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SMART CONTRACTS – TRANSFORMING MARKETS FOR LEMONS INTO MARKETS FOR LEMONADE

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Abstract

In his monumental article, "The Market for "Lemons": Quality Uncertainty and the Market Mechanism", George Akerlof examines the consequences of a lack of information in markets. More precisely, Akerlof proposed the information asymmetry between buyers and sellers can cause an inefficient allocation of goods in the market, which leads to an adverse selection. Since Akerlof's article was written, much ink has been spilled regarding information asymmetry. Unfortunately, despite the broad research about it, some markets still suffer from information asymmetry that causes an inefficient allocation of goods and services. That occurs, because some of the proposed solutions for information asymmetry can't bridge the information gap, some brought to the table a theoretical mechanism that doesn't have suitable legal and technological tools for execution in a feasible way, and others are efficient in solving the information asymmetry problem but lead to undesirable side effects. Hence, it has been a long time that many markets have been waiting for a solution that will enable bridging the information asymmetry between buyers and sellers, in a feasible way, without significant side effects. This solution wasn't found until recently, with the rise of a new technological tool: **the smart contract**. In this article, I will examine the new technological tool and its main characteristics, and I will demonstrate the way its unique attributes can ameliorate adverse selection, caused by information asymmetry. The article's structure consists of three parts: In part I, I will introduce Akerlof's main claims about information asymmetry and its consequences for market performance. In part II, I will conduct a literature review, providing, further analysis of information asymmetry alongside some theoretical and practical solutions which offered to solve it. I will briefly show the problems with current solutions. In part III, I present the smart contract and its unique attributes and demonstrate how smart contracts can eliminate information asymmetry, in a study case of the credit market.

I. INTRODUCTION: INFORMATION ASYMMETRY

George Akerlof's "Lemons" paper relates quality and uncertainty.[1] Akerlof's paper made a significant contribution to the field of economics, by bringing the concept of asymmetric information to light. The key conclusion of the paper - known as the "Lemons Result" - is that in

markets with asymmetric information where the product quality is unobservable by consumers prior to purchase, low-quality products will drive high-quality products out of the market.

In many markets, buyers use some market statistics to judge the quality of prospective purchases. In this case, there is an incentive for sellers to market poor quality goods since the returns for good quality accrue mainly to the entire group whose statistic is affected rather than to the individual seller. As a result, there tends to be a reduction in the average quality of goods.

Akerlof uses the example of used cars to demonstrate the essence of the problem: suppose that there are just four kinds of cars. There are new cars and used cars. There are good cars and bad cars (which in America are known as "lemons"). A new car may be a good car or a lemon, and the same is true of used cars. The individuals in this market buy a new car without knowing whether the car is good or a lemon. But they do know that with probability **q** it is a good car and with probability **(1-q)** it is a lemon; **q** is the proportion of good cars produced, and **(1-q)** is the proportion of lemons.

After owning a specific car, however, the car owner can form a good idea of its quality, so the owner assigns a new probability to the event that his car is a lemon. This estimate is more accurate than the buyer's estimate. An asymmetry in information has developed: the seller has better information about the quality of his car than the buyer. But good cars and bad cars must still sell at the same price - since it's impossible for a buyer to tell the difference between a good car and a bad car. It is apparent that a used car can't have the same valuation as a new car - if it did have the same valuation, it would clearly be advantageous to trade a lemon at the price of a new car, and buy another new car, at a higher probability **q** of being good and a lower probability of being bad. Thus, the owner of a good car must be locked in, and cannot receive the true value of his car. Eventually, most cars traded will be the "lemons", and good cars may not be traded at all.

In summary, the asymmetrical information causes uncertainty regarding the quality for one of the players. The asymmetrical information causes adverse selection - inefficient distribution of goods in the market which leads to a market failure.

II. LITERATURE REVIEW

The following literature review introduces a study case of information asymmetry in the credit market and its consequences. In addition, there will be shown three types of solutions for asymmetrical information have been proposed in previous studies: legal solutions, data transparency, and signaling or screening.

A. Information Asymmetry in the Credit Market

The credit market suffers from information asymmetry between lenders and borrowers, which causes an inefficient allocation of resources and credit rationing. (Bensako & Thakor, 1987) state that lenders usually know less than borrowers about payoff-relevant borrower attributes.[2] (Williamson, 1987) uses monitoring costs to show that, in a credit market with asymmetrically informed lenders and borrowers, there exists rationing in equilibrium where among a group of identical would-be borrowers, some receive loans, while others do not.[3] (Bensako & Thakor, 1987) examine the relationship between collaterals and credit rationing in an environment of information asymmetry. Under the assumption that collaterals are costly, they find it as characterize a perfectly sorting competitive equilibrium. However, their analysis shows that, when collateral constraints are binding, lenders cannot sort borrowers out based on their collateral choices alone, and that the threat of rationing is an effective sorting device in such cases.

A. Legal Solutions

Prevalent legal and contractual solutions to asymmetric information problems are based on the attachment of consequences to the emergence of bad news.[4] At first sight, when information asymmetry exists, and the seller holds superior information about the goods she poses compared to the buyer, imposing a legal duty on the seller to disclose this information prior to the sale sounds as a sufficient solution. (Shavell, 1994) However, a duty to disclose influence the expected value of the information for the party, and therefore influence his incentive to acquire such information.[5] (Cooter & Ulen, 2000) distinguished between productive information and redistributive information (substantive approach), regarding the duty to disclose it. Cooter and Ulen concluded that searching for redistributive information is socially wasteful, and therefore the law should discourage the incentive to do so, which could be effectively done by imposing a duty to disclose such information.[6] (Shavell, 1994) adds another layer for the determination of whether disclosure duty is desirable, according to the acquisition of the information (the process).[7] He distinguished between information that was not acquired deliberately, to information that was acquired by deliberate investment. These two aspects combined, lead to the understanding that with productive information (which has a social value) which was acquired by deliberate investment, a duty to disclose should not be imposed. (Bar-Gill & Porat, 2017) enriched the analysis by pointing out that in many real-world cases, owners of assets have better information about their assets even before they investigate. In such asymmetric information settings, mandatory disclosure doesn't attain the first-best outcome.[8] (Simmons, Garino, et al., 2003) show that under costly verification of loan contracts, truth-telling mechanisms may fail as lenders may choose to deviate from auditing in Nash

Equilibrium. Hence, in many cases, disclosure duty couldn't be perceived as an optimal solution for information asymmetry.[9]

B. Databases and Data Transparency

Blockchain databases are databases of information that are created and maintained by a network with no central authority. Since blockchain technology was first introduced (Haber & Stornetta, 1991), a wide variety and applications offered to it, among them is the potential to diminish adverse selection in markets for assets of different qualities.[10] (Berg, Davidson, & Potts, 2017) assert that transactions facilitated over-blockchain databases should experience fewer problems of information asymmetries.[11] (Aoyagi & Adachi, 2018) were the first to address the question of asymmetric information on blockchain platforms and smart contracts as means to ameliorate it. They model a crude blockchain security level which is the proportion of low-quality assets that the blockchain automatically segregates from the platform.[12] (Notheisen & Weinhardt, 2019) elucidated that merely increased transparency in markets (e.g., blockchain-based) with asymmetric information, could not only reduce uncertainty but also enable opportunistic users to exploit quality information to maximize their individual gains.[13]

C. Signaling and Screening

There are two similar solutions, signaling and screening, that can reduce information asymmetry, and consequently, remedy adverse selection. signaling and screening, differ concerning which party acts first. In the former, the informed party credibly discloses private information. By contrast, the latter occurs when the uninformed party provides a mechanism to incentivize the informed party to credibly disclose private information. (Spence, 1973) first discussed signaling, targeting information asymmetry in labor markets, characterized by different productivity levels of individuals. Spence reasons that high-productivity individuals can take classes to show their superior productivity. Low-productivity types may prefer to avoid mentally taxing schooling and accept lower-paying jobs. In this manner, both types truthfully reveal their quality by choosing different courses of action. [14] (Rothschild & Stiglitz, 1976) demonstrated screening boldly, with an example of information asymmetry in insurance. An insurance company could design multiple contracts that customers can select based on their potential riskiness. They pointed out that when conditions for screening do not exist, a rational insurance company will offer no policies.[15] (Brown, 2020) concluded, that signaling and screening may remedy adverse selection, and current notable uses of these mechanisms include quality disclosure, firm capitalization, limit pricing, and advertising.[16]

III. SMART CONTRACTS – MAKING LEMONADE OUT OF THE LEMONS

A. The Smart Contract

In this paper, a smart contract will be defined as a set of agreements between parties, which is (1) encoded as a computer protocol (2) a blockchain-based (3) and is self-executing.[17] The blockchain technology, which the smart contracts run on, provides some of the key attributes of the smart contracts: efficiency, immutability, and independence- which eliminate the need for the parties in trusting each other, or any other intermediary.[18]

Despite the revolutionary image of smart contracts, storing complex systems for cooperation between components without third parties to perform the certifications, simpler applications that contain material properties have been around for years. The term "smart contract" was coined by Prof. Nick Szabo back in the 90s. Szabo compared the code-based smart contract to vending machines (such as automatic ticket purchase stations, automatic drink machines, etc.).[19] The similarity between the modern smart contract and an automatic machine stem from the same core actions in both: a set of dictated actions formulated in an unambiguous code language, which, when performing a certain action, results in automatic and inevitable enforcement without the need for the involvement of a third party.

Many possible applications for smart contracts have been presented in the literature. For example, a smart contract can be set so that if certain conditions specified in it are met, funds will be transferred from one digital wallet to another, and at the same time, a change will be made in the ownership registry in accordance with the financial transfer. In addition, a smart contract can be paired with various devices connected to the internet ("internet of things") and thus connect the smart contract and its orders to physical objects.[20] The most well-known example of such a device which was widely discussed in the literature, is the starter-interrupter, a device that enables the blocking of leased vehicles in the case of payment defaults.[21]

Smart contracts have many advantages compared to traditional contracts, enforced by courts. First, their high efficiency dramatically reduces transaction and monitoring costs related to the supervision of the agreement and its enforcement. In addition, writing the smart contract in code language, reduce interpretive challenges and ambiguity that exists in human language.[22]

B. Smart Contracts as a Screening Mechanism

As previously described, screening is a possible solution for an information asymmetry, which is provided by the uninformed party in order the sort the "quality" of its partners.[23] One suggestion for a screening mechanism, was an introduction of different contracts to potential customers by the

uninformed party, which their choice between them will sort them, and credibly disclose their private information.[24]

The use of sanctions in contracts as a credible threat that can signal private information to ameliorate information asymmetry was discussed as one of the advantages of self-help remedies.[25] One example, which was used to demonstrate the pure signaling effect of self-help remedies, was the use of "hostage" which is an ancient self-help remedy, was mostly used prior to the establishment of the modern enforcement system. A "hostage" can be anything valuable to the man that wants to signal the credibility of his commitment, and with no value to the one getting it. The signaling function of the hostage was the promisor fails to perform his commitment, the promise can destroy the hostage. Such a threat, incentivize the promisor to perform his commitment, while his choice to include such an element in his contract signals his intention and ability (his "private" information) to perform his commitments.

The self-execution of self-help remedies, which leads to significantly lower execution costs for their user (compared to judicial remedies), make a substantial risk of enforcement against violators. Therefore, the introduction of various contracts, some including self-help remedies and others not, can function as a screening mechanism and sort potential partners according to their private information regarding their ability/ willingness to fulfill their commitments.

Similarly, with the attributes of self-execution and even lower transaction and monitoring costs, smart contracts can perform with the same function of self-help remedies at a higher level of efficiency. This character made some scholars define them as technology-based, self-help remedies.[26] For instance, the use of a starter interrupter device that is paired to a smart contract has the ability to shut down the car or even destroy it. Such a mechanism does not "enforce" the contract, as it does not provide the lender his funds or anything valuable. However, merely the damage that it can cause to the partner, incentivize him to perform his duties and his acceptance of such contract can credibly signal information.

As an example, assume two agents, Reuven and Shimon. Reuven asks Shimon for a loan for purchasing a new car. Under our prior assumption, the borrower (Reuven) holds superior information regarding their ability/ willingness to repay their loan. To overcome the information asymmetry, Shimon can introduce several loan contracts as a screening mechanism (Rothschild & Stiglitz, 1976). A possible range of contracts can include a traditional contract and a smart contract. The smart contracts can be paired with a starter-interrupter that will be installed in the future car. The smart contract, paired with the starter interrupter, can produce an increased threat to the enforcement of the sanction if for any reason a loan payment won't be made on time. The sanction's cost in smart contracts can reduce the benefit of apotential violation of the contract and therefore

distinguish "good" borrowers (which are more likely to accept the use of smart contracts) from "bad" ones (which are more likely to choose other alternatives).

Judicial remedies enforcement is costly [27] and not certain.[28] The reduced transaction & monitoring costs in smart contracts and the automatic enforcement, independently of any third-party action, make the smart contract much more efficient and a possible indicator that can be used to deliver private information between borrowers and lenders. Such information, can reduce information asymmetry, enhance the market efficiency of resource allocation, and prevent credit rationing.

C. Scope & Limitations

A smart contract can function as a screening device subjected to the assumption that borrowers hold superior information compared to lenders.[29] In addition, the proposed mechanism can work in its current format only in dedicated loans – for purchasing a specific object, and only in complete contracts (smart contracts function only when the contract is completed).[30] Another variable that can possibly distort the proposed model is risk aversion variation between borrowers, which can affect their willingness to expose themselves to the risk of automatic enforcement by the smart contract.[31] Moreover, a Reduction of the signaling cost can make lenders rely on the borrowers existing information, rather than collecting new information, which can be superior and lead to more efficient risk allocation.[32] Lastly, the competitive advantage of the proposed solution decreases as in legal systems characterized by lower signaling costs, which can be performed effectively through judicial remedies.[33]

IV. CONCLUSIONS

This paper outlines the very first foundations of the research about smart contracts as a screening mechanism that can ameliorate information asymmetry, and consequently, reduce adverse selection. This paper will be followed by other papers, which will develop the analysis of the proposed model, in different dimensions. The next papers will develop the mathematical model, which lay in the core of the proposed model, and such analysis will be conducted comparatively with other existing screening mechanisms. However, as already shown in this paper, the smart contract has unique attributes, which can take benefits that can be found in existing legal tools to a new level of efficiency. This innovative technological tool has its own challenges, that were not covered sufficiently in this paper, but due to its rapid adoption in many industries, we can expect to see increasing use of smart contracts in many fields. As shown in this paper, one of its potential impacts on tomorrow's economy could be the amelioration of information asymmetries in markets.

V. APPENDIX

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