The Competitor

A bilateral price commercial negotiation between buyer and seller always has the same critical elements: The buyer can reach a mutually beneficial agreement with the seller if they are willing to pay more than the seller's minimum willingness to sell. However, even if both parties agree, there is no guarantee that they will reach an agreement. Both sides have a strong incentive to disclose as little information as possible for various reasons, including the negotiation dilemma, as doing so may assist the other side in achieving a better outcome. However, disclosing little information also reduces the possibility of reaching beneficial solutions overall and increases the likelihood that negotiations will fail.

When negotiating with hostage-takers, breaking off negotiations means endangering the lives of the hostages. Minimizing the risk of negotiation breakdown is a top priority in hostage negotiation. Nevertheless, ransom negotiations also work according to the outlined model. The negotiator has a maximum willingness to pay - the amount they are willing or able to pay. The hostage-taker has a lower limit on the ransom amount they are willing to accept.

In this issue's interview, Tobias Ruthe gives us an exclusive glimpse into hostage negotiations. It turns out that information about the victim's ability to pay plays a central role. If the hostage-taker has prepared well, the duration of the negotiations tends to shorten significantly. The minimum price the hostage-taker would accept is more difficult to determine. However, the results of previous negotiations ("market prices") in the same region provide a clue that can speed up the negotiation. A quick settlement is, of course, a high priority in hostage situations.

Auctions can solve many of the information problems that arise in bilateral bargaining. In a second-price auction, the bidder with the best price wins but receives or pays the bid of the second-best bidder. In this format, disclosing one's willingness to pay or sell is rational. For procurement, reverse auctions offer significant advantages. However, many companies have yet to realize their full potential. The cardinal mistake in conducting auctions is negotiating without commitment. Read more in the article ***Common Mistakes in Purchasing Auctions***.

When bidders form a cartel and set their bids together, auctions and other purchasing negotiations become ineffective and reach their limits. However, the structure of the bids and the prices in the bid itself can provide information about whether a cartel exists. With this knowledge, buyers can better prepare for upcoming negotiations, for example, by increasing the number of bidders. Significantly extending the contract period can also weaken the cohesion of the cartel. Moreover, certain auction formats are less susceptible to bidder collusion, so information about the existence of a cartel should also influence the choice of the auction format.

The last article is about **Benford's Law**. One can use this mathematical principle to detect financial & data irregularities and detect bid rigging. While most statistical methods are concerned with the magnitude of numerical values, the application of Benford's Law examines the digits of numbers that occur.

In this year's upcoming and final issue, one of the topics will be ***Mr. Spock vs. Homer Simpson***. While the rational model of game theory provides a benchmark for behavior and the rational behavior of actors is a productive assumption, there are numerous areas where we do not behave like Mr. Spock but rather like Homer Simpson. For example, When negotiating, it is possible to exploit certain cognitive biases by setting an anchor price. However, setting an anchor price with an initial offer only makes sense under certain conditions. In the next issue, you can determine which small changes promise the greatest value in negotiations.

Christoph Pfeiffer

Negotiating with Hostage-takers and Cyber Extortionists in Times of Global Change

Tobias Ruthe is a crisis manager and managing partner at InCyTect, a management consultancy specializing in crisis management and prevention. With his expertise in strategic planning and risk assessment, he helps companies to manage and prevent crises effectively.

As a consultant, you have been involved in corporate security for many years and have negotiated directly with hostage-takers on several occasions. What is your assessment of the global security situation?

Kidnapping and hostage-taking highly depend on the specific region, resulting in distinct criminal economies across different regions. However, the issue of hostage-taking can also arise in the context of a family dispute or a failed bank robbery. However, these acute situations are usually resolved immediately by operational police forces.

As consultants, we are more likely to be involved in crises and white-collar crime. It is important to distinguish between the target groups of a kidnap for ransom. Local people in business, senior government officials, and their family members are often the focus. Attackers sometimes target international company employees and business travelers, but the likelihood of this happening differs depending on the country. As a rule of thumb, countries with less developed government structures are more prone to kidnapping for ransom. These countries also have a higher incidence of gang and drug-related crime and criminal organizations such as cartels.

Prominent families in Europe have experienced multiple cases of kidnappings for high ransoms. The perpetrators typically establish identifiable relationships within the family before committing the act. These cases are not related to gang structures operating for commercial purposes but rather committed by individual perpetrators.

Higher-risk regions include Latin and Central America and the Middle East. East Africa is known to have a long history of piracy. North African states, West Africa, and, if we turn to Asia, the Philippines are also regions or countries with an increased risk of hostage-taking.

How have risks changed in recent years?

We saw a spike in cybercrime during the lockdown. Many employees were in their home offices, which was a gateway for criminals, as virtual workplaces were often even less secure. The negative impact of the pandemic on the overall economic situation also raises fears of a long-term increase in crime.

We are also seeing a resurgence in business travel. Companies are resuming sending employees abroad again, increasing the risk of attacks and hostage-taking.

How do you negotiate with a hostage taker?

Mostly, commercial motives are the central driving force behind such acts. But of course, political motives can also play a role, and then a hostage or ransom negotiation can drag on for a very long time. But reaching a quick agreement

is usually in the perpetrators' interest. The longer a kidnapping goes on, the more pressure there is on all sides.

Certain patterns of behavior vary from region to region and country to country. For example, there are regional market prices for hostages. To conclude a case successfully, you must be aware of the perpetrators' modus operandi and expectations.

This means criminal organizations with economic interests are interested in a quick settlement while hostage-taking by organizations with political motives can take a long time.

Yes. We can assume that economic motives are the driving force in most cases. Why else would you commit a kidnap for ransom?

So, the perpetrator knows what the ransom will be, but you can't ignore the logistics of the crime. The perpetrator must take care of the hostage and keep them hidden.

What is the risk to the captives during the kidnapping?

This, in turn, is highly dependent on the perpetrator group. We have often seen that purely commercially motivated perpetrator groups treat hostages well under the circumstances. Being in a "jungle camp" and getting noodle soup daily is never nice. But the hostages are generally well cared for, including medical care when necessary.

There you see this criminal logic again. In the criminal economy, hostages are a commodity. The cynical logic is that I get less money if I damage the commodity.

There is no stronger bargaining chip than human life. We try to have a positive impact on the well-being of the hostages during the negotiations. For example, there would be no negotiation without regular proof of life.

It is rather unusual for the perpetrators to harm the hostages. I'm not saying it doesn't happen, especially when political or religious fanaticism plays a role. It may also be that the pressure

from law enforcement increases to the point where there is an increased risk of exposure for the perpetrators. Then the risk to the hostages also increases. In the best case, the perpetrator will simply let the hostages go. In the worst case, he may hurt the hostage, but that is rare.

In a negotiation like this, where lives are at stake, how do you set a ceiling on the ransom?

There is always a moral component to negotiating with hostage-takers, which means you cannot simply walk away from the negotiation as you would with any other commercial good. You have a moral obligation to see the negotiation through, which increases the pressure on the negotiator and everyone involved in the case, whether they are authorities, psychologists, or family members.

However, it would help if you did not immediately accept the hostage-taker's demands. A point that limits the maximum ability to pay is the feasibility of the demand. Not everyone has the amount of money demanded available in time.

In the past, there have been repeated kidnappings in Eastern Europe and Russia. In these cases, however, the perpetrator groups usually had a perfect idea of the financial situation of their targets beforehand. Then they made very realistic demands so that the negotiations focused mostly on the modalities of the handover and less on the ransom amount.

But there is usually room for negotiation based on experience. You should not immediately agree to the initial demands of the perpetrators. Doing so could also arouse greed.

It is known that certain countries like the USA or the UK have a policy of not paying ransom. Does this affect the likelihood of people from these countries being kidnapped?

This consideration may play a role if the perpetrators operate in gang structures and plan their crimes thoroughly. If the selection is based solely on physical appearance and is more ad hoc, the perpetrators may not know the nationalities of the hostages in advance.

However, such consideration may also play a role. If the perpetrators know that a nation will not pay or that a government may send special forces, and they are primarily commercially motivated, they may refrain from committing the crime. For politically motivated perpetrators, it may be the other way around.

Is the negotiation process of cyber extortion similar to a hostage situation, or are there differences between the two?

A cyber attack has certain parallels to a real-life hostage situation. The only difference is that a company's IT infrastructure is at stake instead of human lives. One scenario is that the blackmailer captures certain information and threatens to release it.

Another scenario is that the entire IT is encrypted, and the company cannot access it. Logically, if nothing works, there is little room for negotiation. Some companies, some organizations, take the position that they won't pay. However, parties can often reach an agreement if the claim still falls within the limits. In some cases, the blackmailers reactivate the systems step by step.

The relevant question for negotiation is how much damage has been or could be caused. If data is to be released, the question is, what data? Is it possible to close a loophole after the fact and play for time in the negotiation?

We usually avoid payments in cyber extortion cases, but sometimes that is impossible. In the end, you have to assess your options. If you decide to pay, you must also consider the legal system you operate in. Are payments allowed? There is always the risk of unintended terrorist financing. After all, you don't know who's behind the hacker.

Are there cases where the manufacturing equipment itself is also a gateway for malicious hackers?

This is not uncommon. We once had a case where a network in a factory was not segmented, and if you had just unscrewed one of the surveillance cameras outside and tapped into the network cable, you would have had full access to the production facilities. So, you could have done that with physical access.

But sometimes, access to a company's IT can be gained through online gateways when the patches are outdated. In the food industry, for example, an attacker who gains control of production equipment could change a recipe, rendering the machines unusable or even poisoning the food.

Common Mistakes in Procurement Auctions

For many companies, purchasing auctions is an important part of their procurement process. The advantages of auctions are obvious: They enable significant cost savings with transparent competition.

The reasons for this can be summarized in two points:

1. *The implementation of the auctions is not optimal.*
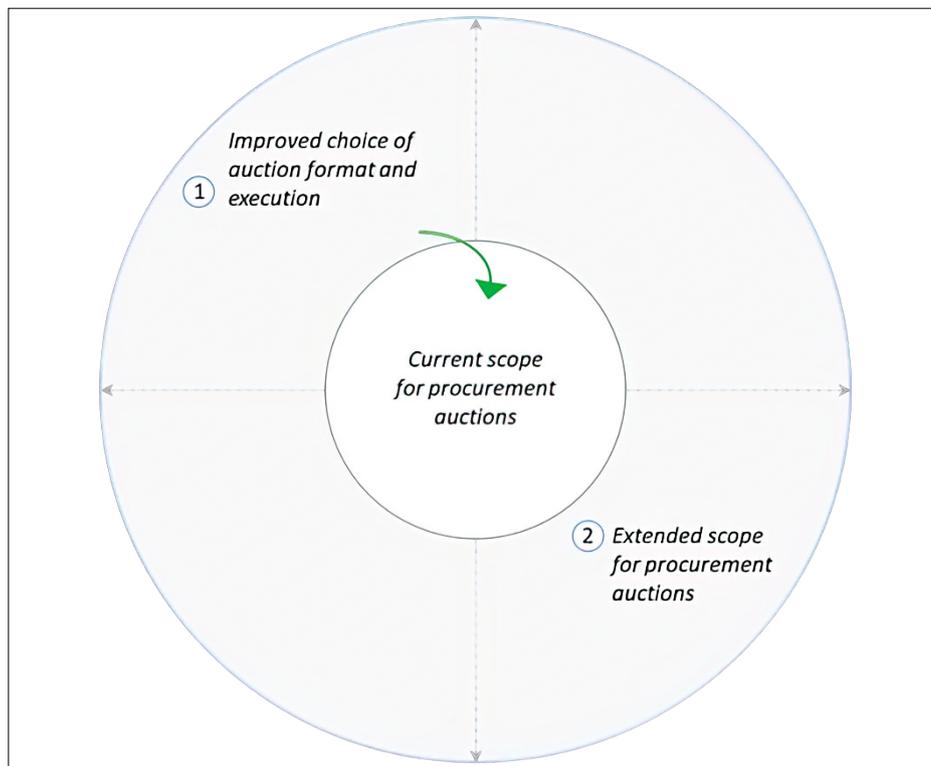2. *The scope of auctions is too small.*

Figure 1.   Starting points for optimizing purchasing auctions

The following is a discussion of the eight most common mistakes.

Mistake #1: Lack of Commitment

A cardinal mistake in auctions is to negotiate without commitment. In a no-commitment auction, the results are not binding, which means there may be renegotiations after the auction. If bidders anticipate this, they will not submit their best price - the mechanism cannot work to its full potential.

Auctions or other purchasing mechanisms should always be conducted with full commitment. Bidders must be aware of the full commitment. For example, if there have been deviations in the past and the procurement rules have yet to be followed or have subsequently been changed, this will lead to a loss of confidence on the part of bidders. Therefore, the commitment to the rules should be communicated to bidders in a particularly binding manner. In practice, this could be done utilizing a so-called commitment sheet signed by several senior executives, which confirms that the rules intended for the auction will also be adhered to in a binding manner.

Mistake #2: Weaknesses in the Auction Format Selection

There are many auction formats, and they vary widely. Choosing the optimal auction format is not trivial. In addition to the number of bidders and the expected price spreads between bids, the expected risk aversion of the bidders should also play a role. Bidders' risk aversion measures how much bidders want to win the auction. The higher the bidders' risk aversion, the lower the spread they are willing to accept. Risk aversion refers to the risk of not winning.

Consider the following situation: You are a sales representative for a manufacturing company. A proposal is due for an important client. The required service to your company is approximately $10 million. There are probably two other bidders, but you do not know their cost structure. The contract is of high strategic importance to your company. You would accept a small margin to win the contract. Failure to win the contract would have very negative consequences and could result in the layoff of several employees. A price below cost would also be unacceptable to your company.

The auction has two other bidders whose cost of providing the requested service is EUR 15 million (Bidder A) and EUR 17 million (Bidder B).

Suppose the tendering company uses an English ticker auction to buy the service. This means that a high price is first called and then gradually lowered. Bidders confirm each price level called,
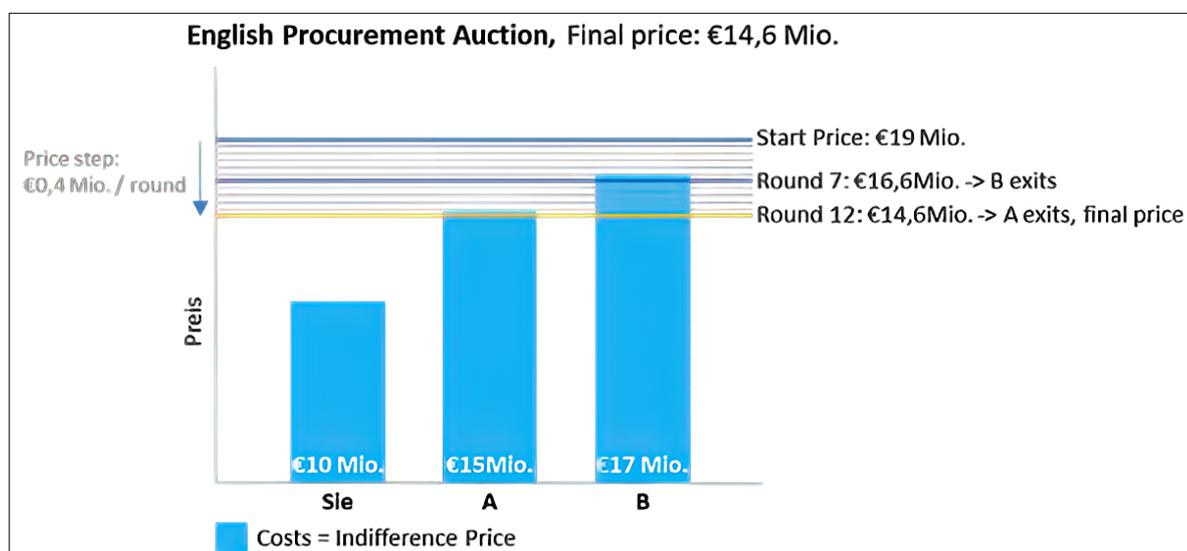

Figure 2. English procurement auction

and the price drops until only one Bidder remains. With a starting price of EUR 19 million and a price step of EUR 0.4 million per round, Bidder A exits in round 7 at EUR 16.6 million. In round 12, Bidder B exits at EUR 14.6 million. This is also the final price, as only one Bidder, you, remain in the race.

The Dutch auction starts with a low price and then gradually increases. With a starting price of EUR 8.3 million and a price increase of EUR 0.4 million per round, the first price above your cost would be reached in round 5. Since you are determined to win the auction and need to know the cost structure of the other bidders, you may accept this price. You may be able to wait a few more rounds. However, the final price will likely be well below the English auction price.
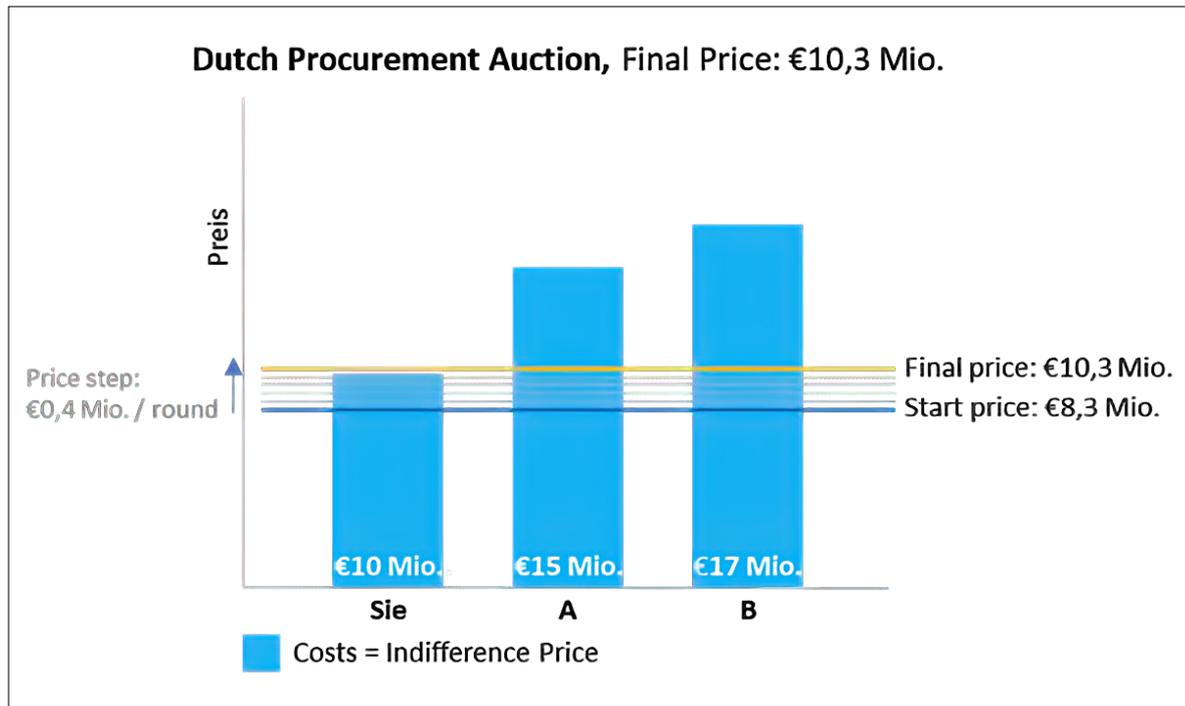

Figure 3. Dutch Procurement Auction

If you accept the first price step above your costs, the difference in final prices to the English auction is EUR 14.6 million - EUR 10.3 million = EUR 4.3 million. This means that choosing the less appropriate auction format, in this case, would result in an additional cost of EUR 4.3 million (42%).

In this case, the buyer would be ill-advised to use the English auction. The English auction is problematic when the price differences between bidders are substantial, especially when the gap between the lowest and second lowest prices is huge. The Dutch auction is advantageous when bidders are very risk-averse, i.e., they want to win at all costs, as in this example. Bidders are then willing to accept a lower margin to win.

The example shows that the choice of auction format can significantly impact the outcome of negotiations.

To derive the optimal auction format, Competitio uses a ***negotiation tree*** that recommends one of five formats based on four objective criteria: These formats are mathematically optimized, highly efficient, and proven in industrial purchasing.

In purchasing practice, the actual competitive situations are often very different. Our approach mathematically captures each situation and derives the optimal auction format for that specific

situation. Companies that do not choose the optimal auction format unintentionally lose significant money yearly. A mistake that would be easy to correct.

Mistake #3: English „Open Outcry" instead of English Ticker Auction

The English buying auction starts with a high price that gradually decreases. In the **open outcry** variant, bidders can then submit a new, lower bid themselves, thereby setting the level of bid increments. In this setting, bidders can submit „jump" bids higher than originally expected, signaling to other bidders that they are willing to bid aggressively to win the auction. Weaker bidders may be forced out of the auction early.

In the English ticker auction, the buyer sets the bid level. Bidders then confirm each price level until only one bidder remains and wins the auction. In the English auction, the second-lowest bidder ultimately sets the final price, which is why it is also known as a second-price auction.

The English **ticker auction** has proven superior to the open outcry variant. On the one hand, it eliminates the possibility of jump bids and thus reduces the premature withdrawal of bidders. On the other hand, the English ticker auction is easier to plan. For example, individual starting prices can be set for bidders, which would be difficult to do in the open-outcry version of the English bidding auction. Another indirect advantage of the English ticker auction is that more information about the indifferent prices or cost structure of the bidders becomes known since the exit times of individual bidders can be tracked.

The probability of a stalled auction is higher in the English free-choice auction. Bidders must choose the size of their bids. The phenomenon of decision fatigue is well-known in behavioral economics. The ability to make decisions is a finite resource; the more decisions we have made, the harder it is for us to make more decisions. More complex decisions fatigue more quickly than simple ones.

The English Ticker Auction places fewer demands on the Bidder's decision-making process. They only have to make a yes/no decision on the amount of their bid. The fatigue effect, and therefore the likelihood that the auction will not move, is, therefore, lower than in the open outcry auction.

Another advantage of the English *open outcry* auction is that it allows bidders to signal their interest in specific commodities to other bidders in multi-commodity auctions. It may also allow bidders to communicate and collude with each other via decimal numbers.

Although many platforms still offer English buying auctions with free bidding, the English ticker auction has become the standard buying practice for the above mentioned reasons.

Mistake #4: Dutch Auction with „Sudden Death"

Many auction platforms offer a „sudden death" logic for the Dutch auction or even apply the Dutch auction exclusively with this logic. Here, the first bidder to accept a certain price level wins. In an online auction, the Internet connection speed could be the deciding factor in which bidder wins.

The speed with which bidders accept a certain price level should not determine whether they are awarded the contract. Also, the „sudden death" logic puts bidders under unnecessary stress.

In the Dutch auction, each participating bidder should be able to accept a proposed price level (full-step logic). For example, if more than one bidder accepts a given price step, a final round can be scheduled in which these bidders can submit a lower final price bid that determines the award.

A legitimate exception to this rule, where not all bidders have an equal chance of winning a given price step in the Dutch reverse auction, is a ranked auction.

Experience shows that auction results are better when bidders are allocated enough time to make difficult decisions.

Mistake #5: Auctions with only One Bidder

If a Bidder is the only participant in a reverse auction, she may mistakenly assume that there are other participants. If the Bidder overestimates the number of participants, the bid will be lower than it would have been in a monopoly auction.

Bidders must make assumptions in many auction processes to submit the optimal bid. Often, bidders' assessments of other bidders' bids are not accurate. The process usually involves attempts to influence bidders' expectations in the buyer's favor. Applying an auction process to only one bidder influences bidders' expectations about the competition. Every time expectations are manipulated, and bidders realize that the manipulation led them in the wrong direction, it becomes more difficult for buyers to influence bidders' future expectations.

From an individual company's perspective, a single-bidder auction may make sense if the bidder is unaware of its monopoly position, if it is a one-time interaction, and if we ignore potential legal issues. For the reputation of buying auctions, running single-bidder auctions tends to be detrimental, so we generally do not recommend this approach. The exception is when bidders have dropped out, and only one bidder remains. In this case, the disadvantages of canceling the process outweigh the benefits, so it is usually a good idea to continue with a single bidder.

Another borderline case arises in a multi-commodity auction with partial monopoly markets. If competition is well developed for most commodities or bundles of commodities, the monopoly lots would have to be segregated and negotiated separately, requiring more effort and not transparently communicating to bidders the particularly strong competitive position for those commodities. Therefore, only an either/or solution would be practical in partially monopolistic markets. Either one relies on the auction process and accepts partial monopolies, or one chooses another negotiation approach, such as sequential or parallel bilateral negotiations.

Mistake #6: Exclusion of Combinatorial or Multi-Good Auctions

Many companies do not use combinatorial auctions because of their complexity. However, combinatorial auctions do not have to be complicated and can benefit buyers and suppliers significantly.

A combinatorial auction can be limited to requesting a few combinations. Suppose a large lot (L) and a small lot (S) are to be procured. The bidders have different capacities, and it is not clear whether the bundle option (L+S) or awarding L and S to different suppliers is the optimal cost solution. In this case, the prices for L+S and L and S could be requested and compared separately, round by round. The combination with the best cost structure will then prevail in the market. If there is a preference for awarding to two suppliers, this can be represented by a risk premium. The risk premium is then added to the single-source solution, making it more difficult for it to prevail.

Combinatorial auctions can be much more complex than the two-lot example. With a larger number of lots, possible combinations increase exponentially, but this can be controlled by using appropriate software.

Bidders can better express their cost advantages in combinatorial auctions, benefiting both bidders and buyers. One study showed that after a first-time combinatorial auction, costs were significantly reduced while suppliers' average margins increased (Olivares et al., 2021).

Mistake #7: Use Auctions only for less Complex and Homogeneous Services

Purchasing auctions are often limited to similar services, so price is the only deciding factor. This means that only services of the same quality can be procured. However, this limitation is not necessary. Negotiating different services with advantages and disadvantages in an auction is also possible. You have to monetize each bid's advantages and disadvantages, i.e., convert them into a monetary value. A disadvantage, such as higher weight, becomes a „penalty" that increases the bid price. An advantage, such as faster delivery, becomes a „bonus" and reduces the bid price. Once the advantages and disadvantages of all bids have been calculated and the corresponding changes made to the bid price, the result is the comparison price, which becomes the sole decision criterion for the auction.

Using the comparison price method makes it possible to negotiate even complex and inhomogeneous services via auctions, thus further exploiting the huge potential of purchasing auctions.

Mistake #8: Incomplete explanation of Process to Suppliers

The chosen auction format plays a central role in achieving the goal of an auction: it allows bidders to express their appreciation for the good or service and influences the outcome. However, for the auction format to have its intended effect, it is essential that bidders fully understand it. A clear and comprehensive explanation will ensure this.

Therefore, explaining the format in advance is important so that each bidder can understand it and prepare accordingly. Auction organizers must provide clear and precise explanations to avoid misunderstandings and ensure that they explain any unique or complicated aspects of the format.

It is equally important to allow bidders sufficient time to ask questions. This opportunity to clarify doubts and ambiguities helps create a transparent and fair auction environment. It gives bidders peace of mind and allows them to make informed decisions.

This is especially true for more complex auction formats. These formats may have multiple rounds, require different bidding strategies, or have special bidding rules. In these cases, understanding the format can be the difference between a winning bid and a losing bid. Therefore, explaining the format and allowing time for questions should be a priority for complex auctions.

Proper communication and understanding of the auction format will enable bidders to realize the full potential of their bids and get the most out of the auction. This is fundamental to the success of an auction and should be done carefully.

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Fraud detection with Benford's Law

In the 1930s, Electrical Engineer and Physicist Frank Benford discovered a curious fact about numbers. The leading digits are not evenly distributed in certain distributions but follow a logarithmic distribution in which the smaller digits appear more likely.

According to Benford's Law (BL), the probability for the first digit of a number can be calculated as

$$P(d) = \log_{10}(1 + \frac{1}{d})$$

Where d is the digit in question and P(d) is the expected probability that the digit d is the first digit in the number.

Thus, the probability that the first digit of a number is a 1, $P(1) = \log_{10}(2) = 30,1\%$. The probability that the first digit is a 9, on the other hand, is only $P(9) = \log_{10}(\frac{10}{9}) = 4,6\%$. Therefore, the probability of observing a 1 as the first digit is six times as high as the probability that the first digit is a 9.

Thus, the probabilities for all nine possible first digits of a number can be calculated as follows:

Table 1. Expected probabilities for the first digit according to Benford's law

First digit	Probability according to Benford's law
1	30.1%
2	17.61%
3	12.49%
4	9.69%
5	7.92%
6	6.69%
7	5.8%
8	5.12%
9	4.58%

It is important to note that BL can only be used when the underlying numbers are over several orders of magnitude.

Mathematically, this condition can be expressed as follows (Kossovsky, 2015):

$$Order\ of\ Mangnitude\ of\ Variability\ (OMV) = \log_{10}(90.PCT) - \log_{10}(10.PCT) > 3$$

A more restrictive measure uses the 90th and 10th percentiles instead of the maximum and minimum (ibid), but in practice, this measure is often too restrictive:

$$Order\ of\ Magniute\ (OOM) = \log_{10}(Max) - \log_{10}(Min) > 3$$

For example, the distribution of adult heights does not fall under the BL. Most adult humans are between one and two meters tall, so the first digit is 1 in most cases. In a freely available data set on height (*https://www.kaggle.com/datasets/burnoutminer/heights-and-weights-dataset*), the OOM = 0.1 and the OMV = 0.01. Both are well below the threshold of 3, so BL cannot apply.

Fortunately, balance sheets and financial data usually meet the requirements, so BL is applicable in such cases. Suspicion of fraud or manipulation arises when the audited figures deviate significantly from Benford's Law.

Whether a deviation is large enough to indicate data manipulation with a high probability can be determined, for example, with the Sum Squares Deviation (SSD) test. Here, the difference is formed between the expected proportion (PEXP) and observed proportion (POBS) for all digits, which are then squared and summed.

$$Sum\ Squares\ Deviation\ (SSD) = \sum_{1}^{D_{max}} (P_{EXP} - P_{Beob})^2$$

The resulting sum helps determine whether the data set behaves according to Benford's Law or whether manipulation is suspected.

Table 2. Threshold values for the SSD (Kossovsky, 2014)

SSD	Corresponds to Benford	Acceptable	Borderline	Not Benford
First digit	<2	2-25	25-100	>100
Second digit	<2	2-10	10-50	>50
First two digits	<2	2-10	10-50	>50
Last two digits	<4	4-40	40-100	>100

The commonly used chi-square test should not be used to test for BL because many underlying assumptions are unmet (Kossovsky, 2021).

A test based on the BL cannot tell you exactly what numbers are being manipulated. Like all indicators, it should be used as a guide for further investigation.

BL is not limited to the first digit of a number; the expected frequency for other digits or combinations of digits can also be used. For example, the expected distribution for the second digit is:

$$P(d) = \sum_{k=0}^{10} \log_{10}(1 + 1/(10k + d))$$

The probability of the first two digits, pq, of a number, can be calculated as follows:

$$P(pq) = \log_{10}(1 + 1/pq)$$

Let's take a look at a few examples of applications.

Census data

Census data from the USA is available for download from the Census.gov website. There are 3193 entries in the CSV file (the link is in the source information). The column CENSUS 2010 POP represents the population of a city in the year 2010.

The OOM measure for the population values is 5.6, well above the threshold of 3. The observed values are very close to the BL probabilities. The squared sum of the deviations from the expected values of BL is 3.07, which confirms the visual impression of small deviations. Thus, there is no evidence of data manipulation here.
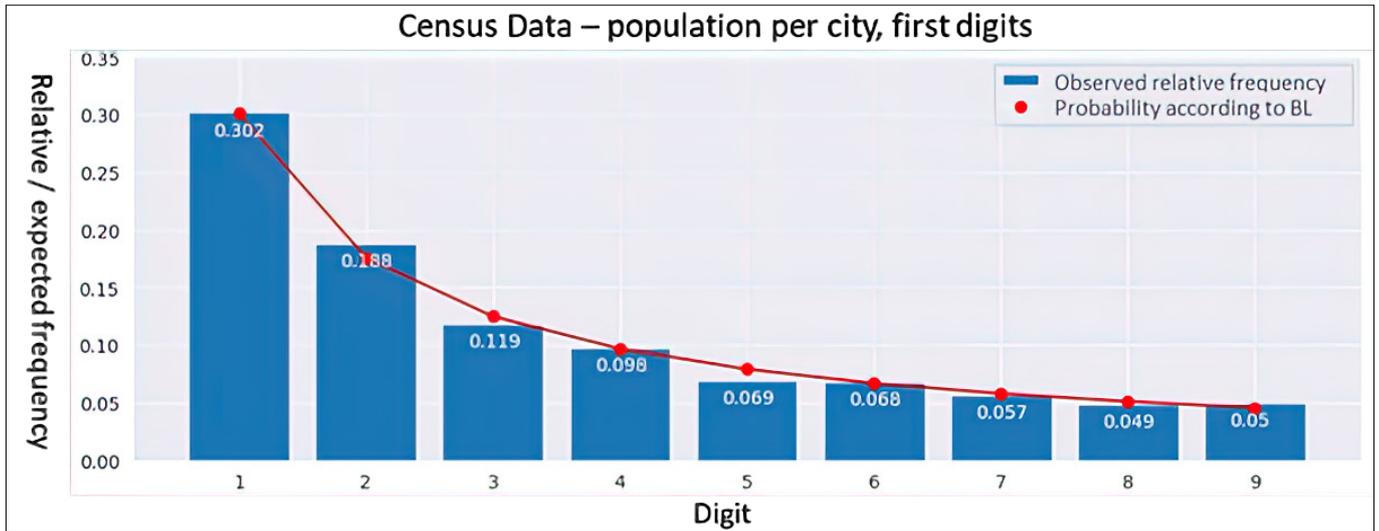

Figure 5. Relative frequencies of the first digit vs. BL probabilities.

Arizona State vs. Nelson

James Nelson worked for the Arizona Department of Revenue and wrote 23 checks to a vendor that did not exist (Nigrini, 2012). The money ended up in his bank account. In court, he said he intended to expose weaknesses in the new financial system.

Since the supplier did not exist, Nelson probably made up the numbers. He started with a small amount and gradually increased the amounts, but he always stayed below the $100,000 limit. He tried to make the numbers look random: Each number appears only once, and there are no rounded numbers.

Amounts issued to fictitious suppliers (J. Nelson).	
$ 1.927,48	$ 96.879,27
$ 27.902,31	$ 91.806,47
$ 86.241,90	$ 84.991,67
$ 72.117,46	$ 90.831,83
$ 81.321,75	$ 93.766,67
$ 97.473,96	$ 88.338,72
$ 93.249,11	$ 94.639,49
$ 89.658,17	$ 83.709,28
$ 87.776,89	$ 96.412,21
$ 92.105,83	$ 88.432,86
$ 79.949,16	$ 71.552,16
$ 87.602,93	**$ 1.878.687,58**

Figure 6. Amounts Issued to Fictitious Suppliers by Nelson

The accumulation of numbers starting with high digits, such as a 7, an 8, or a 9 is striking, violating BL.
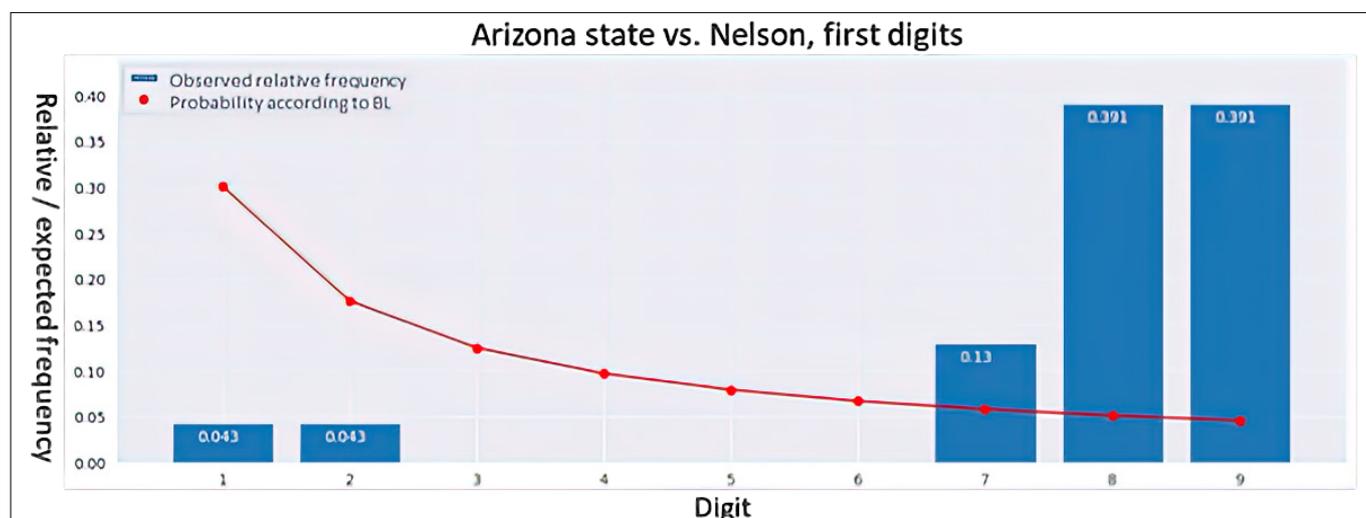

Figure 7. Observed relative frequency vs probability according to BL

Even if the number of observations in the present case is small, an application to the purchasing data as a whole with an evaluation per supplier is possible. BL could also be used in the context of cartel screening. In this case, not only the first digit should be examined, but also sequences of digits such as the first two or decimal places.

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The Competitor

If you have any questions, feedback, criticism, topic ideas,
or new registrations, please send them to

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We will publish our next newsletter in Q4.