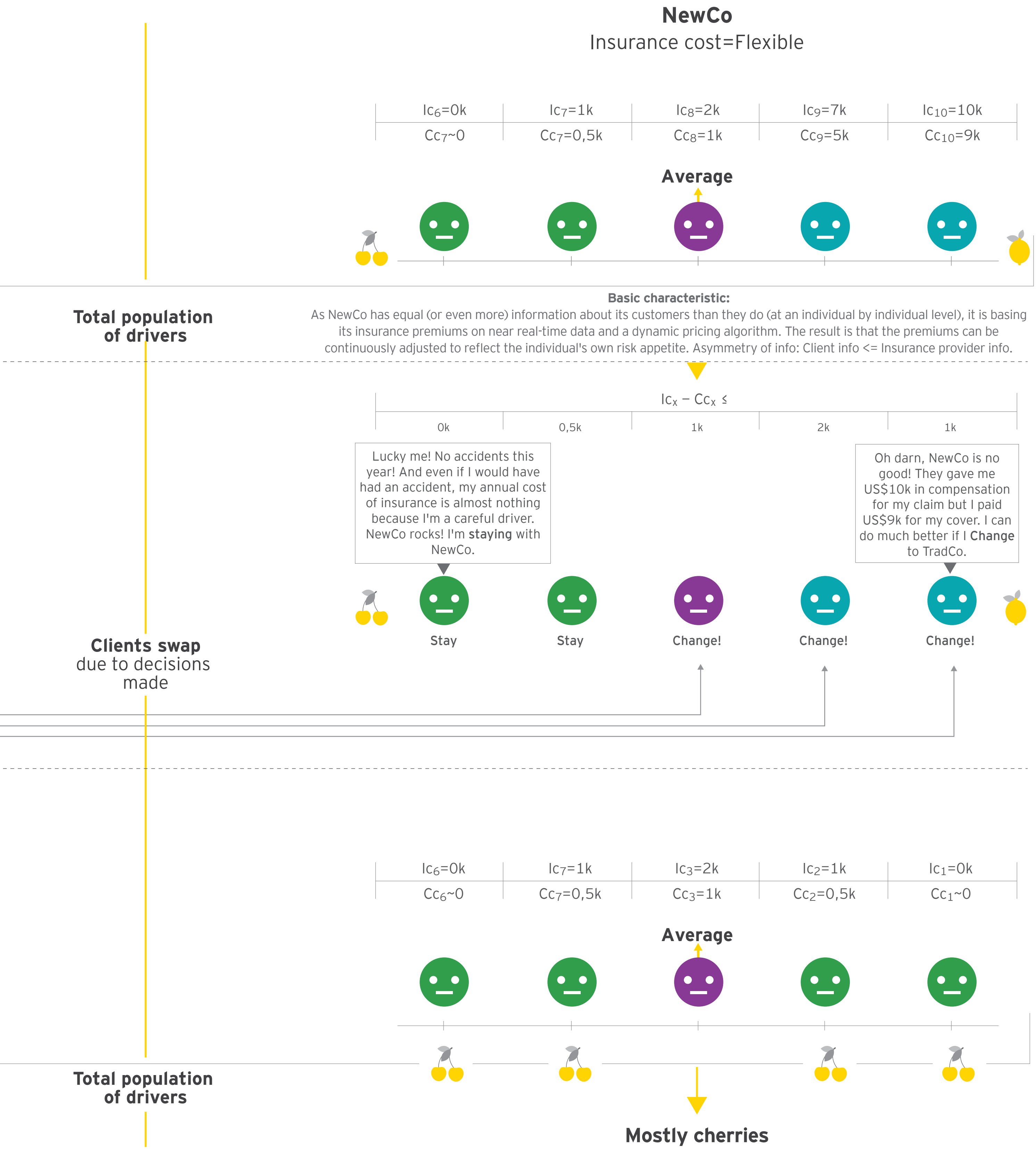
Figure 4. TradCo and NewCo client population migration process (simplified)



Source: own study.

In this example:

- We have assumed that there are only two companies in the market.
- We have not shown or analyzed the companies'profit margins. Instead we have focused on how, due to differences in driving patterns and individual predispositions (i.e., a risk-aware versus a risk-taking attitude) and from core reasoning (i.e., a fixed insurance cost with TradCo versus dynamic pricing with NewCo), the process of client migration will occur.



- We have assumed that, because TradCo has a significant delay in the verification of historical data about claims, at the beginning of the second year, its client costs are not yet adjusted to the new reality. To put it in other words, at the beginning of year two, TradCo cannot know that its average cost of insurance is too small for its business to be viable.
- This simplified example demonstrates how certain clients, i.e., risk takers, will tend to go with organizations that use traditional methods for calculating insurance costs. This is because they will not want to reveal their driving characteristics and risk appetite, and the total cost of their insurance with TradCo will be smaller than with NewCo.

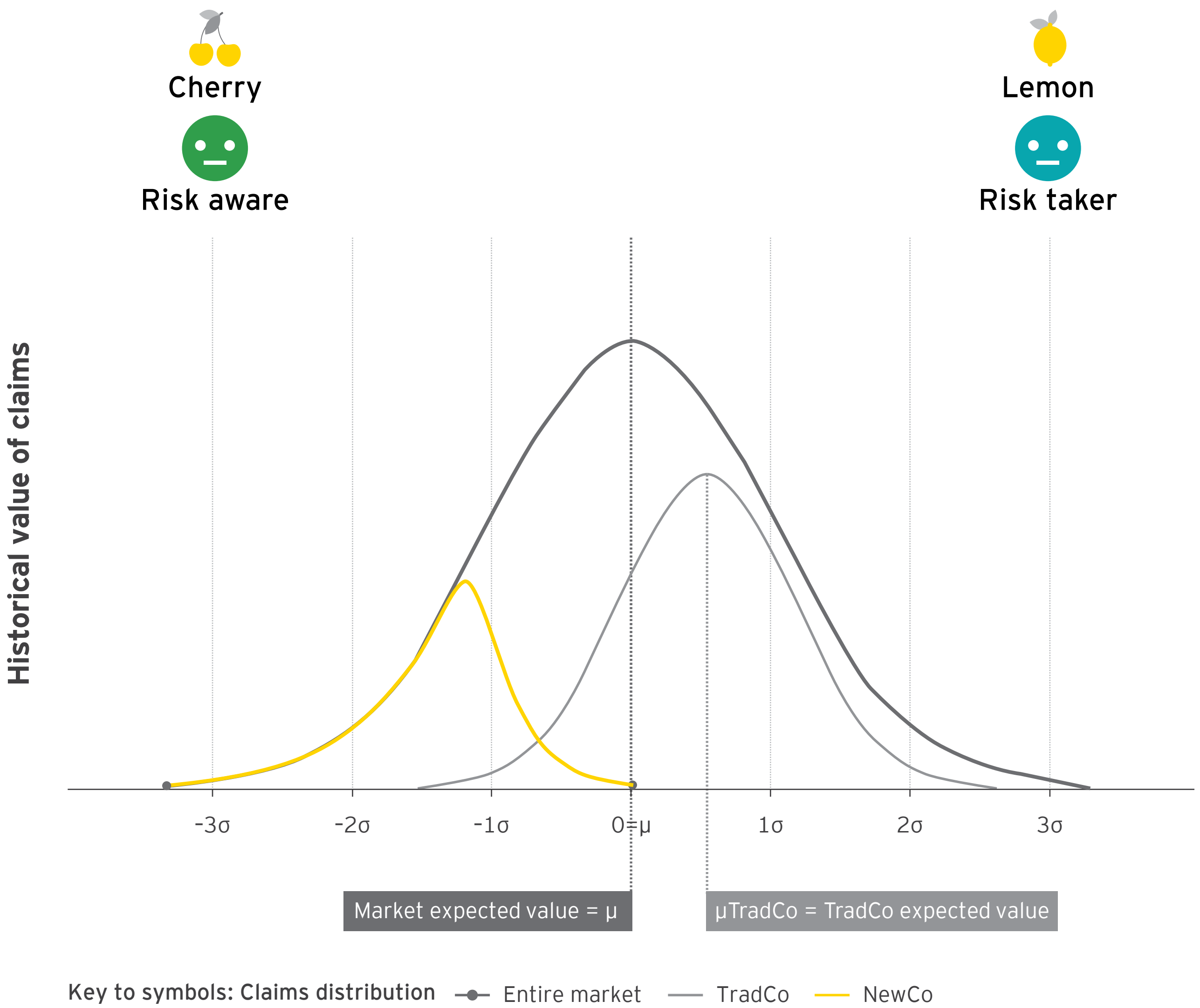
IoT's impact on information asymmetry

If, therefore, NewCo has drivers generating statistically less damage, it will be able to offer more and more favorable insurance rates. This will further accelerate the flow of customers between the companies and, as a result, will affect the statistical distribution of losses throughout the market.

As a result, for NewCo, the expected value of damage (due to claims made) will decrease. Whereas for TradCo, it will increase, with a tendency to further increase owing to the deepening market segmentation. Of course, the speed of market segmentation can be stimulated by the use of more or less aggressive pricing models by NewCo and TradCo, but two factors are undeniable:

- The cause disrupting the motor insurance market is the change in the established **information asymmetry** by the massive deployment of IoT.
- There will be a significant delay between the adaptation of risk management models and the changes in the market. Whereas NewCo will be operating in almost real time due to the ongoing monitoring of driver behavior, TradCo will, by necessity, have to gather sufficient statistical data to assess the impact of damage by non-monitored drivers.

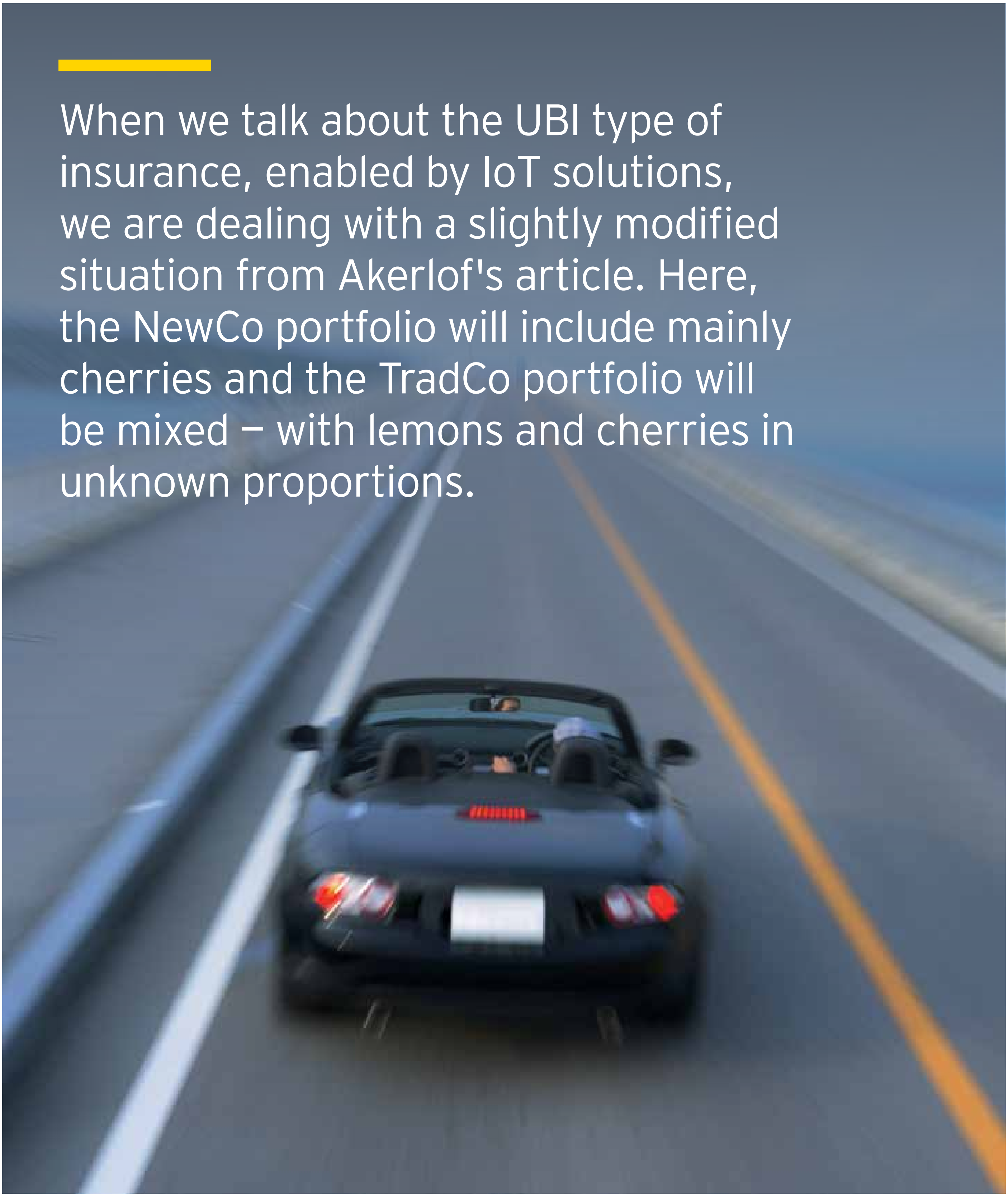
Figure 5. Standard normal distribution of claims (simplified)



Source: own study.

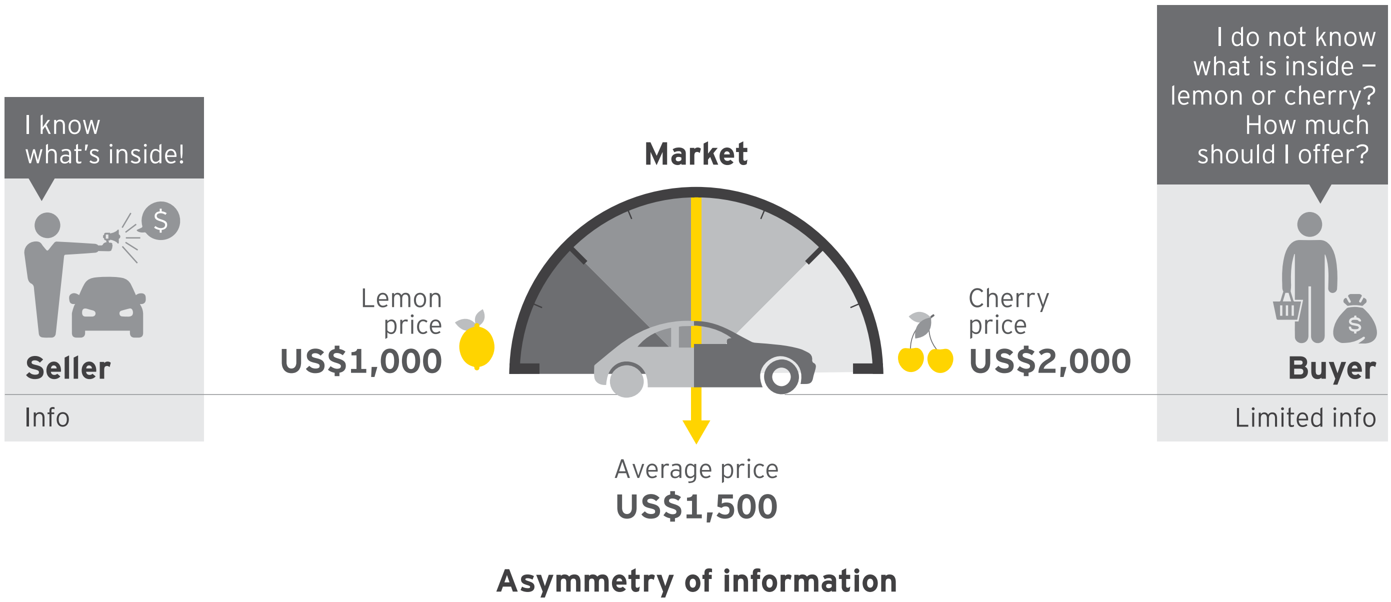
Points to note:

- The main point to note is that those of TradCo's clients who are more risk-aware (cherries) moved to NewCo, hence the bigger the shift to the right of TradCo's expected value. In other words, the more risk-taking clients (lemons) TradCo has in its portfolio, the more claims it will have and, therefore, the less viable and more uncertain its business.
- The shape depicted in the graph is just to facilitate understanding of the phenomenon. In reality, subtracting NewCo's curve from the entire market's would result in a different shaped curve for TradCo. There are also, of course, more organizations in the actual market.



When we talk about the UBI type of insurance, enabled by IoT solutions, we are dealing with a slightly modified situation from Akerlof's article. Here, the NewCo portfolio will include mainly cherries and the TradCo portfolio will be mixed — with lemons and cherries in unknown proportions.

Figure 6. Market based on unequal or incomplete information (asymmetry of information)



Source: own study, inspired by George A. Akerlof.

As a car buyer can't be sure if he is about to buy a lemon or a cherry, in order to minimize his risk he offers an average price.

In 1970, George A. Akerlof published the paper "The market for lemons: quality uncertainty and the market mechanism."(5) In 2001, he was awarded the Nobel Memorial Prize in Economics jointly with A. Michael Spence and Joseph Stiglitz "for laying the foundations for the theory of markets with asymmetric information."[7] (6)

In his article, Akerlof described the two types of vehicles he had identified in the used-car market:

- "Cherries" – used, high-valued cars
- "Lemons" – used, lower-quality cars (e.g., due to higher mileage or other conditions that mean they are valued more cheaply)

Because the market operates in conditions of incomplete information, potential buyers are not able to assess whether they are dealing with cherries or lemons and, as a result, the price is at an intermediate value (see Figure 6).

For the owners of lemons, the price is acceptable, therefore they sell quickly. While the owners of cherries have trouble selling and, as a result, decide to make transactions outside of the regular market. A potential consequence of this behavior is a collapse of the entire market.

When we talk about the UBI type of insurance, enabled by IoT solutions, we are dealing with a slightly modified situation from Akerlof's article. Here, the NewCo portfolio will include mainly cherries and the TradCo portfolio will be mixed – with lemons and cherries in unknown proportions.

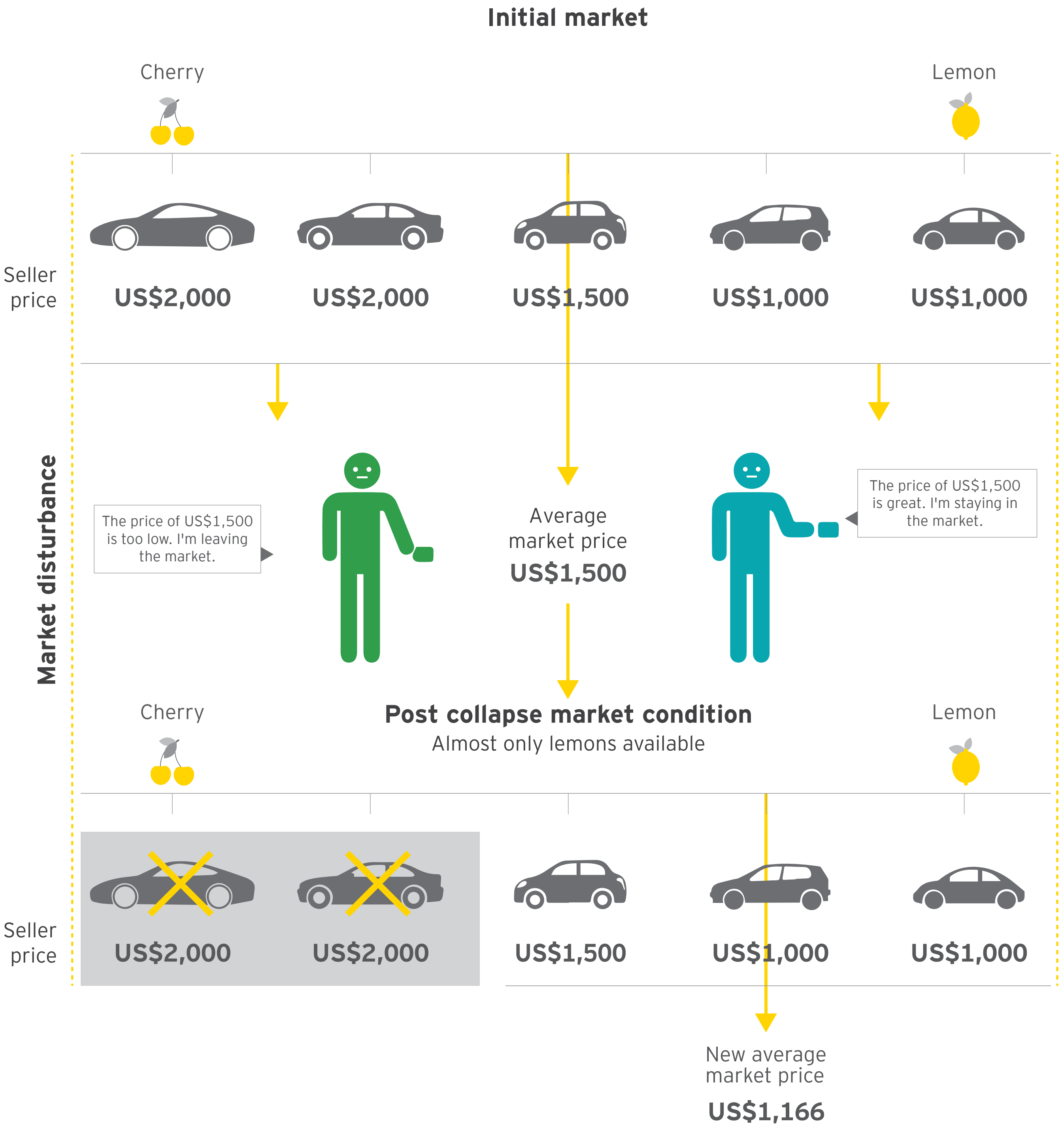
What is even more interesting is that the introduction of UBI in TradCo will not necessarily improve its competitive situation. The problem in this case is the group of drivers not covered by monitoring,[8] whose impact on the amount of compensations paid can only be tracked statistically (after collecting relevant data), and therefore with a significant delay.

In the example described, the impact of IoT directly affects the asymmetry of information. Or, more precisely, using Ackoff's definition, asymmetry between entities offering services in the insurance market, potentially resulting in the destabilization of the entire market. What follows is a consideration of the disruption of information asymmetry between suppliers of services and customers.

[7]The impact of information asymmetry on how insurance companies operate in a competitive market can be found in Michael Rothschild and Joseph Stiglitz's essay "Equilibrium in Competitive Insurance Markets: An Essay on the Economics of Imperfect Information."

[8]In this context, it is worth taking into account the phenomenon of "moral hazard" (the tendency to change behavior when the cost of that behavior will be borne by others) described by Kenneth Arrow.

Figure 7. Asymmetry of information as the root cause of market collapse.



Source: own study.

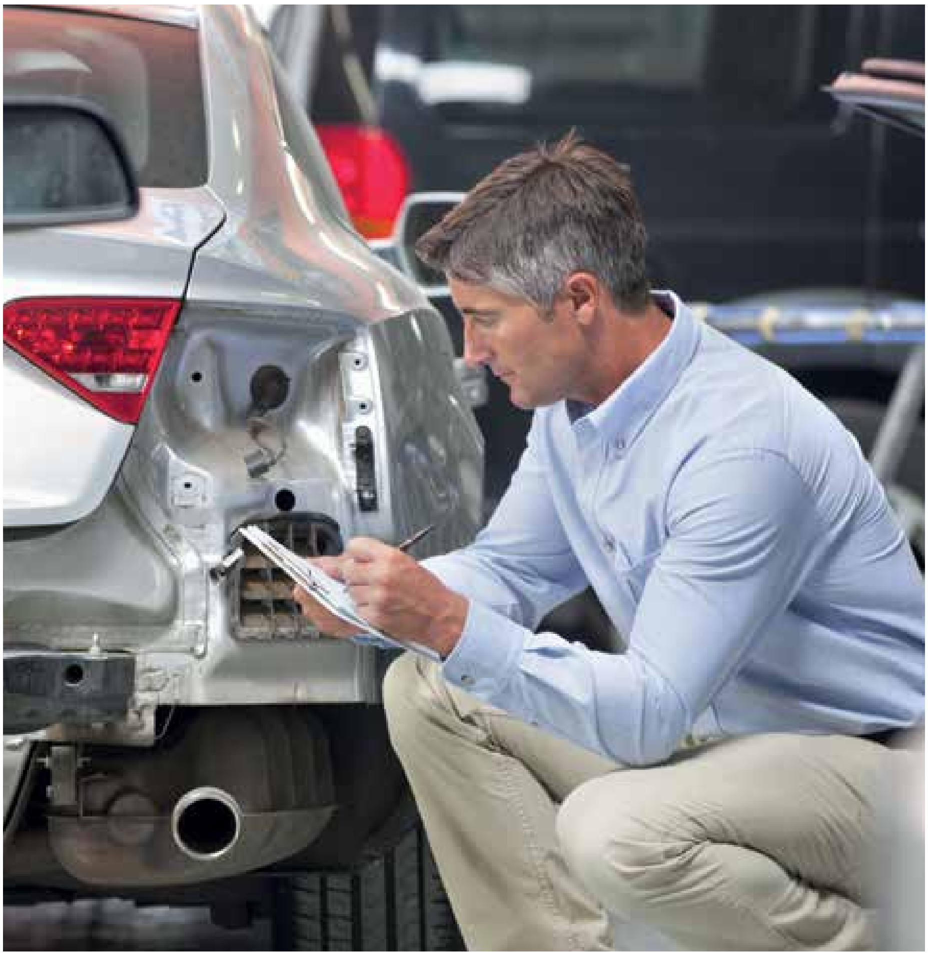
This diagram is a simplified visual interpretation of the thesis put forward by Akerlof in his paper (5) on how "bad' cars (lemons) tend to drive out "good" cars (cherries) – in a similar way to how bad money overrides the good (Copernicus and Gresham's law). (7)

From observation to intervention

UPS is an example of an organization that is a pioneer in the implementation of IoT in its operations. Based on the monitoring of its own fleet of more than 50,000 vehicles, UPS optimizes preventive inspections and repairs to avoid problems related to the late delivery of shipments.

Geolocation data are also used to optimize travel routes and manage repair services in the event of a failure.(7) "Given that the 55,000 trucks in UPS's American fleet make 16 million deliveries daily, the potential for inefficient routing is enormous. But by applying telematics and algorithms, the company saves its drivers 85 million miles a year, resulting in cost savings of $2.55 billion."(8)

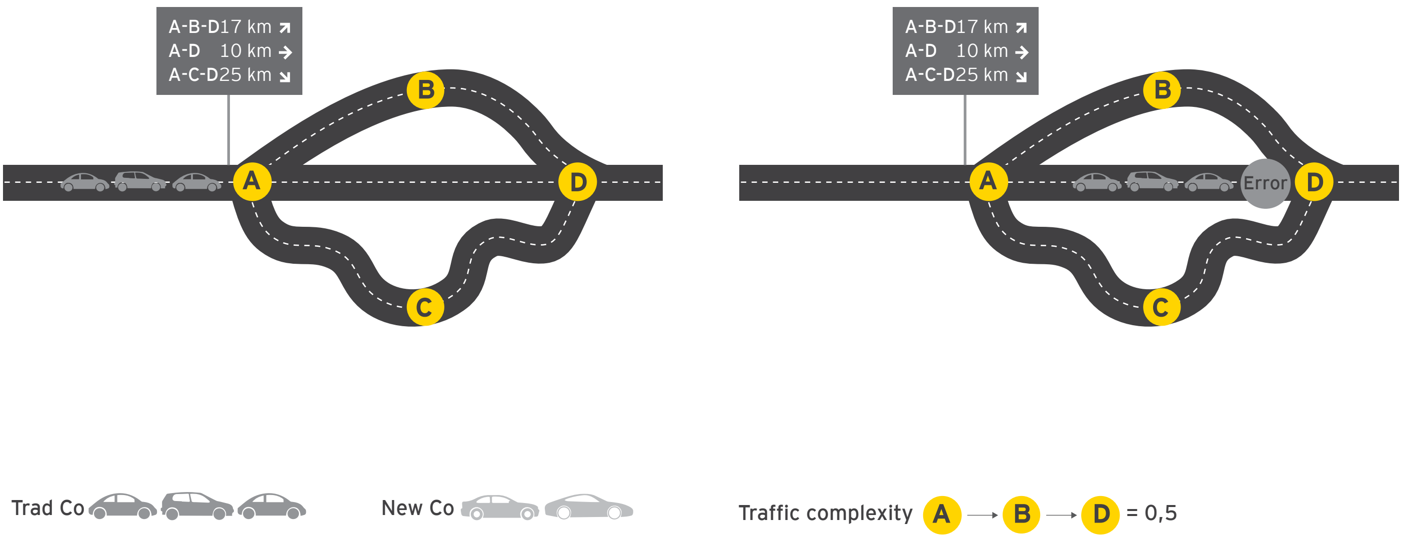
Initially, the data was collected and analyzed directly by UPS Logistics, but it was seen as a limitation on the possibility of obtaining data from the competition. That is why, in 2010, UPS sold its own data analysis department to an external company. Currently, this company, under the Roadnet Technologies brand, is collecting data from many customers and providing comparative analysis for the entire industry, used both by UPS and its competitors.(9)



From observation to intervention

This example is often cited to illustrate the benefits of the IoT for optimizing the efficiency of logistics processes. Let's try to look at this story from a different perspective: The UPS fleet, although huge, represents only 0.02% of vehicles used in the US. Therefore, the **change of the algorithm controlling the traffic** of these vehicles probably remained unnoticed. But what will happen if NewCo, from our earlier example, starts offering a navigation system that allows it to optimize routes, avoid accidents, and reduce the costs of fuel burned? The answer is simple. With a statistically significant number of NewCo customers in relation to the entire market, the **traffic control algorithm will have a significant impact on the entire transportation system.** Additionally, NewCo can optimize its own profits using navigation related to insured car value (with preference to high-valued cars, i.e., high-valued cars would be given routes of lower overall

Figure 8. Simplified example of various traffic flow scenarios, dependently on differing optimization factors.



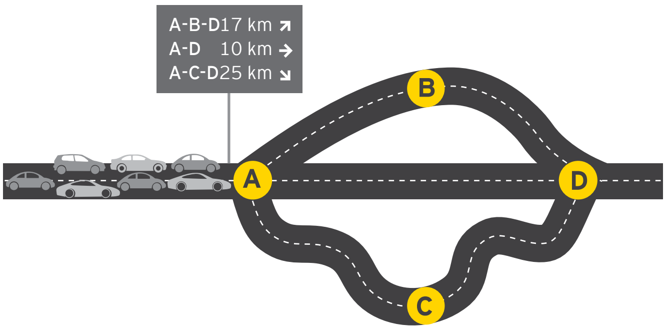
Source: own study.

Points to note:

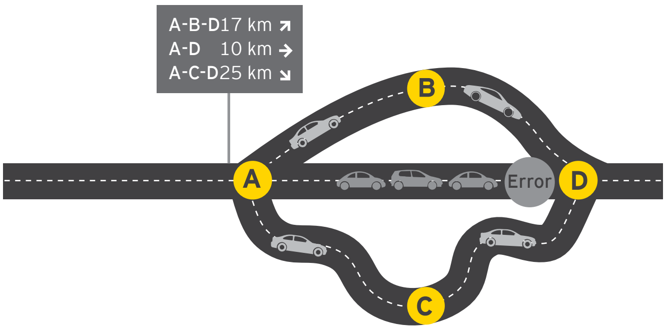
- Point D is the ultimate destination for all drivers.
- The drivers of the cars in the top left and top right of the diagram have no information other than the distance they have to travel.
- In the first scenario, top left and top right, drivers have chosen the shortest distance to cover, but as they had no idea there was an obstacle, they have experienced significant delays.

complexity in order to minimize the chance of an accident and, thus, a claim).

It should be noted that, even though car navigation systems have been around for several years, there are no known examples of traffic manipulation such as described in Figure 8. There are two main reasons why this is the case. First of all, companies currently offering navigation systems would not gain any benefit from influencing the behavior of drivers. Whereas for insurance companies, such "optimization" could bring tangible benefits (e.g., additional "protection" for high-valued vehicles). Secondly, current navigation systems do not have direct motivational mechanisms aimed at their users. UBI's connection to the navigation system, even if it does not force direct adherence to its instructions (human freewill will always exist!), will certainly have a stronger impact on the behavior of drivers.



Traffic complexity A → D = 1,0



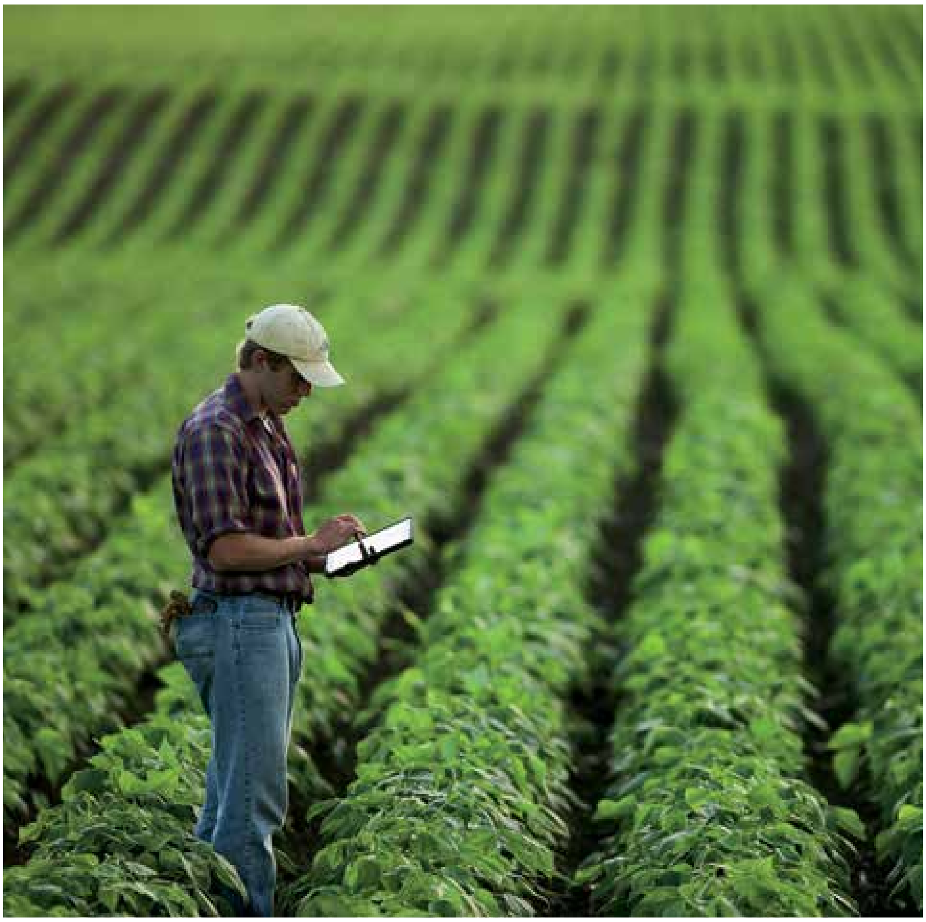
Traffic complexity A → C → D = 1,5

- In the second scenario, drivers from NewCo are advised to take alternative paths and bypass the obstacle. This means they get to their final destination faster than clients of TradCo.
- In addition to providing information about the obstacle, NewCo has also provided an alternative route that is most appropriate for the type of vehicle being driven. For example, NewCo clients with high-valued cars are directed to route ABD (as this has low traffic complexity), while NewCo clients driving less valuable cars are advised to take a route with higher traffic complexity (ACD).

Applicability in other areas

So far, we have discussed only examples from the insurance sector. However, the phenomenon we are describing has a much wider application. For example:

- **Mortgage loan valuations and real estate transactions:** This could include the availability of data on the actual state of the construction status of buildings, environmental conditions, and security level via infrastructure IoT.
- **Lifestyle measurements:** Consumer IoT could provide data specific to an individual person that could be used as part of their health insurance assessment.
- **Crop prices:** Agriculture IoT could provide forward contract valuations and on the new derivatives market
- **Changes in financial markets:** The changes taking place in financial markets will result directly from the exponential growth in the number of objective data sources (IoT), differing access to them (depending on the adopted strategies in the IoT area) and changes in the way these data are processed into knowledge.



The changes taking place in financial markets will result directly from the exponential growth in the number of objective data sources (IoT), differing access to them (depending on the adopted strategies in the IoT area) and changes in the way these data are processed into knowledge.

Data to knowledge transformation

While discussing the issues of decision-making models based on statistical rules, we indicated the imperfection of these methods resulting from the omission of information (which answers questions such as who? what? where? when? and how many?) and the resulting errors in building understanding. In currently-used IoT solutions, the data provided allow us to transform data into information. However, this stage is frequently omitted by so-called Artificial Intelligence (AI) systems.

For example, self-learning algorithms, commonly referred to as artificial neural networks, are based on the principle of a repeated trial-and-error procedures to "teach" a pattern algorithm that processes available input data for maximum correlation with the output pattern.

Due to the much greater accuracy of their mapping, compared to the previously used linear models, they provide significant improvements in the quality of the forecast. This is achieved without changing the fundamental principle that by formulating the "what to do?" instruction they do not improve the understanding of the cause (understanding). Thus, business models based solely on the use of the IoT — in conjunction with algorithms of artificial neural networks — will be important for the temporary benefits related to the change in information asymmetry to achieve economic benefits. But, the long-term competitive advantage will be questionable.

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Cynefin – decision support framework

In 2003, two IBM employees (C. F. Kurtz and D. J. Snowden) published a document entitled "The new dynamics of strategy: Sense-making in a complex and complicated world."(10) They presented in it a new framework, named Cynefin, which orders the rules for making decisions in various conditions of uncertainty.

This study contains many interesting perspectives, sometimes fundamental for building business and operational models in the modern world. Here, we would like to use the Cynefin framework to visualize changes in the decision-making mechanism caused by the migration from the "chaotic domain" to the "complex domain,"which are core to IoT disruption, at least for the financial industry.

Snowden[9] in the Cynefin framework, describes four key domains[10] differing in their internal order, and as a consequence also in the mechanisms for reaching a decision. These are:

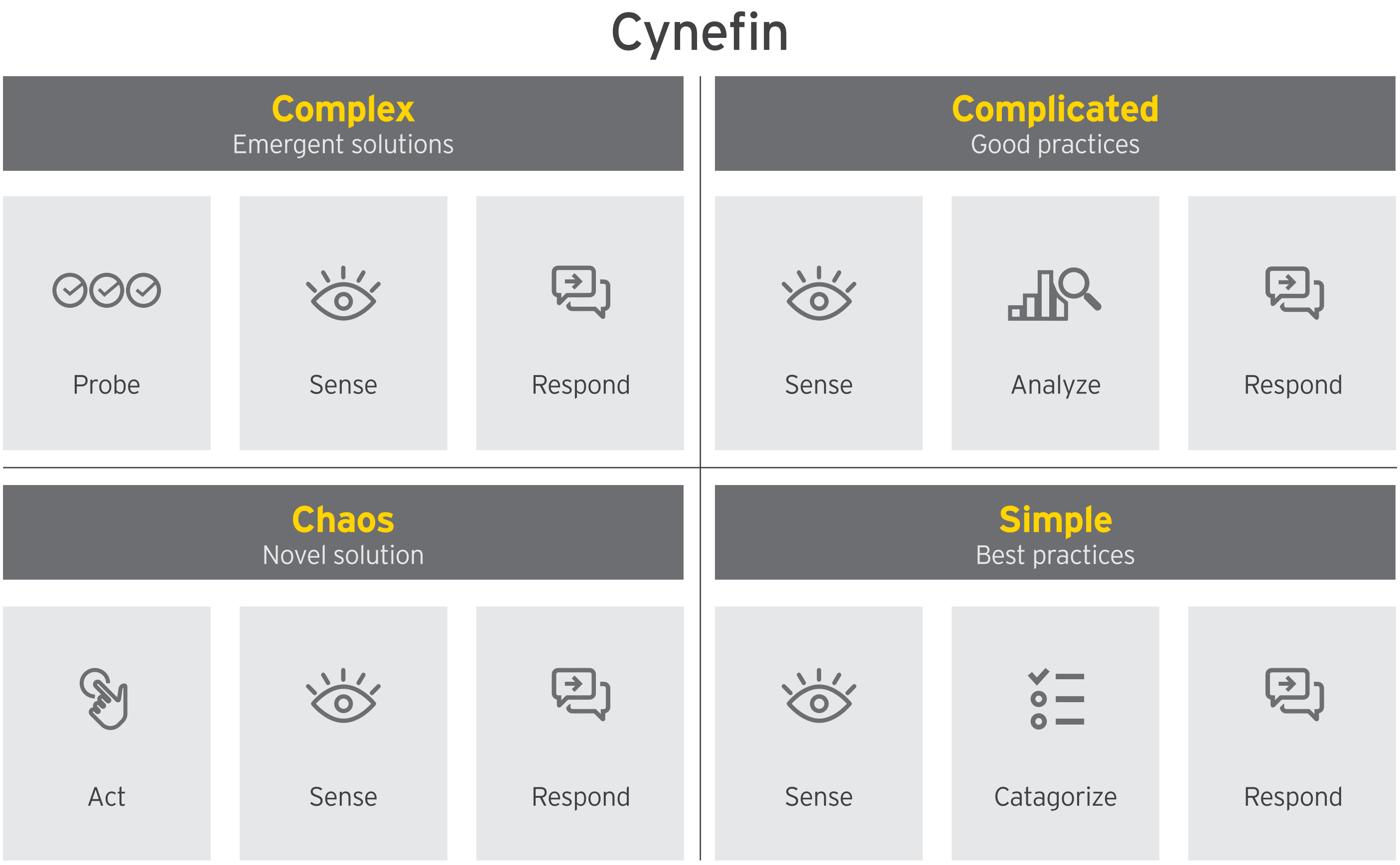
- The domain of knowns (sometimes called "simple"): In this domain, cause-and-effect relationships are repetitive, universally seen and predictable. **There is no information asymmetry.**[11] It is justified to use "best practices," standard operating procedures and strictly defined processes. The decision mechanism is Sense-Categorize-Respond. **IoT applications**[12] **in this area are limited to control functions examining deviations from the set process parameters.**
- The domain of the knowable (sometimes called "complicated"): Cause and effect are separated in time and space. It requires the right kind of analytical and reductionist approach. **Information asymmetry is potentially due to differences in professional knowledge.** The decision mechanism is Sense-Analyze-Respond. **IoT applications in this area are, in particular, a better understanding of the process and, to a lesser extent, a (non-disruptive) reduction of the asymmetry of information between the seller and the buyer.**
- The domain of the complex: Cause and effect are consistent only in retrospect and are not repeated. Decisions are based on observed patterns. **The decision mechanism is Probe-Sense-Respond. The most fundamental changes resulting from IoT applications will take place in this area; the basis for making decisions is "Probe." This domain can be called "the domain of the IoT." Pattern-detection algorithms (e.g., artificial neural networks) can introduce significant changes in the asymmetry of information as described previously.**
- The domain of chaos: No visible cause and effect relationships. Interventions are focused on stability. The basis for the decision-making mechanisms are Act-Sense-Respond. **IoT applications in this area can be used to examine how actions taken affect the functioning of the system. The chaos domain is the basic area of application for statistical tools. Information asymmetry results from the difference in the quantity and quality of available data for statistical analysis.**

IoT applications are possible in all of the domains. However, the most economically significant effect will be when their implementation moves a part of the system to a different domain. The reason why is that it will result in changes to the decision mechanisms applied and, in consequence, different decision mechanisms used by interrelated market players.

In the UBI examples described previously, the use of IoT resulted in client

[9]The authors of this material were C. F. Kurtz and D. J. Snowden, however, Snowden was also the author of other studies on the subject of Cynefin and therefore we present him as the lead author of this methodology.
[10]In the original framework, the fifth domain (disorder) may also be found, but as it is considered a transient and unstable state, it was omitted in this analysis.
[11]Please note, however, that Snowden does not refer to the concept of information asymmetry.
[12]Please note, the IoT is not the subject of Snowden's work.

Figure 9. Cynefin framework based on Snowden and Kurtz's work (10)



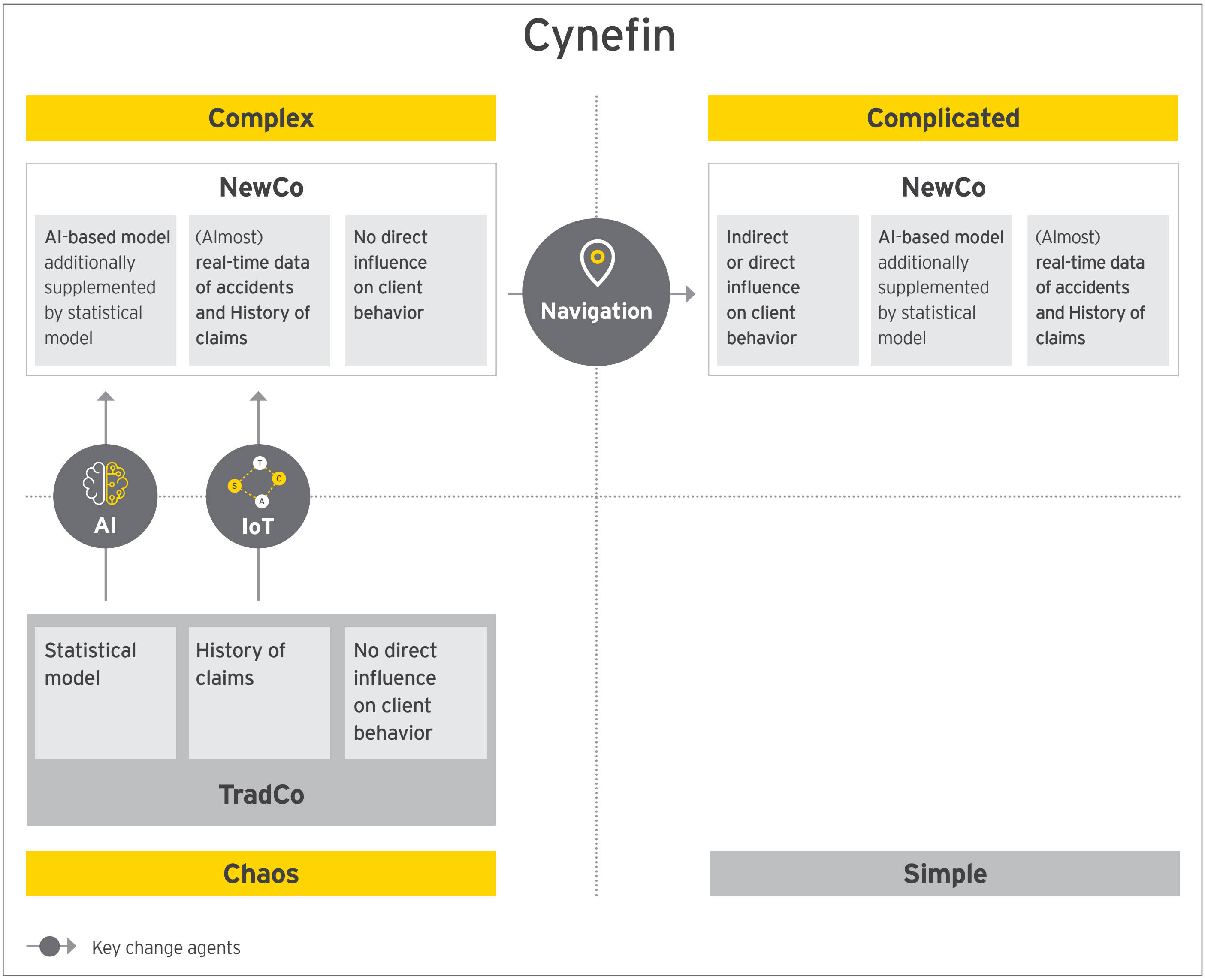
This study contains many interesting perspectives, sometimes fundamental for building business and operational models in the modern world.

Cynefin – decision support framework

segmentation (the isolation of a certain group from the chaos domain and their transfer to the complex domain). Possible attempts to influence their behavior (integrated navigation systems) could cause this group to be transferred to the knowable domain. The use of stronger mechanisms forcing drivers to behave would result in the transfer of this group to the known domain.

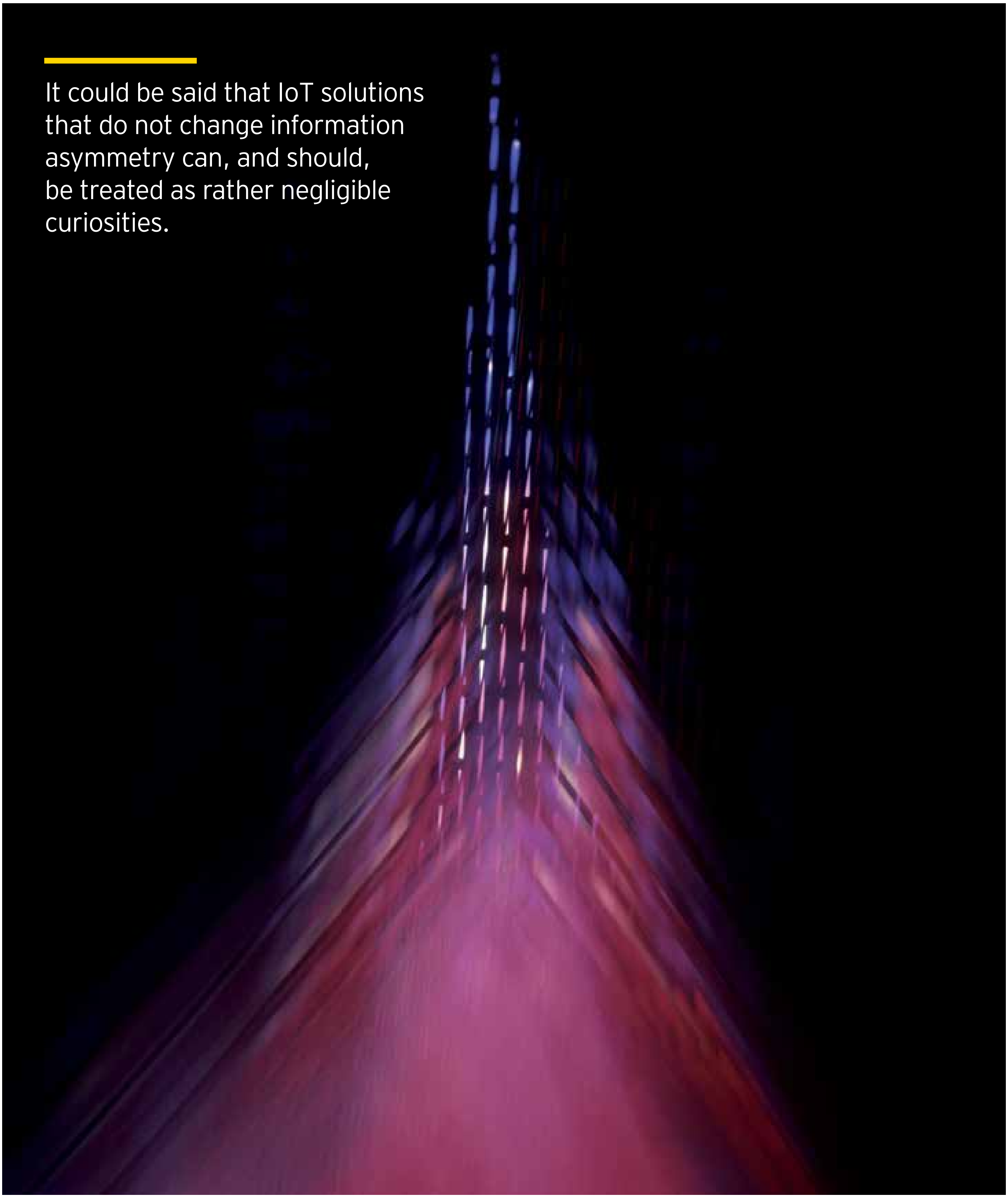
Left to its own devices, the effect would be to modify the decision-making mechanisms among different players from the insurance industry, resulting in the disruption of the previously stable market. Different decision rules will result not only in modelling accuracy. Models based on current sensor data will also result in near-real-time adaptations to the changes in the system conditions, while the statistical model will have significant delays before being accurate, because of the necessity to collect a representative amount of historical data.

Figure 10. Illustrative diagram of insurance companies' transition between Cynefin domains due to change factors such as IoT and AI.



Source: own study.

It could be said that IoT solutions that do not change information asymmetry can, and should, be treated as rather negligible curiosities.



Conclusions

Economic and technical factors will cause the mass application of IoT sensors and controllers in consumer, industrial, infrastructural and commercial spaces. Many of these will be negligible for the financial industry. However, some of them may have a fundamental impact on the functioning of markets. But, which are the factors?

Probably **the most important and fundamental change that the IoT introduces to the financial sector is the disruption of established information asymmetry.**

It could be said that IoT solutions that do not change information asymmetry can, and should, be treated as rather negligible curiosities. While the rest of them will significantly and permanently change the current status quo of business and operating models.

Currently, there is an asymmetry of information between sellers of financial sector services and their buyers, i.e., there is relatively balanced access to similar data by various entities competing in the market. However, the existence of this market will be significantly disturbed by massive IoT deployment.

First, there will be a new information asymmetry between the entities (cherry hunters), who will start to use data from IoT sensors and correlation models to manage the acceptable level of uncertainty (risk) in relation to entities (lemon farmers) on the basis of historical data and methods of statistical risk analysis.

The subsequent effect will be a change in the asymmetry of information between suppliers and buyers of services. This is a direct result of the sharing of the knowledge available to them (i.e., by offering navigation systems optimized to avoid the risk of an accident) to maximize the economic potential resulting from the imbalance of information created in the market.

A possible and probable effect is the emergence of new types of financial entities which will establish their entire business model on the opportunities created by asymmetry of information (i.e., platform-type businesses). This will be the case both in relation to competing financial institutions offering services, as well as between suppliers and buyers.

It is likely that the final stage of this disruption will be the consolidation of data circulation within several entities and a significant unification of data correlation algorithms. This may lead to a new equilibrium in the economic market, taking into account the increased data availability and a new model for processing this data into knowledge. However, the process of reaching a new level of equilibrium will have a fundamental impact on the economic effectiveness of individual entities in the financial sector during the transition period. This may well be accompanied by the potential collapse of some laggards too slow to adapt to the new environment.

In simple terms, the IoT is just a new source of data acquisition and a mechanism to enable the control of physical objects remotely. However, the indirect impact will be disruption in markets where uncertainty about the future plays a significant role. Financial sector enterprises will have to revise their operational models by adapting them to market requirements, as well as their business models. They will need to decide in which areas they should cooperate with other entities for the common goal of broader market stabilization, and which fields of their operations will represent their unique competitive advantage.

When looking for a way to achieve a new equilibrium, financial institutions should particularly analyze the impact of the IoT from the following perspectives:

- Changes in the asymmetry of information, both between competitors in the market as well as between suppliers and service buyers.
- Significantly faster adaptation of risk models based on IoT data processing (complex domain) in relation to statistical models (chaos domain), especially when market segmentation is changing.
- The impact of the data processing algorithms used to build knowledge (according to Ackoff's definition), particularly with regard to building understanding of the causes of changes.
- The possibility of influencing the behavior of market participants (system nodes) using IoT solutions (i.e., transitioning from the complex domain to the domain of the knowable).

It should also be taken into account that on the way to this new equilibrium, some market players may use suboptimal risk management strategies, resulting from the use of legacy decision models, which are sufficient for changing market conditions.

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