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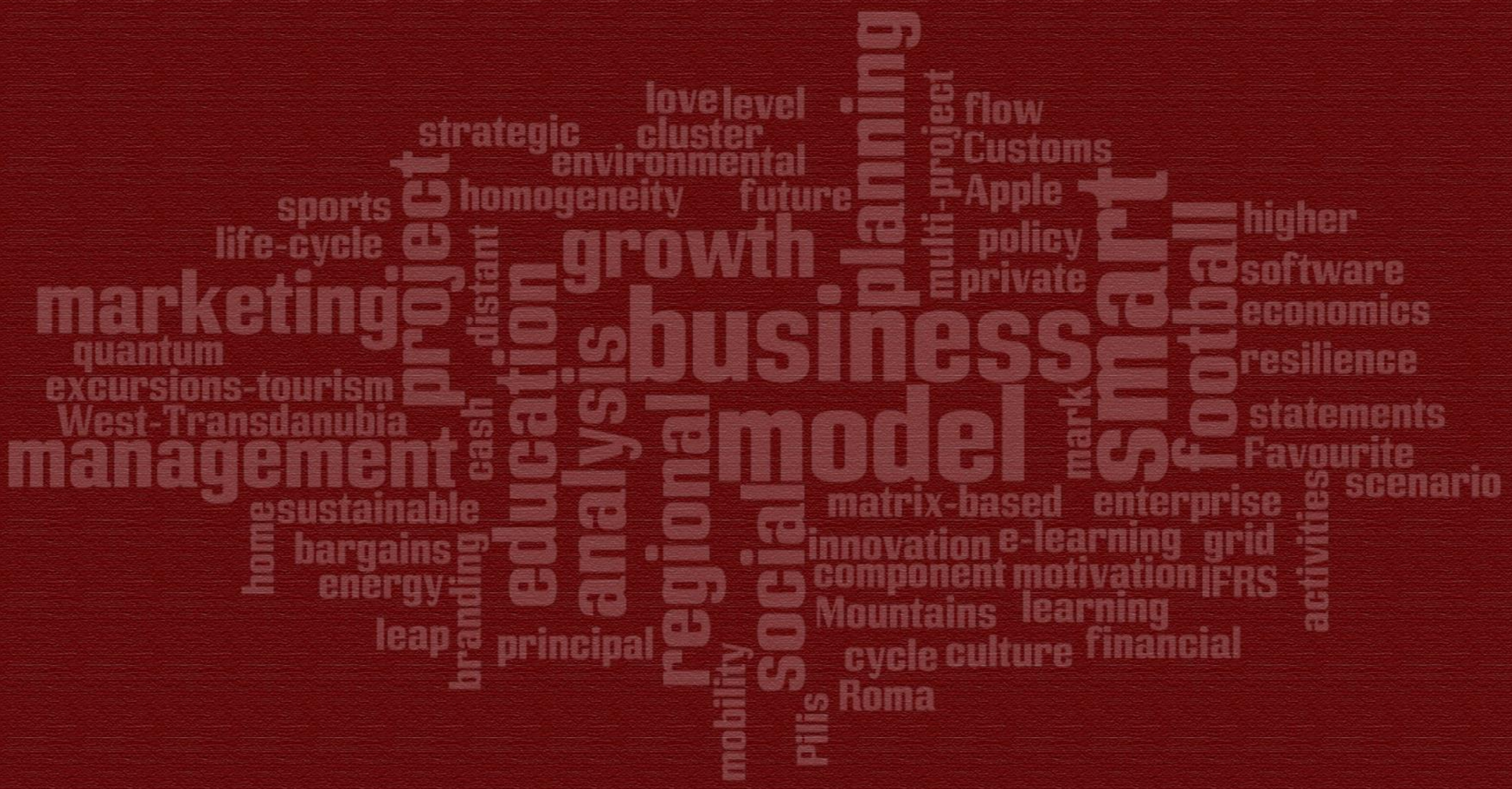

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Battling Transaction Costs: Establishing an e-Exchange System for Coaseian Bargaining[1]

Márton Szemenyei[2]

The role of Information Communication Technology (ICT) in environmental protection has become a significant topic in the last decade. Most existing ICT systems, however, don't go beyond the traditional role of distributing information to their users. Moreover, most of these software systems don't provide an integrated solution for several connected problems, which makes them hard to use.

In this paper we will explore the use of software in environmental protection in a top-down approach, starting with the basic problems of environmental economics, namely internalizing externalities. We will propose a system that will try to achieve this by providing solutions to significantly decrease the transaction costs of Coaseian bargaining, while also providing a platform for other types of tools.

The goal of this paper is to give an in-depth analysis of the proposed software. In order to do that, we describe the system in a non-technical, feature-oriented way, and analyze its most important functions. We will focus on establishing the requirements of the system based on the results of environmental and institutional economics. The most important part of our work is a detailed cost-benefit analysis of creating and maintaining the software, which includes the effect on the costs of Coaseian bargaining.

Keywords: environmental policy, private bargains, software
JEL Codes: Q01, Q58

Harc a tranzakciós költségek ellen: Egy e-tőzsde rendszer létrehozása coase-i alkuk számára

Az elmúlt évtizedben az infokommunikációs technológiák (ICT – Information Communication Technology) szerepe a környezetvédelemben releváns területté vált. A legtöbb létező ICT rendszer azonban nem emelkedik az információszolgáltatás hagyományos szerepe fölé. Ezen felül a legtöbb rendszer nem képes több, összefüggő problémára integrált megoldást nyújtani, ami meglehetősen megnehezíti a használatukat.

A tanulmány feltárja a szoftveres megoldások lehetséges szerepét a környezetvédelemben, egy top-down megközelítés segítségével. Ebben a megközelítésben a téma kiindulópontja a környezetgazdaságtan alapvető problémája – az externáliák internalizálása. A cikkben ajánlást teszünk egy rendszerre, amely képes a coase-i magánalkuk tranzakciós költségeinek csökkentésével az alapproblémát kezelni, miközben teret ad más eszközök alkalmazására is.

A tanulmány során a tárgyalt szoftver részletes elemzését végezzük el, melyhez először bemutatjuk a rendszer technikai részleteket mellőző, funkció-orientált leírását, valamint elemezzük a leglényegesebb szolgáltatásait. Az elemzés és a leírás során a hangsúlyt a platform követelményeinek megadására fektetjük, amelyeket a környezetgazdaságtan eredményei alapján állítunk. A munkánk fő része a szoftver létrehozásának és fenntartásának költség-haszon elemzése, amely a coase-i magánalkuk költségeire kifejtett hatásokat is magába foglalja.

Kulcsszavak: környezetszabályozás, magánalkuk, szoftver
JEL-kódok: Q01, Q58

1. This paper is based on 'Battling Transaction Costs: Establishing an e-Exchange System for Coaseian Bargaining' (Szemenyei, 2013) presented at the Economic Section of the 32nd National Scientific Students' Associations Conference where it was awarded First Place in the Session of Environmental Economics, Sustainable Development. The study was prepared under the supervision of Tibor Princz-Jakovics, assistant professor at the Budapest University of Technology and Economics, Faculty of Economic and Social Sciences.
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Introduction, goals

Sustainability is one of the key challenges faced by economies around the globe. It is generally recognized that efficient environmental policy is essential to preserve natural and artificial resources for future generations, while maintaining economic growth.

The main goal of environmental policy is to internalize externalities so that environmental factors may be considered in economic decision making. Usually, we consider two types of policy tools: Pigovian and Coaseian methods. Pigovian environmental policy (*Pigou, 1920*) relies on direct government intervention, such as the use of regulation or economic incentives that force agents to consider their impact on the environment. When using Pigovian tools, the government determines the optimal level of the use of nature and enforces it.

Coaseian policy on the other hand relies on private bargains of the affected parties to solve environmental issues (*Coase, 1960*). In this case the optimal level is determined and enforced by the parties themselves, the government only provides the infrastructure necessary to enable bargains. One of the main advantages of Coaseian policy is flexibility, since it allows parties to consider the peculiarities of individual situations. However, practical difficulties may arise during deal-making that may make bargains infeasible under real-world circumstances.

These difficulties are usually modeled by assuming that the costs of the bargaining process – the transaction costs – are non-zero, therefore the Coase theorem, which is the basis of the efficiency of private bargaining, doesn’t hold. Therefore in cases where transaction costs are considerable regulators are left with Pigovian alternatives. However, it is possible to reduce the transaction costs of bargaining thus making private deal-making a viable alternative. It is known that establishing legal and institutional infrastructures designed to aid bargaining can significantly reduce tranasction costs. A general distribution of property rights for many types of natural capital is often discussed as part of such an infrastructure.

In our work, instead of focusing on the institutional and legal part of such an infrastructure, we discuss the possibility of establishing a software platform that can tackle several essential practical and administrative problems that arise during bargaining. Our major argument for doing this is that in order to convince lawmakers to undertake such a monumental task practical issues need to be addressed first.

In this paper, we collect and discuss some of the major practical problems, and based on that we briefly describe the software platform needed to solve them by presenting its most important features. It is worth noting that our description of the software system will be a feature-oriented discussion free of technological details. We also perform a preliminary cost-benefit analysis in order to evaluate the efficiency of the proposed platform and to determine the possible social benefits of the system.

In the next chapter we introduce the theoretical background and difficulties of Coaseian bargains, focusing on transaction costs. We also present a few cases of private deals in the past and some of the existing environmental software systems. *Methodology* chapter is dedicated to presenting our methodology for creating the concept design of the software and for performing the cost-benefit analysis. In *The proposed system* chapter we discuss the concept of the software infrastructure and present some of the most important features in greater detail. Following that we present the results of the costs-benefit analysis and draw the necessary conclusions regarding the proposed infrastructure.

Background

In this chapter we discuss the theoretical background of private bargaining, by defining the environmental problem and stating the Coase theorem. We will then focus on transaction costs and examine the factors that influence these costs. Then, to complete the discussion we present a few relevant cases for private environmental bargains. Lastly, at the end of the section we give a brief overview of the existing environmental software systems and highlight some of their shortcomings.

A good definition of the environmental conflict can be found in *Table 1*, which divides the problem into two types: source, and sink type conflicts. To make things simpler, in the rest of the paper we will only discuss sink-type problems. This can be done without loss of generality, since source-type problems can be modeled as the emission of "economic/environmental antimatter" which destroys natural resources.

Table 1: Environmental Conflicts

Source Problems	Sink Problems
By accelerating consumption of ecologically neutral, non-renewable natural resources, causing them to run out, we hurt future generations.	By emitting pollution or waste we damage the health of the ecosystem.
By expropriating resources that play a role in ecological systems, we damage the ecosystem.	This pollution can also damage human health and artificial capital.

Source: Bartus & Akos, 2012

It is generally accepted that market failures, most commonly externalities are responsible for the existence of these conflicts. Therefore the aim of environmental policy should be to internalize externalities, in turn making the market closer to efficient. Coaseian policy tools rely on the Coase theorem which states that if the rights of the parties are established ex ante, and the transaction costs are zero, then the private bargain between parties will achieve an optimal result (*Bartus & Akos, 2012*). It can be argued that the first requirement is unnecessary, since if rights are not known, then effort and money has to be spent to establish them, therefore transaction costs cannot be zero.

There is a stronger form of the theorem, which states, that is in addition of the two previous conditions, there is no effect on the wealth of the parties, than the private deal will be pareto optimal and invariant to the initial distribution of the rights. Of course there still may be differences between outcomes regarding the distribution of wealth and social justice.

A major critique of the theorem is that transaction costs are hardly ever zero, which makes the theorem irrelevant. True, in cases where the costs of bargaining are higher than the possible gains of a successful deal, the outcome of the bargain will not only be suboptimal, but actually nonexistent, since the parties will choose not to negotiate. Still, this critique misunderstands the point of the theorem. It is not meant to be an interesting thought experiment inspecting an unrealistic world, but an argument for recognizing the significance of transaction costs (or a Coase first called them "the costs of using the price mechanism" (*Coase, 1937)*).

In this light the theorem provides us with a way to implement successful environmental policy without direct government intervention and its classical pitfalls: enabling private bargains by reducing transaction costs. However, in order to achieve this we must understand transactions costs and the factors and variables that determine their magnitude. These factors can be divided into two groups: behavioral attributes and transaction attributes.

Behavioral attributes, such as bounded rationality and opportunism are attached to the bargaining parties (*Williamson, 1998*). As discussed by Brad DeLong (*DeLong, 2013*), the latter can be a serious hindrance in bargains, especially if coupled with unwise distribution of property rights. On the other hand, transaction attributes are tied to the situation or the bargain itself. These factors include uncertainty and frequency of the transaction which influence transaction costs through relatively straightforward mechanisms (*Williamson, 1981*).

The factors considered to be one of the most important by Williamson is asset specificity. (*Williamson, 1981*) In such situations one of the parties is in possession of a unique asset that is required for the bargain. This asset can be knowledge, a specific skill or expertise, or more commonly in the case of environmental issues a specific location. The party in possession of the asset will be in a monopolistic situation which (coupled with opportunism) may result in a serious increase in transaction costs. A final problem that is common in case of environmental issues is the presence of too many parties at the bargaining table. A simple case of air pollution can involve several towns, each with thousands of citizens. In this case dealing with each of them individually is simply impossible.

In order to illustrate the difficulties of Coaseian bargaining we provide two cases of bargains. The first is the relatively recent dispute between the government of Újpest and the organizers of the Sziget festival. The major of Újpest attempted to get the organizers of the festival to reduce the noise pollution caused by the loud concerts. What followed was several years of litigation which the government eventually lost, after the ruling of the Appeals Court in 2009. Following that, the new major managed to bargain with the organizers which eventually resulted in the organizers agreeing to reduce noise levels by rearranging stages and other methods. (*zipp, 2011*) Even if the bargain was successful in the end, it can be argued that with the proper distribution of rights and a bargaining infrastructure the court battle would have been avoided.

The other, lesser known case is the construction of a hazardous waste incinerator in the town of Garé. (*Bartus, 2006*) In this case the townspeople managed to reach a deal with the contractor company that was responsible for the building of the incinerator. The deal contained measures to minimize the risks the town's citizens were facing. They, however, failed to include the citizens of neighboring villages who would also have been affected by the project. Eventually, a negative campaign against the incinerator succeeded in stopping the project. Here, the problem is much clearer: the insufficient information about *whom* the incinerator would affect and *how* resulted in an inappropriate deal.

In the final part of this chapter we present a short overview of the environmental software systems available today and discuss their key shortcomings. The most common environmental software systems are environmental and/or pollution databases. There are several national sites, such as OKIR (*OKIR, 2015*) or TEIR (*TEIR, 2015*) in Hungary, or PortalU (*Konstantinidis, Kruse, Klenke, 2009*) in Germany, while there are also a few higher-level databases, such as CEIP. Another project worth mentioning is the INSPIRE (*European Comission, 2015*) directive, which establishes an EU level spatial database, however, at the time of this writing it is not completed yet.

One can find tools for certain tasks required for bargaining, such as pollution propagation estimation (*Vibrocomp, 2015*), monitoring tools (*Schabauer, Schimak, Dünnebeil, Litzenberger, 2012*), or attempts at automatic evaluation of certain aspects of the state of the environment (*Steuer, Kunert, Schulz, Schilcher, 2010*). It is worth noting that these tools are fragmented, there is no "do it all" system that would grant users access to every required tool, and there is no solution for guiding the user through the steps of the deal-making process. Most of the information systems mentioned above suffer from poor usability and they provide little or no explanation for the effects that certain pollutant might have and no information about the severity of the pollution.

Methodology

In this chapter we detail our methodology to assess the feasibility of the proposed software system. In order to do that, we perform the cost benefit analysis, while we also estimate the social costs and benefits of establishing the ICT and the institutional infrastructure. However, in order to determine these costs and benefits at least the basic design of the proposed system needs to be known. Since the necessary features of the system have not been determined yet, we use an agile software design methodology called the Rational Unified Process (RUP) to provide an initial design of the system that can be used for later estimates. A few key details of this design are discussed in *The proposed system* chapter.

In our analysis, we consider the costs of creating and maintaining both the software system and the necessary legal/institutional infrastructure. Similarly, the social benefits of lower transactions costs are also estimated and included in the cost-benefit analysis. In order to collect all parts of the costs we employ a transaction cost typology used in institutional economics (*McCann, Colby, Easter, Kasterine, Kuperan, 2005*). Here, transaction costs mean the costs of institutional change. (*Barbier, 2011*) The typology used and the actual cost types are shown in *Table 2*.

Table 2: The transaction Cost Typology

Types of Transaction Costs	Actual Parts of Costs
Research and Information	Data Collection
Legislation	Passing Legislation
Design & Implementation	Development & Maintenance Server Upkeep Carbon Emission Caused by the System
Support & Administration	Legal Support Administration
Contracting	Benefits from lower bargaining costs Ad Revenue
Monitoring Detection	Costs of extra monitoring equipment
Prosecution/Enforcement	No change in costs

Source: own edition

For a fair share of the costs above, the average number of monthly users of the system is a key determinant. Therefore, in order to give valid estimates of these costs, the number of users has to be determined as well. We project the number of monthly users based on existing web pages with similar functionality, namely Ügyfélkapu, the e-government portal of the Hungarian government. From this data, we derive a pessimistic, a realistic and an optimistic estimate and calculate the costs and benefits for all three cases. In addition to this, we also provide projections of the costs and benefits for both a Hungary-only and an EU-level application of the system. Our estimates for the number of users, as well as several other key assumptions are shown in *Table 3*.

Table 3: Key assumptions

Length of estimation:	10 years
Discount Rate:	5.5%
Minimum Monthly Users	20,000
Average Monthly Users	100,000
Maximum Monthly Users	200,000
Minimum Monthly Users (EU)	1,000,000
Average Monthly Users (EU)	5,000,000
Maximum Monthly Users (EU)	10,000,000

Source: own edition

It is important to note, that our estimates have high uncertainty, while the risks of erring on either side are not symmetric. We believe that in this early phase, overestimating the benefits is the more severe error, therefore we increase our estimate of total costs and decrease the benefits by 50% to arrive at a more conservative projection.

The proposed system

In this chapter we provide a short description of the proposed software system and some of its most important functions. The design of the system itself was created using the Rational Unified Process, which is an iterative and incremental software design process. This means that first the coarse outline of the system is set up and filled with more detail at every step. At the first stage the general vision of the system is established and its functionality discussed.

We establish functional requirements by collecting the most relevant practical issues we see with private bargaining and attempt to devise a feature that is able to treat the particular problems effectively. Our vision is an internet portal that connects possible parties and provides them a workflow that guides them through the step of the deal-making process and tools to aid them at step. The key steps are collecting information, bargaining and contracting, and monitoring. The main issues and features to solve them are presented in *Table 4*.

Table 4: Obstacles and requirements designed to overcome them

Obstacle	Requirement
It is hard to find all information about the quality of one's environment in one place.	Users should be able to access understandable environmental information including effects
It requires a large effort to understand the particular effects that pollution has on someone.	
It is hard to find the source of the pollution in one's property.	Users should be able to link pollution to the source with one click
It is difficult to find out what one can do to reduce the pollution in his or her property.	Users should be guided through the bargaining process by a clear workflow
	Users should be able to search environmental information about products, and green technologies
There is no established infrastructure for negotiating and striking environmental contracts.	Parties should be able to use computer-aided negotiating and contracting
	Users should be able to access e-Exchange system for emission permits from within the system
In the case of new economic activities the process of impact assessment, and/or authorization can be long and expensive.	The administrators should be able to perform quick computer-aided propagation estimation and impact evaluation
If many are affected by a pollution, then negotiation will be very expensive.	Users should be able to form groups and enter negotiations as a group
	Users should be able to access group decision aiding services

Source: own edition

The first core feature to discuss is providing understandable information, where users can access environmental data on a map-based service. There are several important steps towards making information understandable for users who possess no expertise in environmental protection. The first is to always display real-world effects of the pollution users are exposed to. The second is to let the users choose the level of detail that the system uses to display information. This way the users can fine-tune the information they are presented. A further integral part of providing information that users must be able to connect the effects they endure with the cause of those effects easily.

The second main function of the software platform is contract creation. This is a relatively difficult task that usually requires the involvement of lawyers. This, however raises transaction costs significantly. Still, it is possible to handle this difficulty: The system may provide intelligent contract templates that can be easily filled with specific information and turned into a complete contract using document automation software. Such templates can be made for most common situations thus virtually increasing the frequency of transactions. Advanced users may also access intelligent contract elements that they can use to build new templates usable for less common scenarios. Using this solution lawyers are needed only to provide support and to handle peculiar cases.

The last key requirement to discuss aims to solve the problem of too many parties mentioned in *Background* chapter. The software allows users to form groups and enter negotiations as groups thus reducing the number of parties at the bargaining table. However, if we leave it at that, the feature will only hide the problem: the difficulties caused by too many parties will simply happen inside the group. Therefore it is essential to supply groups with decision-making tools to aid them in reaching a unified stance. To achieve this users need to have access to individual decision support methods, such as the ones discussed in (*Fülöp, 2004*). In addition to that, group decision support software is also required to provide means of communication and voting for users. A viable candidate for a group decision support system is Dotmocracy (*Nash – Diceman, 2010*), which allows users to discuss and rate ideas, while also giving them opportunity to voice concerns or offer alternatives.

Results

In this section we present our estimates for the costs of the ICT and the institutional infrastructure. We have already introduced the individual cost types in *Methodology* chapter, here, we will give a short description for how we estimated each part. For a more detailed derivation of the estimates, please refer to (*Szemenyei, 2015*).

We begin our discussion with the estimates of the costs related to the software infrastructure. The first part of the costs is development and maintenance costs. In order to determine the costs associated with these activities, we collect the detailed functional requirements (use cases) of our system, and use the methodology provided by (*Carroll, 2005*) and (*Jones, 2006*). Another important part of the ICT infrastructure costs are server expenses. To determine these costs we first need to estimate the amount of traffic our system would produce and the number of servers that can handle the estimated traffic. Once that is done, we can use estimates of the 10-year TCO of servers (*APC, 2005*) to derive the costs.

The last important part of the software-related expenses is the cost of carbon-emission caused by the servers. To derive these costs, we use the aforementioned estimates of the data transmission caused by our system, and use the following results (*Taylor – Koomey, 2008*) to estimate the resulting carbon emission. There is one more category of costs that should be discussed here, despite not being part of the software system in a strict sense, and that is the cost of mobile measurement units. Here, we only consider the costs of mobile computer systems that record and transmit the measured data, and exclude the costs of the measurement devices themselves. The reason for this is that the extremely wide variety of pollution makes this estimate problematic, and far beyond the scope of this paper. Luckily, giving an estimate of the number of mobile units needed is enough to estimate of their costs.

The other large group of costs are expenses related to the implementation and maintenance of the legal and institutional infrastructure required by the system. The first part of these costs are legislation costs. Here, we assume, that in order to implement the system, an average-sized law needs to be passed by the Hungarian or the European Parliament. We estimate the cost of passing a law by using the methodology described in (*Wilson, Nghiem, Foster, Cobiac, Blakely, 2012*). The other part of the implementation costs is related to data collection. To estimate these expenses, we give a man-hour projection of the effort required to collect several kinds of data required by the system: spatial, environmental, and impact assessment data.

The maintenance of the infrastructure is also a crucial part of the costs. Here, we consider two important types of costs: administration costs and expenses of providing legal support for users. Both of these costs depend heavily on the number of monthly users, and the number of transactions they initiate, therefore an estimate for the number of transactions is required. With that, by estimating the administrative and supporting effort per transaction, the total cost can be calculated.

The single financial benefit of our system is revenue from ads displayed by the system. Here, we consider two types of advertising. First, the system could display ads aimed at the general population. Secondly, green technology companies could use the system to recommend their solutions to other parties currently engaging in negotiation. To estimate the ad revenues of the system, we use the following online model (*MarginHound, n.d.*). Our final estimates for the costs of the infrastructure are shown in *Table 5* below. The social benefits of the system will be estimated in the second part of the section.

Table 5: The total financial return of the system (in 1000s of dollars)

Number of Users (1000)	**20**	**100**	**200**	**1,000**	**5,000**	**10,000**
Development & Maintenance	$924	$924	$924	$1,445	$1,445	$1,445
Server Costs	$76	$96	$153	$688	$3,441	$6,882
Data Collection	$55	$55	$55	$1,859	$1,859	$1,859
Carbon Emission	$11	$55	$111	$561	$2,798	$5,594
Legal Support	$271	$271	$271	$4,237	$10,593	$21,187
Legislation	$507	$507	$507	$1,298	$1,298	$1,298
Administration	$116	$116	$232	$1,816	$8,717	$17,252
Motes	$49	$49	$49	$3,214	$3,214	$3,214
Ad Revenues	$307	$1,537	$3,075	$15,376	$76,883	$153,767
Total Return	**-$1,704**	**-$538**	**$768**	**$256**	**$43,515**	**$95,032**

Source: own edition

The second part of this chapter is dedicated to the quantitative assessment of the social benefits of lower transaction costs. We will begin by examining the effect on a single transaction by breaking down the bargaining process into functional units and estimating the effort required for each unit before and after the system was established. We will then use our previous estimate of the number of monthly transactions to compute the total social benefits. The effects on a single transaction and the total social benefits are shown in *Table 6* and *Table 7* below. For a detailed discussion of these estimates, please refer to (*Szemenyei, 2015*).

Table 6: Our estimates for the effort of one bargain with and without the systems assistance

Activity	Effort Without (man-hours)	Effort With (man-hours)
Find information about pollution around you	0.5	0.1
Find parties to deal with	4	0.05
Find alternatives	8	0.5
EIA or other assessment	32	0.5
Effort spent Negotiating	20	6
Effort of making a decision	20	6
Lawyer costs of making a contract	17.6	0.01
Litigation costs	11	1.1
Costs of reporting a problem	0.5	0.1
Administrative costs of monitoring a deal	2	0.1
Total	**116.1**	**14.46**

Source: own edition

Table 7: The total 10-year social benefits of the system (millions of dollars)

Number of Users (1000)	20	100	200	1,000	5,000	10,000
Total 10-Year Social Benefits	$21	$106	$213	$1,668	$8,341	$16,682

Source: own edition

Conclusion

In this paper, we discussed the importance of tackling some of the important practical problems that arise during private bargaining. We argue that a way to make general bargaining feasible is needed before the distribution of property rights is discussed. We began our discussion by exploring the literature of transaction costs and by presenting existing environmental software. We then presented our proposal for an ICT (Information and Communication Technology) platform that can make private deal-making feasible by decreasing transaction costs. We completed our analysis by performing a cost-benefit analysis that gave a preliminary estimate on the 10-year social return of the software infrastructure.

We have been successful in providing features that are powerful tools to mitigate the practical problems we collected. Therefore, we conclude that the software platform is likely to provide a significant decrease in the costs of bargaining. Our own cost-benefit analysis has shown that the social return of the ICT infrastructure is likely to be positive. Our investigation has been fruitful, since we were able to find solution to most (but not all) problems of bargaining. It goes without saying that the we do not claim that a software can solve all the difficulties of deal-making, since the existence of other types (legal, institutional, etc.) of infrastructure are essential to the success of our proposal. The cost-benefit analysis was performed assuming that the distribution of rights has been completed (and it is included among the costs). Without that the efficiency of the software would be greatly diminished, however the information providing feature would still be a significant improvement to current conditions.

Based on our result, we recommend further investigation of the role of software systems in environmental protection. It is likely that there are other features and possibilities that are worth including in a general environmental platform. Also, by further refining the requirements of the system will increase the accuracy of the development costs, while many of our estimates in the cost-benefit analysis require further consideration.

Also we have not discussed the legal and institutional infrastructure required by our system in depth. Still, these are topics that require a significant amount of consideration. There are several possible methods for distributing property (or emission) rights which differ greatly in terms of efficiency and social justice, something we avoided in this paper. We have also avoided discussing the macroeconomic effects of large-scale private bargaining. A short discussion can be found in (*Szemenyei, 2015*).

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