Proof of Concept: The punishment mechanism of SavAct

SavAct is a cryptocurrency with several applications. This includes a financially bounding voting system and preventing fraud attempts in online shops. Both are made possible by an integrated punishment mechanism.

As with trustee services, it is possible that sellers are being wrongly punished. This analysis examines the frequency at which sellers in online shops are being punished.
Furthermore, SavAct is being compared with already established trustee systems. In order to be able to compare the various systems in numerical values, reference values are determined in order to create general cost factors.

SavAct will also find use in the anonymous domain in which trustworthy trustees cannot provide their services because of their centrality and state dependence. The acquired reference values provide an overview of the user perception in online shops and should therefore also provide insight for the use in the anonymous domain.

Functionality of trustee services:

Trustee systems are designed to protect against fraud by holding the payment back until the service has been successfully provided. In problem cases they mediate between buyer and seller and decide who is entitled to keep the payment. Sellers offer trustee systems as a payment method to provide their customers with more security and trust.

Reference to the costs:

The fee of a trustee system is usually covered by the seller and deducted from the amount of money received. This fee is considered as an expenditure for the seller.

In case the trustee sides with the buyer in a problem case, the seller's payment will be denied. This may happen for example if a buyer claims that he has not received the paid goods. The seller loses his goods and does not receive any payment. Averaged over several sales, this can be used to determine a loss factor for the seller.

Usually, these additional costs are already included in the sales price and are therefore passed on directly to the customer [PAY-19]. However, a higher selling price compared to competitors lowers the sales [RUS-10]. In order for the system to be worthwhile for the seller, the costs V of the payment method must be kept as low as possible. For comparison, the cost factor is given in percent.

$$Price_{WithoutTrustee} = BuyingPrice_{Retailer} + Profit_{Retailer} + Costs_{Retailer}$$

The fees of trustee services usually relate to the selling price, therefore:

$$FinalPrice - FinalPrice \cdot V = Price_{WithoutTrustee}, \qquad V \leq 1$$

$$V = 1 - \frac{Price_{WithoutTrustee}}{FinalPrice}, \qquad FinalPrice > 0$$

Comparison:

In order to compare the resulting costs of the systems, the relative frequency P of unjustly punished sellers is added to the relative fees F of a transaction. The lower the costs when using a system, the lower the resulting cost factor V.
Thus, the cost factor V is optimal when approaching zero.

$$V = F + P$$

The fees F consist of the percentage fee F_{Var} and the relative fixed fee F_{Fix} of a transaction.

$$F = F_{Var} + F_{Fix}$$

$$F_{Fix} = \frac{F_{Fix,Absolute}}{SellingPrice}$$

Fees of trustee systems:

The percentage fees differ according to the amount of the monthly transaction volume of the respective dealer. Cheaper fees are offered when reaching a transaction volume of several thousand Euro and reach their minimum between fifty thousand and one hundred thousand Euro.

	Percentage basic fee	Absolute fixed fee	Transaction with border crossing			
			Additional fee	Total percentage fee		
				Universal	China	USA
PayPal	1,49% - 2,49%	0,35€	1,8% - 3,3%	3,49% - 5,79%	4,79% - 5,79%	3,49% - 4,49%
AmazonPay	1,2% - 1,9%	0,35€	2,0% - 3,3% (Within EU 0%)	3,2% - 5,2%	4,5% - 5,2%	3,2% - 3,9%
Min / Max	1,2% / 2,49%	0,35€	1,8% / 3,3%	3,2% / 5,79%	4,5% / 5,79%	3,2% / 4,49%

Table 1: PayPal and AmazonPay fee overview, last updated: December 2018 [PAY-18, AMA-18].

The absolute fixed fee $F_{Fix,Absolute}$ is comparable for the established systems and has only a marginal effect on larger payment amounts. To simplify the further approach, this is not considered anymore:

$$F_{Fix,Absolute} = 0 \Rightarrow F_{Fix} = 0$$

The intervals of fees for domestic and foreign trade:

$$F_{PayPal,In} = \{1,49\% \leq x \leq 2,49\%\} \qquad F_{PayPal,Out} = \{3,2\% \leq x \leq 5,2\%\}$$

$$F_{AmazonPay,In} = \{1,2\% \leq x \leq 1,9\%\} \qquad F_{AmazonPay,Out} = \{3,2\% \leq x \leq 5,79\%\}$$

For the comparison between SavAct and the already established trustee systems, only the minimum and maximum values are being considered. The resulting costs are similar if SavAct's values are between these. However, SavAct definitely has an advantage if the values are below the minimum.

$$F_{Min,In} = 1,2\% \qquad F_{Min,Out} = 3,2\%$$

$$F_{Max,In} = 3,2\% \qquad F_{Max,Out} = 5,79\%$$

SavAct is based on a different principle than trustees that does not have any percentage transaction fees.

$$F_{SavAct} = F_{SavAct,In} = F_{SavAct,Out} = 0$$

Therefore, SavAct only needs to take P_{SavAct} into account.

$$V_{SavAct} = F_{SavAct} + P_{SavAct} = P_{SavAct}$$

Case distinction:

Table 2 shows at which values SavAct is advantageous or disadvantageous in terms of cost compared to the established systems. V_{Min} and V_{Max} describe the smallest and largest cost factors of the considered trustee systems. How often trustee systems decide against sellers and thus punish them is expressed by the still unknown frequency P_T.

$$V_{Min} = F_{Min} + P_T \qquad V_{Max} = F_{Max} + P_T$$

There are no established and reliable trustees in the decentralized and anonymous domain to draw a relevant comparison [BAN-18, EMP-18, PEA-18A, PEA-18B]. Therefore, only the values from the public domain can be compared with SavAct.

	SavAct is equivalent	SavAct is definitely advantageous	SavAct is definitely disadvantageous
Condition	$V_{Min} \leq V_{SavAct} \leq V_{Max}$	$V_{SavAct} < V_{Min}$	$V_{SavAct} > V_{Max}$
Transaction without border crossing	$1{,}2\% + P_T \leq V_{SavAct} \leq 2{,}49\% + P_T$	$V_{SavAct} < 1{,}2\% + P_T$	$V_{SavAct} > 2{,}49\% + P_T$
Transaction with border crossing Universal	$3{,}2\% + P_T \leq V_{SavAct} \leq 5{,}79\% + P_T$	$V_{SavAct} < 3{,}2\% + P_T$	$V_{SavAct} > 5{,}79\% + P_T$
China	$4{,}5\% + P_T \leq V_{SavAct} \leq 5{,}2\% + P_T$	$V_{SavAct} < 4{,}5\% + P_T$	$V_{SavAct} > 5{,}79\% + P_T$
USA	$3{,}2\% + P_T \leq V_{SavAct} \leq 4{,}49\% + P_T$	$V_{SavAct} < 3{,}2\% + P_T$	$V_{SavAct} > 4{,}49\% + P_T$

Table 2: SavAct in relation to total costs.

Relative frequency P in comparison:

There is no disclosed official data from established trustee systems regarding the relative frequency P, i.e. how often sellers are being punished. A possible reputational damage could be the reason for that. Nevertheless, in order to be able to make a statement about the frequency P, a comparison between the advantages and disadvantages of buyer complaints is drawn up. Legal actions are very difficult to enforce across national borders [HAR-17], which is why the following comparison does not include legal actions or the possibility of concessions by the involved parties.

Buyer complaint is justified (seller cheats)

	SavAct		Escrow service / Mediator		Direct payment	
	Seller	Buyer	Seller	Buyer	Seller	Buyer
Buyer obtains approbation	*No profit*	*No refund*	*No profit*	*Refund*	*Profit through fraud*	*No refund*
Seller obtains approbation			*Profit through fraud*	*No refund*		

Buyer complaint is unjustified (buyer cheats)

	SavAct		Escrow service / Mediator		Direct payment	
	Seller	Buyer	Seller	Buyer	Seller	Buyer
Buyer obtains approbation	*No profit*	*No refund*	*No profit*	*Refund by fraud*	*Profit*	*No refund*
Seller obtains approbation			*Profit*	*No refund*		

Table 3: Fraud possibilities in comparison if no agreement can be found. Successful fraud is marked using red underlined font.

Red and underlined are the advantages of the seller or buyer in a fraud attempt. The core principle of SavAct is based on the fact that no party benefits from fraud. Here it should be noted that even though a fraudulent buyer received the goods he still has paid for it and is not able to get his funds back. While it might be easier for the buyer to punish the seller when using SavAct he does not benefit by doing so. However, in trustee systems they do have an advantage since the buyer can get his funds back. The established trustee systems usually act very customer-oriented, especially across national borders [BRI-12, BRÜ-16, QUE-17]. Therefore, it is reasonable to assume that the frequency

at which merchants would be wrongly punished with SavAct is lower than with established trustee systems.

$$P_{SavAct} < P_{PayPal}$$

$$P_{SavAct} < P_{AmazonPay}$$

This allows to deduce a lower cost factor V_{SavAct} and confirms the benefits for sellers compared to the mentioned established trustee systems.

$$V_{SavAct} < V_{Min}$$

Even if the assumptions were to be incorrect and the frequency P_{SavAct} is greater compared to other trustee systems, there is a margin where SavAct would still be more attractive to sellers due to the lack of the percentage fees. For illustration purposes, the frequency P_T is being subtracted. The result is a rate Q which describes the usefulness of SavAct when the trustee systems act as an irrevocable direct payment method, i.e. never decide against the seller.

$$Q_{SavAct} = V_{SavAct} - P_T$$

		SavAct is equivalent	SavAct is definitely advantageous	SavAct is definitely disadvantageous
Transaction without border crossing		$1{,}2\% \leq Q_{SavAct} \leq 2{,}49\%$	$Q_{SavAct} < 1{,}2\%$	$Q_{SavAct} > 2{,}49\%$
Transaction with border crossing	Universal	$3{,}2\% \leq Q_{SavAct} \leq 5{,}79\%$	$Q_{SavAct} < 3{,}2\%$	$Q_{SavAct} > 5{,}79\%$
	China	$4{,}5\% \leq Q_{SavAct} \leq 5{,}2\%$	$Q_{SavAct} < 4{,}5\%$	$Q_{SavAct} > 5{,}79\%$
	USA	$3{,}2\% \leq Q_{SavAct} \leq 4{,}49\%$	$Q_{SavAct} < 3{,}2\%$	$Q_{SavAct} > 4{,}49\%$

Table 4: SavAct in relation to the total cost if trustee systems decide exclusively for the seller.

The table compares SavAct with central and state-regulated systems. In the anonymous domain there are no trustworthy alternatives to which the quota Q_{SavAct} can be compared [BAN-18, PEA-18A, PEA-18B].

Nevertheless, in order to estimate the frequency of P_{SavAct}, comparisons with other systems have to be drawn. In the rating system of eBay, buyers gain no advantage by rating the seller negatively for no reason. They receive no funds for the negative rating, but a negative rating is equal to a punishment of the seller. Furthermore, customers can only submit reviews once they have purchased the goods. From a buyer's perspective, these properties are the same as SavAct's. The buyer has no advantage in punishing the seller because he does not get his funds back.

For these reasons, it can be assumed that the frequency of negative ratings correlates with the frequency of punishments in SavAct.

The evaluation of the reviews provides the customer satisfaction, the mindset of customers towards sellers, which is independent of financial benefits. The resulting reference values should therefore also provide orientation for the anonymous domain.

In the following sections, the ratings of sellers on the platform eBay are analyzed for a statistical evaluation.

General conditions:

eBay Germany with delivery destination Germany is used for the statistical evaluation. Search terms that are also known across borders were selected. The first 50 different sellers are being considered for each search term, seller location, and sorting option. The used sorting options are "Price + Shipping: lowest first" and "Price + Shipping: highest first". Sellers without ratings are excluded. The considered seller locations are Germany, USA, China, and Worldwide. A total of 1948 data sets with 21,317,251 individual ratings are taken into account.

Evaluation:

The seller's overall rating used by eBay r_{ebay} is the ratio between the positive ratings r_+ and the sum of the positive and negative ratings $r_+ + r_-$ of the last 12 months [EBA-18].

$$r_{ebay} = \frac{r_+}{r_+ + r_-}$$

In contrast to the eBay seller rating r_{ebay}, the neutral ratings r_o are respectively added to the negative and positive ratings by 50% for further analysis. The relative total seller rating r is calculated as follows:

$$r = \frac{\frac{1}{2} \cdot r_o + r_+}{r_+ + r_o + r_-}$$

Due to the low number of negative ratings ($r_- = 218.481$) relative to the positive ones ($r_+ = 20.837.701$), the total seller rating r becomes lower.

$$r_- < r_+ => r < r_{ebay}$$

Mathematical proof: $\qquad\qquad r < r_{ebay}, \qquad r_+, r_o, r_- \geq 0$

$$\frac{\frac{1}{2} * r_o + r_+}{r_+ + r_o + r_-} < \frac{r_+}{r_+ + r_-}$$

$$\vdots$$

$$=> r_- < r_+$$

The lower value r has an unfavorable effect on P_{SavAct}. Nonetheless, this assumption is made to determine definitive advantages of SavAct compared to other systems.

Narrowing:

Not all eBay purchases are being rated by customers. Presumably, dissatisfied customers have a greater incentive to give a rating than satisfied customers. However, since the total number of items sold per seller is not disclosed, only the total number of ratings can be referred to. This also causes a less favorable result of P_{SavAct}.

Because making an exact prediction is not feasible, reasonable limits for P_{SavAct} are to be determined. Therefore, the assumptions and explanations given so far are sufficient, even though they have a more unfavorable effect on SavAct in the calculations than they would have in the actual system.

Results:

The cheapest sellers in the "Worldwide" category are mostly located in China. As export leaders [WTO-17], China and the USA are used as prime examples for cross-border trades.

Country	Rating
Germany	99,21
Worldwide	98,95
China	98,59
USA	99,06

Graph 1: Positive rating r_{ebay} according to eBay.

Country	Rating
Germany	98,79
Worldwide	98,56
China	98,13
USA	98,72

Graph 2: Positive rating r with consideration of neutral ratings.

The category Worldwide also incorporates domestic sellers and is therefore given as orientation only. Consequently, only China and the USA are considered as case scenarios for cross-border transactions.

It is noticeable that the average rating of sellers from China is between 0.47% to 0.59% lower compared to sellers from the USA, depending on how the ratings are weighted. Simplified to SavAct, this would mean that Chinese sellers can increase their profits by about this amount if they increase customer satisfaction to the same level as the USA. This would be possible by e.g. increasing the product quality, reliability or reducing the delivery time.

Sellers based in Germany have the best average ratings. Since the target country in the measurement data is also Germany (see section "General Conditions"), the higher average will be attributed to the sales being domestic. Shorter shipping routes lead to fewer complications, there are no language barriers and legal consequences must be expected if problems are not resolved. These points will probably lead to a more reliable purchase and thus to better ratings. Therefore, in the following the sellers from Germany are considered as an example for domestic sellers. However, German sellers do not only have domestic ratings. Thus, a certain error rate occurs in this analysis. Since the international sellers are rated worse, it is reasonable to assume that the average rating for domestic sellers would be even better if all cross-border sales were excluded.

Sellers from China have a lower average rating, but according to eBay they only have 1.41% negative ratings. Adding half of the neutral ratings to the negative ones results in 1.87% negative ratings.

$$P = 100\% - r$$

In the less favorable case, the average for P_{SavAct} is 1.21% within the domestic market, 1.28% for sellers in the USA and 1.87% for sellers in China.

$$V_{SavAct} = P_{SavAct}$$

$$V_{SavAct,In} = 1,21\% \qquad V_{SavAct,USA} = 1,28\% \qquad V_{SavAct,China} = 1,87\%$$

Table 5 compares SavAct to the other trustee systems, assuming that they strictly decide seller-oriented. When trading domestically, SavAct is equivalent to the optimal values of the trustee systems with potential costs slightly above 1.2%. SavAct saves sellers several percent of costs on cross-border transactions. Sellers based in China save at least 2.63%, while sellers in the USA save at least 1.92%. Graph 3 compares the minimum and maximum fees of the respective trustee systems with the potential costs of SavAct.

$$P_{Escrow} = 0 \qquad => V_{SavAct} = Q_{SavAct}$$

		Result for sellers	Q_{SavAct}	Case
Transaction without border crossing		SavAct is equivalent	1,21%	$1,2\% \leq Q_{SavAct} \leq 2,49\%$
Transaction with border crossing	**China**	SavAct is definitely advantageous	1,87%	$Q_{SavAct} < 4,5\%$
	USA	SavAct is definitely disadvantageous	1,28%	$Q_{SavAct} < 3,2\%$

Table 5: Relative frequency of seller penalties and comparison to trustees.

The illustrated Table 5 and Graph 3 do not consider sellers' losses which result from wrong decisions of the trustee systems but refer to the theoretical case in which the trustees always agree with the sellers and who then may keep all payments without exception.
Graph 4 gives a more realistic view by considering these losses. The more client-oriented the trustee systems decide, the higher are the potential costs.
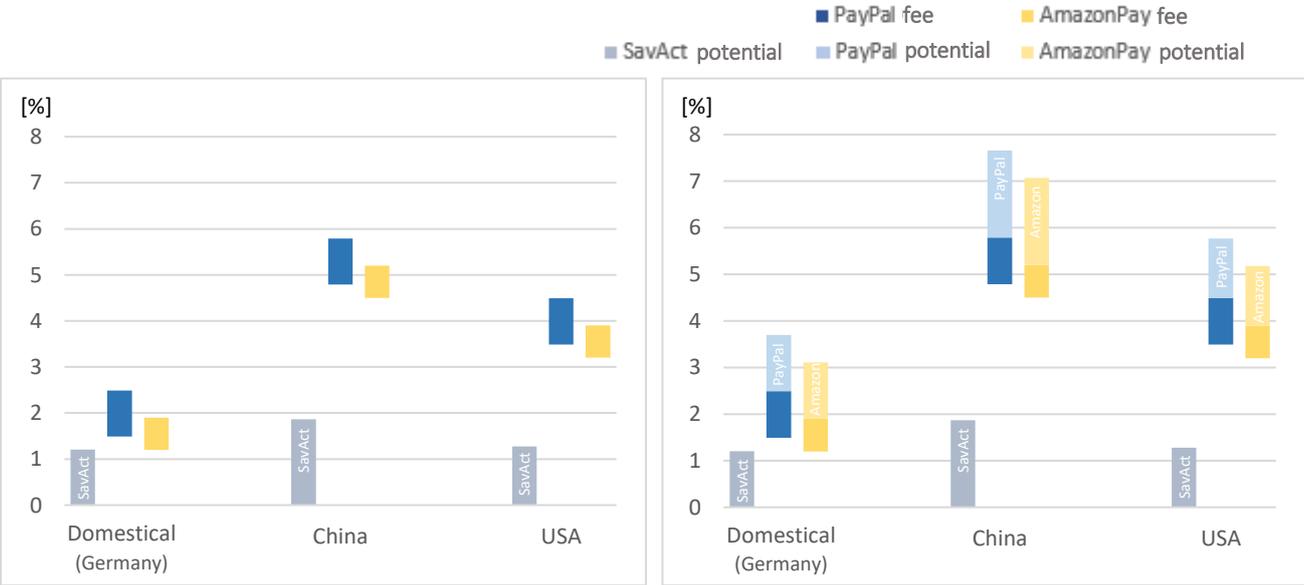
Graph 3: Cost range for sellers in present - Seller-oriented decisions.

Graph 4: Cost range of sellers in present - Buyer-oriented decisions.

The savings associated with using SavAct are evident in all domains. SavAct is particularly lucrative in cross-border transactions, as well as for sellers with a few thousand Euro monthly transaction volume.

| Seller location	Resulting savings through the use of SavAct instead of the respective systems			
	Absolute to PayPal (min. / max.)	Relative to PayPal (max.)	Absolute to AmazonPay (min. / max.)	Relative to AmazonPay (max.)
Domestical (Germany)	0,28% to 3,7%	67,3%	-0,01% to 3,11%	61,1%
China	2,92% to 7,66%	75,6%	2,63% to 7,07%	73,6%
USA	2,21% to 5,77%	77,8%	1,92% to 5,18%	75,3%

Table 6: Savings caused by using SavAct in comparison to trustee systems.

With trustee systems, there is an incentive to deceive in order to recover the payment (see "Relative Frequency P in Comparison"), which could lead to more cases of fraud. Accordingly, the potential losses when using trustees might be higher than shown in Graph 4. Likewise, SavAct's savings would be greater than indicated in Table 6.
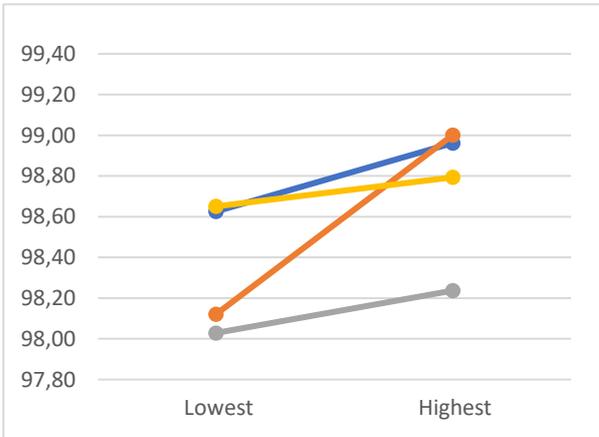
Addition:
Using the search options "Price + Shipping: lowest first" and "Price + Shipping: highest first" results in the average ratings represented by region in Graph 5 and Graph 6.
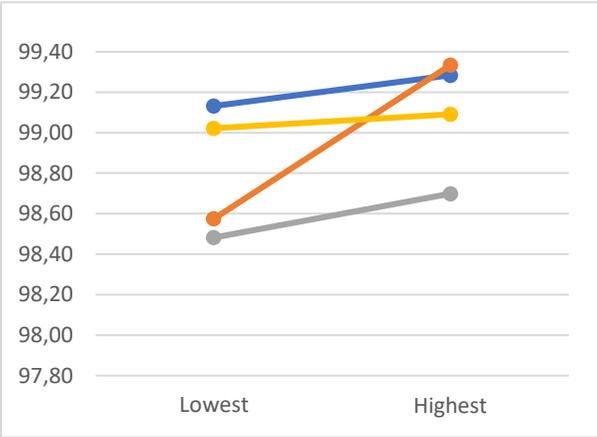
Graph 5: Positive rating according to eBay.

Graph 6: Positive rating with consideration of neutral ratings.

There is a slight tendency for sellers with the cheapest products to have a lower customer satisfaction compared to sellers with the most expensive products. Domestically, customers buying more expensive products are on average 0.33% more satisfied while China has a higher satisfaction of 0.21% and the USA of 0.14%. It is likely that on average the cheapest sellers save on factors that reduce customer satisfaction. These factors might be the quality of the products or the packaging. To confirm this assumption, a wider range of products would have to be used, the similarity of the products should be checked and the product quantity per listing should be taken into account.

Through SavAct, sellers are directly tied to their customer satisfaction and are therefore committed to consistently ensure the quality of their services.

From the seller's perspective, this is comparable to online shops which display the ratings of their customers. The frequency of negative ratings for the seller leads to lower sales and thus to loss of profits [NLJ-08]. However, it is not the aim of this study to determine how much customer satisfaction in online trading is increased by using SavAct and thus will not be further elaborated on.

It is possible that some customers rate negatively without any justification to harm sellers. With rating portals, buyers could give negative ratings in order to scare potential customers off. On the online trading platform eBay, the goods must be purchased before ratings can be given. These circumstances and their comparability with SavAct have been addressed in the section 'Relation to costs'. If such unjustified attacks have occurred in the data sets, they have been included in the calculation of the resulting costs of SavAct. Nevertheless, there still is a significant cost saving using SavAct compared to trustee systems (see Graph 4 and Table 6).
In the case of trustee systems, it is additionally possible to get the payment refunded despite the receipt of the goods. It is difficult to indubitably prove a malicious intention to a third party. The attacker could claim that the goods did not arrive, a wrong or even an empty parcel was sent. Particularly client-oriented trustee systems therefore represent a certain risk for the seller. Since trustee systems are nevertheless common, this suggests that such attacks are rare and do not cause major damage. When using SavAct, an attacker may receive the goods, but does not receive the payment back unless the seller explicitly agrees. This suggests that such attacks are even less frequent with SavAct than with trustee systems. In addition, there are some simple protection measures to prevent such attacks, which are explained by SavAct [SFA-19].

Conclusion:
SavAct provides an indirect buyer protection by making fraud unprofitable. This makes SavAct comparable to trustee systems, its extent of benefits apparent and eliminates possible concerns.

The frequency of punishments when using SavAct has been determined statistically. For this, a data set including more than 21 million ratings of about 2000 sellers in Germany, the USA and China has been gathered and evaluated. The resulting costs for sellers were compared to the costs that would occur when using the established trustee systems (see 'Reference to the costs').
All assumptions were intentionally chosen such that the values of SavAct are worse than they are expected to be in practice. Despite this, SavAct still shows significant cost savings compared to the established trustee systems, even when assuming their best conditions. The savings on international transactions are particularly high. Transactions to China result in cost savings of up to 75.6% and up to 77.8% when transferring into the USA. These savings should increase the willingness of sellers to offer SavAct as payment option and thus spread SavAct quickly. Due to competition, it is likely that the savings will be passed down to the customers by offering a lower selling price to the buyers.

Trustee systems are bound to governmental regulations due to their centrality and human decision makers. They annul essential advantages of cryptocurrencies [KAS-17] as they are not decentral, bound to government regulations, and at risk of being deceived. Consequently, no trustworthy and functioning buyer protection has yet been able to establish itself in the anonymous domain [BAN-18, EMP-18, PEA-18A, PEA-18B]. SavAct offers significant benefits, especially in the anonymous domain, due to its complete decentralization, its deterministic mechanism, and its resulting independence from third parties. The advantages for honest sellers and buyers, as well as the disadvantages for fraudsters promise a similar market success in this domain as the established trustee systems once did in the public domain.

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Appendix:

Complete data set of the study:
„PoC1_Dataset.pdf" (https://savact.com/PoC1_Dataset.pdf)