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Grado en Economía
Curso 2020/2021

TRANSACTION COSTS IN DUERO RIVER BASIN; A LONGITUDINAL STUDY

Conducted by Juan Mejino López

Supervised by the Professor Carlos Dionisio Pérez-Blanco

Salamanca, 13/07/2021

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El Tutor autoriza la presentación del Trabajo	El Estudiante desea realizar la presentación del Trabajo
PEREZ BLANCO CARLOS DIONISIO - 70881953R Firmado digitalmente por PEREZ BLANCO CARLOS DIONISIO - 70881953R Fecha: 2021.07.14 10:53:22 +02'00'	Firmado por Juan Mejino López el día 13/07/2021 con un certificado emitido por FNMT

Contents

Tables and Figures

ABSTRACT

Given the fact that a global water crisis has already started and it will get worse due to factors such as population growth or climate change, new transformational water reallocation solutions will be needed within the institutions related to water management. Transaction costs measurement will have to be added up to conventional abatement costs in order to pursue an accurate and more complete analysis about the efficiency and public performance of water institutions.

The focus of this study is the analysis of the institutional transaction costs involved within the CHD (Confederación Hidrográfica del Duero), the water management institution for the Spanish Duero River Basin. Therefore, a literature review covering the theoretical and empirical framework has been applied to the creation and econometric analysis of our own database for the period of 2004-2021. The results obtained give us insights about the structure and characteristics of the institutional transaction costs involved over this period. Nevertheless, further research needs to be done in order to assess more accurately possible trends and paths which may be followed by the institution in the coming decades.

Key Words: Institutional Transaction Costs, Water Management, Adaptive Efficiency.

1. INTRODUCTION

The world is facing a global water crisis which will get worse in the future given factors such as population growth or climate change; by 2030 demand will outstrip supply by 40%, causing drops by up to 6% of GDP in water scarce areas such as Mediterranean basins (2030 Water Resources Group, 2019). The incoming problems will have to be faced through transformational water reallocation policies, i.e., systemic (much larger scale) and/or paradigm shifts (truly new to a particular location) in water resources management that mitigate socioeconomic impacts from supply-demand imbalances. Yet, as water scarcity problems mount, the adoption of transformational adaptation policies remains elusive. A major reason is that the world is facing a "monumental challenge" in overcoming institutional rigidities (Barbier, 2011). While traditional neoclassical economics argues that incremental efficiency improvements in economic exchanges are sufficient to drive the adoption of superior allocations, applied studies show that the path-dependent increasing returns to adopted institutions and related technologies may require up to an order-of-magnitude improvement in economic performance to induce transition (Loch et al., 2020; Unruh, 2002). This reveals additional costs to policy reform in the form of institutional *transaction costs*, which add up to conventional neoclassical *abatement costs*.

Traditionally, mainstream neoclassical economics has assessed adaptation costs through changes in supply and demand conditions of the markets where the relevant commodity is traded (e.g. abatement costs). However, new institutional economics (Arthur, 1994; North, 1990) has led mainstream economics to accept the importance of transaction costs when policy performance or policy options comparisons have to be assessed. Our research focuses on the analysis of institutional transaction costs, which are defined here as the institutional (rules and regulation capacity) and organizational investments (people and knowledge capacity) required to arrange a resource reallocation ex-ante, and then monitoring and enforcing it ex-post, as opposed to the more conventional abatement costs (also referred to as production or transformation costs) which are the costs of executing the reallocation (Matthews, 1986).
Applying the methods and theoretical framework found within the literature, we obtain the different characteristics and possible future trends to be followed by the transaction costs involved in the institution analysed.

2. LITERATURE REVIEW ON INSTITUTIONAL TRANSACTION COSTS

Since the middle of the 90s-decade, TC research has grown in a considerable and permanent rhythm (see figure 1) developing new theories and research questions and opening a broad sphere of research. Two categories of transaction costs are typically considered: private transaction costs and institutional transaction costs.

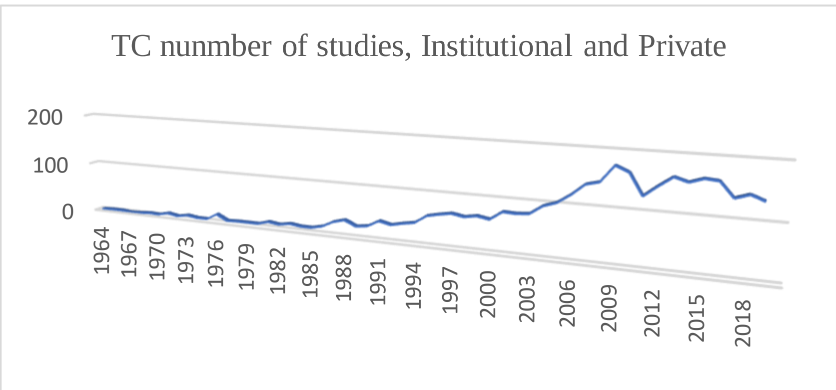

Figure 2.1, source: own elaboration with data from Recursos Científicos FECYT

Private transaction costs involve search and information costs, bargaining costs and policing and enforcement costs incurred in economic exchanges (Williamson, 1998). Private transaction costs measurement can add realistic features to the characterization of micro-level decision making in socio-ecological systems such as human-water systems, particularly where systems dynamics involve collective action or economic trades (Garrick and Aylward, 2012). Available measurements focus on water markets in the US and Australia and suggest private transaction costs may inflate trading costs from 6% (Colby, 1990) to more than 35% (Fang Feng et al., 2007). Nevertheless, although they are relevant for design and evaluation of policies, "very few studies have investigated the impacts of private transaction costs over time" (Loch et al., 2018).
Institutional transaction costs include: 1) administering, monitoring, contracting and enforcing current policy arrangements (termed *static transaction costs*); and 2) periodically designing, enabling, implementing new management arrangements and/or transitioning existing management arrangements (termed *transition costs*); where 3) transaction cost investments are also affected by previous policy or institutional choices which may enhance or constrain future selections (termed *technological and institutional lock-in* costs) (Marshall, 2013). Recent research has monetized the institutional transaction costs of water policy reform in the US and Australia, finding that transaction costs can represent up to 30% of abatement costs (Crase et al., 2013; Garrick et al., 2013; Garrick and Aylward, 2012; Loch and Gregg, 2018; Martin et al., 2008; McCann and Easter, 1999; Pannell et al., 2013). Yet, the empirical base on institutional transaction costs of water policy reform elsewhere is virtually non-existent (Gomez et al., 2017). Moreover, in those areas where transaction costs data are available, studies usually do not quantify them over time, which complicates the use of time series analysis to prognosticate future performance (Loch and Gregg, 2018).

The limited evidence available on transaction costs calls for additional studies that collect, measure, and monetize the economic costs of frictions in economic trades (*private transaction costs*) and institutional reform (*institutional transaction costs*), so to assess policy feasibility and develop strategies to minimize future transaction costs. Our study bridges this gap by implementing the first institutional transaction costs assessment of water policy design in Spain.

2.1 Relevance of Institutional Transaction Costs

The influence of New Institutional Economics has led mainstream economics to consider the importance of institutional transaction costs (Arthur, 1994; North, 1990) and applied research has been conducted to monetize these costs in Australia and the US (Garrick et al., 2013; Loch and Gregg, 2018; McCann and Easter, 1999).

Why should we measure institutional transaction costs? To begin with, we must consider transaction costs together with abatement costs in order to compare alternative water reallocations and assess policy performance through frameworks such as cost-effectiveness. Otherwise, we would underestimate costs and have a partial understanding of the system and misleading policy recommendations (Loch and Gregg, 2018).

Secondly, institutional transaction costs are needed to understand institutional adaptability and policy feasibility. Existing technologies and institutions can constrain the range of transformational policies that can be adopted through institutional lock-in (Seto et al., 2016). In the context of water resource management under scarcity, lock-in refers to the inertia of conventional supply-side policies due to the mutually reinforcing physical, economic and social constraints that emerge from existing technologies and institutions. Water resources management is particularly prone to the lock-in of conventional water-supply policies due to large capital investments and long infrastructure lifetimes. The combined interrelationships between technological systems and basins' institutional matrices typically result in a self-referential system whose value increases with the growth of the "techno-institutional complex" (Unruh, 2000). In this regard, longitudinal information of institutional transaction costs is instrumental to understand whether we are investing in 1) trajectories with large transaction costs in which past decisions constrain future policy options (transaction costs increase) or 2) trajectories with high institutional flexibility (adaptive efficiency) in which reforms allow for relatively lower transaction cost-intensive policy adoption (transaction costs plateau and/or decrease) (Garrick, 2015). ***Garrick (2015) associates adaptive efficiency with "three performance indicators: 1) how well the objective(s) have been met (i.e. effectiveness); 2) the average public transaction costs per unit of the met objective(s); and 3) total program budgets". For an adaptively efficient institutional complex, these three performance targets should be "increasing, decreasing and sufficient", respectively (Garrick, 2015).***

2.2 Measurement problems and empirical evaluation constraints

Despite a growing number of theoretical contributions, the measurement of transaction costs is usually challenging and limits the comprehension of them Loch (2018). As it is noted by Garrick (2013), TC, particularly those related to environmental economics, are incomplete, defined for their complexity, and also the uncertainty of environmental problems.

TC are usually not accessible, and are difficult to obtain in order to do empirical research. Surveys, interviews and secondary data usage are the three main ways of retrieving transaction costs data during analysis which make TC data collection expensive and the data base creation not accessible.

Once our variable has been defined, we may proceed to measure it. As stated by Williamson (1998), realizing that TC matters is not enough, incorporation of them into empirical analysis is needed.

Notwithstanding, we face many difficulties in order to carry empirical studies due to the lack of measurement techniques.

Different fields of economics have developed empirical and measurement treatments, this is not the case in terms of TC however. We have not developed a systematic treatment of the issues involved, McCann (2005).

Together with the broad definition and complexity, different issues appear once their measurement is needed such as lack of studies and then few applications to Transaction Cost data. As per the spatial dimension, the empirical base on transaction costs of water reallocation reform outside the US and Australia is virtually non-existent (Njiraini et al., 2017). As per the temporal dimension, in those areas where transaction costs data is available, studies usually do not quantify them over time. The development of a proper empirical evaluation is hence complicated.

3. CASE STUDY

The Duero River basin is the biggest basin in terms of surface area in the Iberian Peninsula. It has 98.400 square km, 78.952 out of them belong to the Spanish part, controlled by Confederación Hidrográfica del Duero (CHD). It is mostly present in the region of Castille and León, 96.12% out of the total surface belonging to Spain.

Although the institution is responsible of many different tasks, we may discern the next objectives which are fixed in the TRLA (Texto Refundido de la Ley de Aguas) for every basin institution in Spain.

1) The elaboration of a hydrologic planning together with its monitoring and revision.

2) The control and administration of the public hydrologic domain.

3) The administration and control of the general interest which affects more than one Autonomous Community.

4) Project, construction and infrastructure usage of those infrastructures belonging to the organism and those mentioned by the State.

5) Other infrastructures derived from region, local corporation or particular treaties.

Following these aspects, the CHD has certain general goals such as the good quality and state of water, increase water availability, maintain demand satisfaction, environmental protection or alleviating the effects of floods and droughts. In particular, for the last objective, many different measures have been taken in the last lustrums; the drought plan as well as different systems and bodies were developed in order to minimize the effects of droughts.

Specifically, drought management is considered as an important part of the hydrologic planification, having its own dependent plan. This the case of floods as well. Droughts are measured through the global drought indicator of the basin which is divided in 4 distinct states: normality, pre-alert, alert, and emergency. Each of these situations involves different measures which are taken by the institution management in order to minimize the effects of a possible drought and try to assess the best possible solutions together with the stakeholders involved in the Duero River basin. As these measures imply meetings and other kind of decisions, it is likely that they will be a source of institutional transaction costs.

All the measures developed by each plan play an influence on the economic activities surrounding this area such as agriculture or energy production. In fact, a macroeconomic analysis is also developed by the hydrological plan in order to account its effects on employment, agriculture, electric energy (20% of hydrological electricity in Spain is generated in the basin) and public policies.

The Duero basin produces around 5% of the total GDP of Spain and it has followed a positive growth trend until the financial crisis of 2008 with an annual growth around 7% per year. Its economic structure is similar to a developed economy with the service sector leading the value of production and level of employment followed by industry and the primary sector. The annual productivity of each sector follows the same pattern. With respect to the demographic situation, a negative trend may be seen during the last decades with a prevision of remaining at the same tendency.

Focusing on agriculture, the droughts suffered by the basin may imply a considerable economic lose and impact (even though primary sector is the smallest one it implies an important part in the economy of the region; 5% of GDP). This factor explains the importance given to this aspect through the permanent drought body and the system of drought indicators which determines the usage of water.

The number of areas and people affected by droughts have increased by 20% in the EU since 1976 and the economic costs are estimated in €100 billion; these problems are particularly growing in the south of Europe; Mediterranean basins such Spain. Only in the Duero River basin, 4 periods of extraordinary drought have been produced since 2002.

Given the fact that economic problems are increasing and could turn even worse, transformational institutional solutions and responses are needed if the problem is wanted to be solved. On the other hand, drought management will imply water and other resources reallocations which will affect agriculture and the sectors stated before. It is likely that these reforms and structural changes will involve a high level of transaction costs.

4. METHODS

4.1 Framework

Our research studies the time series of 2004 to 2021 (both years included) and takes into account primarily the Institutional Transaction Costs found amongst the previous goals developed by the CHD. Due to data unavailability a time constraint was found, the temporal framework could not be longer as data before 2004 is not completely stored and could not be retrieved through the study methods.

In order to understand the dynamics and trends of the costs, firstly, we need to comprehend the importance and evolution of the hydrologic plans carried by the CHD.

To begin with, the first hydrologic plan was approved in 1998 and remained until 2008 just before the modern plans started working. This constituted an important development of infrastructures and measures. Nevertheless, due to the lack of data stored together and non-uniformity of the existent one, the first years of the period (until 2003, included) could not be studied by our research.

From 2009 on, modern plans began working and improved some issues such as data storage and data uniformity. We may distinguish three different plans since then, two of them already enforced, and the last one starting in 2022.

*2009-2015

*2016-2021

*2022-2027

These plans are the key part of the planification and they detail every aspect and reform which will take place over the Duero River basin. Within them we may find the hydrologic characteristics of the basin updated to each year such as the water usage and water demands of the basin, water restrictions, protected areas, environmental objectives or the programme of measures to be enforced.

Together with these plans, a scarcity programme was also developed in 2007 and it took importance until 2016, when its functions were replaced by the general plan.

As we will see during the empirical analysis, these periods are of vital importance due to their influence of TC dynamics. Aspects such as monitoring or designing carried by the water authority are directly influenced by these plans. The scarcity plan of 2007 is also a source of TC due to meetings and activities carried by an institution created specifically for problems related to scarcity.

Using the theories and methods stablished in the literature, a new database was created in order to measure TC involved in the institution. The structure and development of this database is explained in the following paragraphs.

This is the first database of Institutional Transaction Costs created in Spain related to Water management and particularly to this Confederation. It gives us the opportunity of fixing existing gaps in the field such as the lack of longitudinal research. Additionally, it may start a source of new TC studies in Spain and in the field of environmental economics.

4.2 Types of Transaction Costs and Database development

Following Thompson (1999), McCann developed a framework already commented for analysing Transaction Costs. Additionally, there are works carried by Marshall (2013) and Garrick (2015) together with Ofei-Mensah (2013) which provide us with a TC definition structure. Firstly, we may distinguish between costs involved before and after the transaction, ex-ante and ex-post. All of them together constitute Total Transaction Costs which may be further classified as static transaction costs, institutional transition costs and institutional lock-in costs (see definitions section). Taking into consideration this structure, we may add the sub-costs involved during the last classification giving the area they below in brackets.

a) Research and Information (Transition Costs): costs are concerned with gathering and analyzing information or market intelligence during policy formulation to define the nature of the problem and make decisions. They include the costs of inquiring and seeking clarification about the policy measure; conducting public education; preparing application and guidelines; searching for information about buyers and sellers.

b) Design and Implementation (Transition Costs): costs include the costs of designing permit allocation system, defining trading rules, and regulatory delay.

c) Support and Administration (Static Transaction Costs): ongoing costs involving communication and assistance. They include the costs of giving information about a policy; assessing applications; performing auditing tasks; providing permit price forecasts; keeping records; consultation processes; developing required resources such as training agency staff for new tasks, purchasing and installing relevant equipment.

d) Monitoring and Detection (Static Transaction Costs) are largely the costs of monitoring subsequent behaviors to ensure that they are consistent with the decision. Examples are the costs of policing property rights or con- tracts, through inspection, to determine whether the terms of the contract are being observed. They also involve evaluation costs to determine the effectiveness of policy programs.

e) Adaptation or Replacement (Lock-in costs): costs related with changes in policy application which are affected by the previous decisions taken and which may also imply future constraints.

Measuring transaction costs demands the collection of data from public organizations involved in water allocation reform. Some data can be obtained from financial records or other publicly available information after the implementation of the policy. In other cases, records may be unavailable because they were not collected in the first place. To bridge this gap, we actively engaged with public institutions to collect information from the following sources: i) records kept by institutions, including staff salaries, studies, fees, travel, equipment, etc. (Njiraini et al., 2017); ii) personal interviews to collect data from selected people in relevant institutions, such as time used, number of staff and salaries, etc. (see e.g. the questionnaires developed by McCann and Easter (1999) and Ofei-Mensah and Bennett (2013)); iii) estimates through sensible adjustment of transaction costs incurred under similar policies elsewhere (see e.g. Ofei-Mensah and Bennett, 2013); and iv) structured interviews, involving informal and personal communication with experts who can deliver estimates for transaction costs items that could not be obtained using other methods (Mettepenningen et al., 2011).

Most common measurement techniques have been used during the creation of this TC database. Following the literature and processes suggested before (see also McCann 2005), we expected that different types of data would be needed, from data obtained in already created databases, to indirect techniques such as interviews with stakeholders or estimations of the costs involved. The latter is an instance of the difficulties TC measurement may imply.
Then, different steps were taken in order to obtain separate data and subsequently, aggregate it in a time series format.

Firstly, in November 2019, we started examining every document related to each particular plan and Law regulating the institution. Through this data we obtained the infrastructures built and planned by the confederation, together with other administrative tasks enforced and areas where it was involved. We also detected which frames would most likely involve Transaction Costs, focusing on them later. A distinction between the infrastructures which were finally built had to be done due to the fact that some parts of the initial planification were not ultimately developed. The information was retrieved from the different hydrological plans, since 1998 (first plan) till the modern plans mentioned before.

Once we discerned and obtained all publicly available information related to the planification and infrastructures, certain series of interviews needed to be conducted with the responsible of the planification office of the Duero River basin.

Our goal was to increase data collection and answer many questions related to the planification process and planning development. Given the non-intuitive concept of Institutional Transaction Cost we faced some problems to get the information needed instead of financial or abatement costs. For this proposal, we started explaining the concepts definitions and parts which may involve TC through structured interviews which facilitated the retrieval of data and gave us insights of the next steps to be taken to improve and keep building the database.

The first interview conducted was the first out of three and gave us comprehension for the institutional database "Mírame". This Database constitutes the main source of information related to the ongoing work of the institution, from abatement or operational costs to, most importantly to our end, Transaction Costs such as designing, research or monitoring.

The number of observations of this source was close to three thousand. However, less than 200 of them were only Transaction Costs, being the majority either infrastructure or operational costs. A process of analysis and evaluation of each of these items needed to be done as many of them did not have values and others contained misleading information which could had been caused by typos when it was storage. More interviews were used with the goal of assessing these particular measures and try to get the most accurate value of each observation. Different official documents and guidance were provided by the expert which gave us more insights and accuracy with respect to the transaction costs involved in the planification process. The transaction costs included information on design costs (e.g. studies about flood risk management, studies about volume of water), research and information costs (e.g. hydrological planification), adaptation or replacement costs (e.g. Government Council meeting, Scarcity Management meeting, coordination improvement with meteorology agency) and monitoring costs (e.g. tracking of quantitative measures, tracking of water volume, tracking European Funds).

Given this database together with other private data allowed by the Technical Officer, we started filtering, structuring and disaggregating every observation and checking the possible sources of interest for TC analysis. As each measure and expenditure is different, this classification process was made mainly manually and for each of the approximately 3000 observations. As it is stated before, some of these classifications were consulted with the Chief Planification Officer of the Basin due to different reasons which vary from data unavailability with respect to the budget, to values which could be considered as extreme observations.

Once the measures were analysed and filtered individually, they were introduced in the spreadsheet made on Microsoft Excel and the first model of the database was obtained.

After this data collection more interviews were made in order to solve scarce data problems and questions related to some measures not included in the database "Mírame". These last interviews were conducted via video call as gathering was not possible due to the COVID and health situation.

Later on, once we had obtained the primary data, we moved to some secondary sources of TC such as meetings related to the execution plan and drought management.

Firstly, as no meetings were available in "Mírame", we observed the records of droughts in order to evaluate when the reunions related to drought management might have taken place. For this purpose, we analysed the press provided by the River basin management since the last decade and we focused on the months where water scarcity existed; these press notes covered most of the weeks of each year and had to be analysed individually and manually as most of them were not tidy data and were just scanned documents. The insights obtained through these steps were also discussed and checked with the Chief Planification Officer.

Secondly, we collected different gatherings realized during the last two decades by the administrative parts of the institution and other non administrative but also public organs. The organs involved were the following: Competent Authorities Committee (Comité de Autoridades Competentes), Technical Scarcity Office (Oficina Técnica de sequía), Government Council (Junta de Gobierno), Water Council (Consejo del Agua), Users Assembly (Asamblea de Usuarios), Committee of Planification and Social Participation (Comité de Planificación y Participación Ciudadana) and the Commission of Water

Discharge (Comisión de Desembalse). For this goal, another interview was needed and allowed us to collect more information which was not publicly available.

A total of 48 meetings of the organs mentioned above and their minutes were found. They involved around 1127 participants whose wages and costs needed to be calculated.
In order to calculate the costs of this part, we estimated indirectly the salary of the participants; being the fact that most of them had public jobs, their salaries were estimated through the public data available and given by the Ministry of Finance (Mº de Hacienda). For some of the participants, due to public information and the one obtained through the interviews their salaries were known accurately and did not have to be estimated. This is the case, for instance, of the president of the Institution. Nevertheless, for most of them, due to data unavailability, an estimation was needed, and the information obtained within the interviews was also used for this aim. An equivalent wage of ~€19.49 per hour was used for most of the participants as it was recommended by the expert consulted. This salary was obtained through the public information commented before, particularly the document of the law *Real Decreto-ley 2/2020 "Restribuciones del personal funcionario, haber regulador y cuotas a las mutualidades de funcionarios y de derechos pasivos"*.

The transportation costs implied by these meetings were calculated stablishing €0.21, the standard cost per kilometre and applying it to participants' respective places of departure and destination. Most of these places were also obtained within the data available in the meeting minutes and were assigned to each member. A minority of them were inferred. The distance between the departure and destination places was obtained through Google Maps choosing the optimal way by car.
Ultimately, the amount of salaries involved (wage per hour multiplicated by the number of hours involved of each participant in each meeting, also considering traveling hours) were added to the transportation costs and the final observations of these meetings were obtained and introduced to the database.

Thirdly, many of the infrastructures and operations developed by the institution imply environmental controls and then, they usually need to be analysed by agencies to check they do not have a clear damage on environment.

This particular cost is also taken into account as a TC. Part of the environmental impact evaluations were obtained through the public data obtained within the River basin information but other parts were missing and more documents were needed. As this frame relies on the competence of the autonomous government of Castille and León, its database and official documents were obtained and used with the aim of improving the accuracy of our database.

Additionally, some consultancies such as the structured interviews already commented, and others made with the companies involved in these projects, e.g. PROINTEC, were needed to assess these observations and quantify and monetize the value of them.

This was the ultimate step before putting everything together and classifying all the different inputs obtained and store them in our database.

In order to complete the process before doing the empirical analysis, we proceeded to make the classification of Transaction Costs, distinguishing the different categories where

Category	Typology of TC	Policy-Examples from CHD	Data Source
Transition Costs	*Research and Information	Hydrologic Planification, Cartography Studies	Database Mírame, Secondary Sources,
	*Design and Implementation	Flood Studies, Ecologic Studies	Structured Interviews Database Mírame, Structured Interviews
Static Transaction Costs	*Support and Administration	DIA (*Declaración de Impacto Ambiental*), Information System for Hydrological Plannification	Database Mírame, Structured Interviews, Consultancies, Publicly Available Records.
	*Monitoring and Detection	Redes SAIH (monitoring system), Water Levels Tracking, Quality Tracking.	Database Mírame, Structured Interviews.
Lock-in costs	*Adaptation or replacement	Hydrologic Planification-Update, Meetings	Database Mírame, Meetings Minutes, Public Salaries, travel distances.

Table 4.1 TC categorisation and instances. Source: Own elaboration

they rely on. Although different definitions and examples may be found in the literature as we mentioned before, we can explain our process through the next table, adapted from Marshall (2013) and Garrick (2015) and following definitions from Albert Ofei-Mensah (2013).

In the table 1 above we may observe the distinct categories related to Transaction Costs, starting from Transition Costs, Static Transaction costs and Lock-in costs, subsequently divided in Research and information, Design and implementation, Support and administration, Monitoring and detection and Adaptation or Replacement.
The three main categories were already defined before (see definitions section) together with sub-categories which are explained during the first part of this section.

Applying the definitions listed before, we ended up with a total of 506 observations related to 18 years (2005-2021). 35 observations correspond to Research and Information, 30 are Design and Implementation measures, 132 Support and Administration, 230 Monitoring and Detection and finally 79 are Adaptation and Replacement. A further analysis of the distribution and weight of each range will be provided in the Empirical and Econometrics part.

Lastly, once the items were classified, homogenization of their respective costs had to be done in order to make fair comparisons and subtract the possible effect of inflation.
For this proposal, GDP deflator obtained through the World Bank was used and applied to each of our observations, being 2004, first year of the time series, used as year-base.

Once the Database was completed and adapted to be measured, the econometric analysis was done.

5. RESULTS

The results section is structured as follows: firstly, the time series of the total transaction costs as well as the disaggregated components will be analysed; the autocorrelation and Dickey Fuller test will also be provided. Secondly, two prediction models will be used in order to assess the possible values transaction costs which will be produced in the next years.

Time series analysis

As we stated before, our data begins in 2004 when the hydrological plans started to be implemented by the institution. From that year on, we experienced a continuous growth tendency as it can be seen through the tendency line drawn on figure 2. Within the period 2009 to 2013 a decreasing trend may be observed, followed by another growth till 2015. After this last year, we have a V form until 2018 which is finally continued by a decreasing trend again until nowadays.

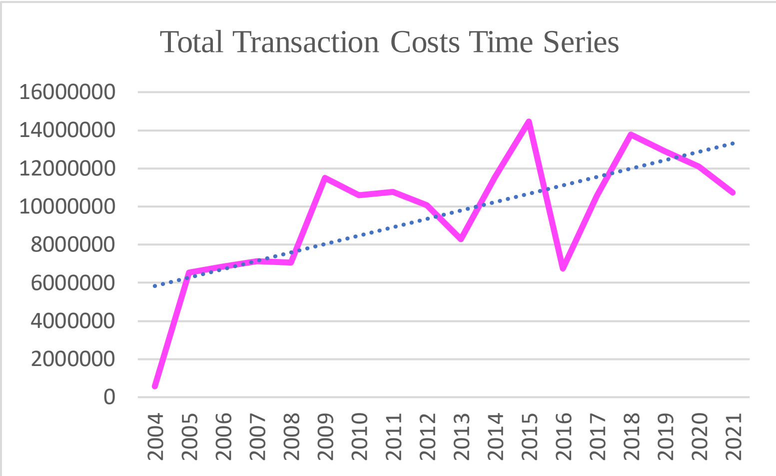

Figure 5.1, TC Time Series. Source: own elaboration

The time series plot of the disaggregated components is represented in figure 3. Also, in the appendix the plots of the different components may be observed, giving an individual perspective of each of them. It is also added the disaggregated graph by percentages of each category of TC.

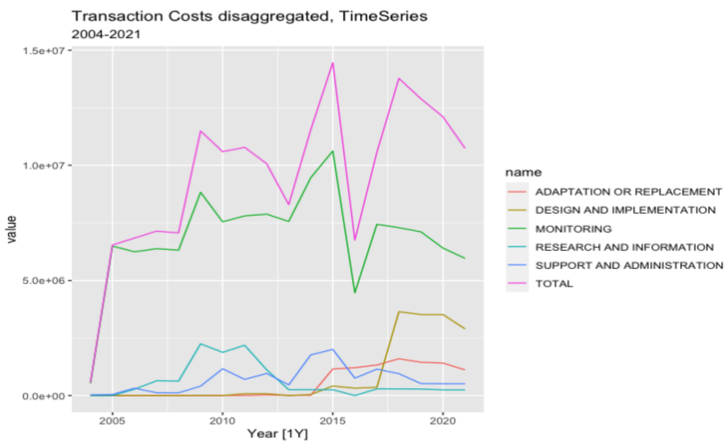

Figure 5.2 Transaction Costs disaggregated, Time Series. Source: own elaboration

The main component of total transaction costs is monitoring which accounts for more than 80% of them during the first years until 2008. It is followed by Research and

Information, which is the second most important component until 2012, implying up to 20% of the costs in 2011.

From 2013 on, Support and Administration component grows until 2015. During the last years, Design and Implementation component increases consisting in a weight around 25% of Total Costs

Augmented Dickey-Fuller test

In order to carry further research and a deeper econometric analysis, certain tests should be done such as Augmented Dickey Fuller test or the autocorrelation function of the components. The former provides us with the information about the stationarity of the series or not. Performing the analysis, we obtain the next results and we may observe that in the case of drift and trend/no trend we reject the hypothesis of unitary root. Therefore, the series would be stationary and there is no clear tendency of them. However, a wider range of data would be necessary to conclude it.

Table 5.1 Dickey-Fuller Test
Source: own elaboration

```
Type 1: no drift no trend
     lag     ADF p.value
[1,]   0 -0.1924   0.580
[2,]   1  0.0614   0.653
[3,]   2  0.6516   0.823
[4,]   3  0.9350   0.902
Type 2: with drift no trend
     lag   ADF p.value
[1,]   0 -3.81   0.010
[2,]   1 -2.52   0.142
[3,]   2 -2.42   0.180
[4,]   3 -2.19   0.263
Type 3: with drift and trend
     lag   ADF p.value
[1,]   0 -4.38  0.0101
[2,]   1 -3.45  0.0705
[3,]   2 -2.66  0.3114
[4,]   3 -2.26  0.4576
----
Note: in fact, p.value = 0.01 means p.value <= 0.01
```

Autocorrelation Function

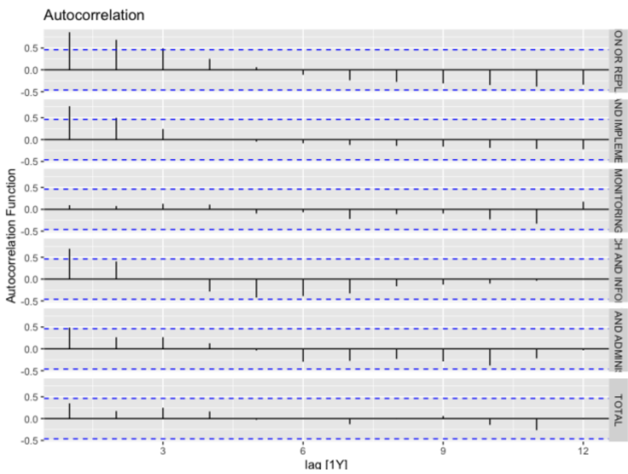

Figure 5.3 Autocorrelation Function; Disaggregated Components. Source: own elaboration

Mean TC

	Category	Value
	<chr>	<dbl>
1	ADAPTATION OR REPLACEMENT	518589.
2	DESIGN AND IMPLEMENTATION	827312.
3	MONITORING	6907709.
4	RESEARCH AND INFORMATION	618004.
5	SUPPORT AND ADMINISTRATION	696065.
6	TOTAL	9567679.

Table 5.2 Mean Values. Source: Own elaboration

Prediction Arima and ETS models.

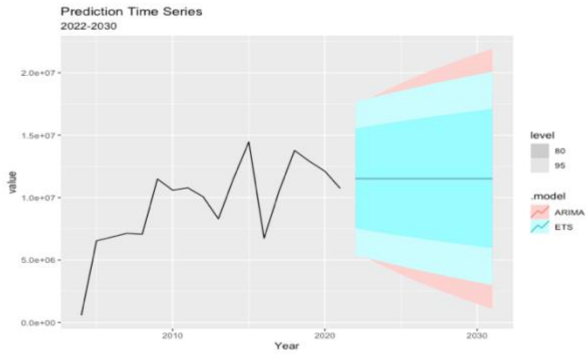

Figure 2. 4, Prediction Time Series. Source: Own elaboration

<u>6. DISCUSSION AND ANALYSIS OF RESULTS</u>

6.1 Evolution of Transaction costs

In 2004, the implementation and development of the planification process began in our institution. Since that year, we have a constant growth until 2009 where the responsible for this peak are Monitoring and Research and Information; particularly the latter experiences a growth of more than 350% with respect to the value of 2008. This category is also the main reason why there is a slow down during 2013 (the series turn back to initial values).

From 2015 onwards, the types or transaction costs observed influencing the trend are mainly related to Support and Administration together with Adaptation or Replacement; altogether they have a weight of 21% in the year commented.

In 2016, the minimum experienced is due to another drop in Research and Information expenditure (it does not exist during this year) and Support and Administration. From 2017 afterwards, the upward trend is influenced by Design and Implementation costs.

Some remarks which have to be considered:

-The main component of Total Transaction Costs is Monitoring, implying more than half of the total value during every period. However, it is important to see that its weight is clearly downward as it started with a 90 and even 100 percent during the first years, and it has a weight of 55% during the last year covered by our database, 2021.

-Research and information took an important weight until 2011, period when the planning was starting to be implemented.

-Design and implementation do not influence until 2015, here it jumps up and makes the already commented peak produced.

-Respect to Support and Administration, the trend fluctuates, and its ultimate weight is similar to the beginning of the series.

The upward trend followed by the series may indicate that the institution does not follow adaptive efficiency. Notwithstanding, it is true that we observe a downward evolution during the last years until 2021 where our observations end up. Once we get this point, we move to the prediction area which will be commented in the subsequent part.

The reason why we experiment this upward trend is the beginning of the planification process implementation and growth of every cost, see Research and Information.

From 2013 on, the costs related to Support and Administration as well as Adaptation and Replacement increased and also generated an upward trend. On the other side, the evolution of Research and Information indicates that this component is no longer necessary once the planifications are implemented, this is confirmed with the lack of importance during the last years.

Which are the scenarios which could be observed during the following years?

6.2 Prediction

During the coming years, the predictions estimated through ARIMA and ETS models just show that any scenario is possible, an upward or backward trend. We still do not have enough data to conclude and calculate accurate paths to be followed by the Transaction Costs series.

However, it is possible to analyse the instincts and possibilities of the situation.

Nowadays, the expenditure is mainly explained by Design and Implementation, the costs of planification are vanished due to the fact that the elements planned and researched are already being implemented. It is possible then that, in the short-medium term, we observe a downward trend in total transaction costs.

Regarding the aspect of adaptive efficiency previously defined, we can analyse the evolution commented above and try to evaluate the performance of the institution.

As it was previously stated, the beginning and establishment of the institution caused the increasing trend of the first years as the organization core basis needed to be done. From this initial trend (until 2009) on, we may see different fluctuations of our time series.

Considering the data we have, a positive and increasing general trend is observed as we can see in figure 2. However, it would be misleading to conclude that the institution is not adaptive efficient, given the fact of data scarcity and the need of further years to be incorporated into our analysis. We cannot conclude that the institution will follow an increasing trend and is involved in irreversibility and path dependency issues.

Following the prediction models that we applied, we may formulate the following two hypotheses:

a) Once the planification and research process have been produced, designing and implementation measures start to be implemented. Ultimately, these categories are reduced since there is no more necessity of these figures in the institutions. The costs will be reduced to monitoring. Therefore, the institution could be considered as adaptive and efficient as the objectives are met with an average public transaction costs declining and a sufficient total budget. The institution would succeed in solving evolving and complex dilemmas keeping the TC in flat or decreasing trend.

b) The second hypothesis assumes a dynamic process whereas the first one does a static one. It is possible that new shocks occur in the future (e.g. climate change, droughts…) and they make the institution to develop new measures related to the other costs, more than monitoring. We would face new planification processes with costs such as Research or Designing. If this expenditure is higher than the one already observed, we would not obtain adaptive efficiency as it would be involved in increasing trends of the average transaction costs and it would fall into irreversible and path dependency tendencies.

7. CONCLUSIONS OF OUR ANALYSIS AND FURTHER RESEARCH.

The goal of this study was to provide insights and answers to certain parts of the literature related to institutional transaction costs, where lack of information and empirical evidence are found.

During this thesis a broad literature review has been done, providing a better understanding of the current trends in the field and a comprehensive definition of the most important concepts. Additionally, the database creation process has been explained, guiding and leading future research and institutional management in environmental institutional transaction costs, particularly in Spain.

Respect to the case study, we cannot conclude if the institution is adaptive efficient or not as the empirical data obtained is not enough. The scarcity of data makes this task not possible yet. Therefore, further research should be done in the future years to cover this issue and provide a more concrete answer.

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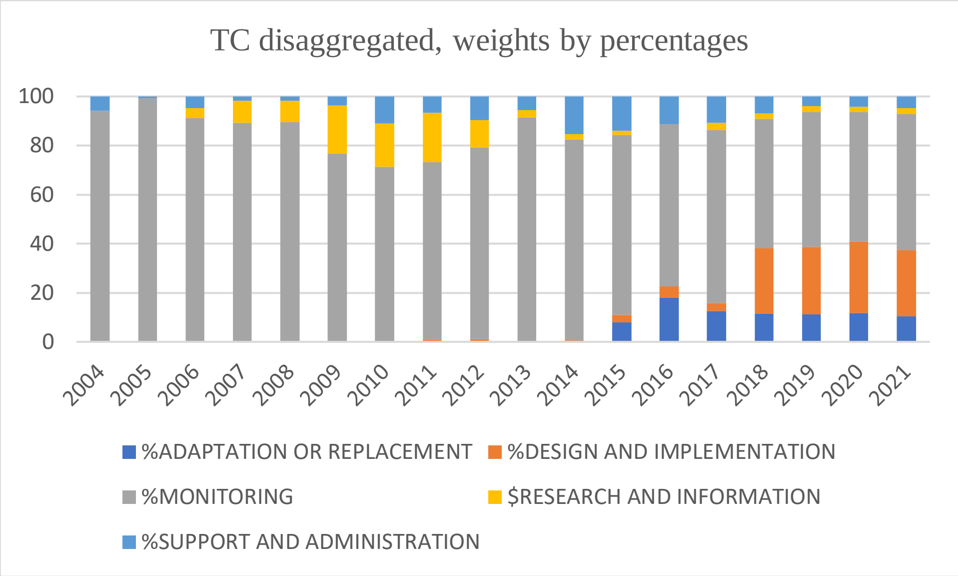
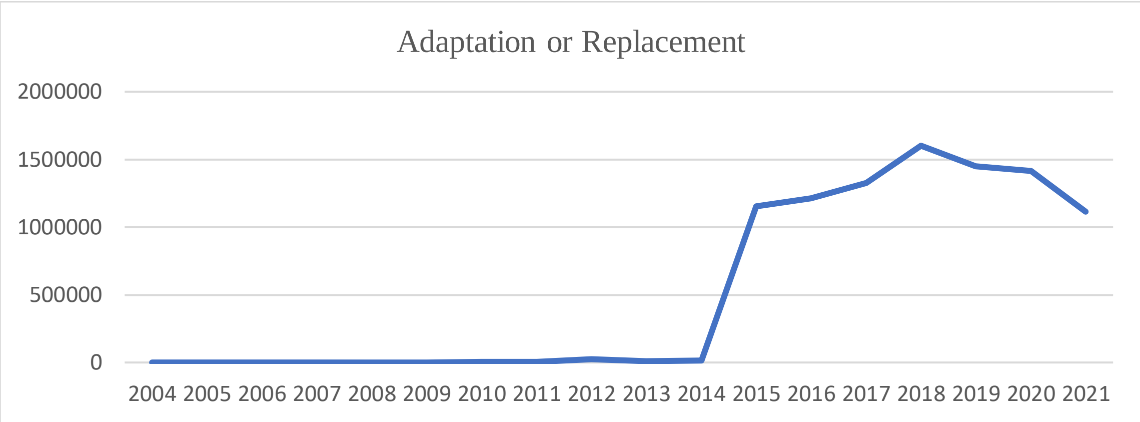
Appendix A

A1; TC disaggregated by components; percentages



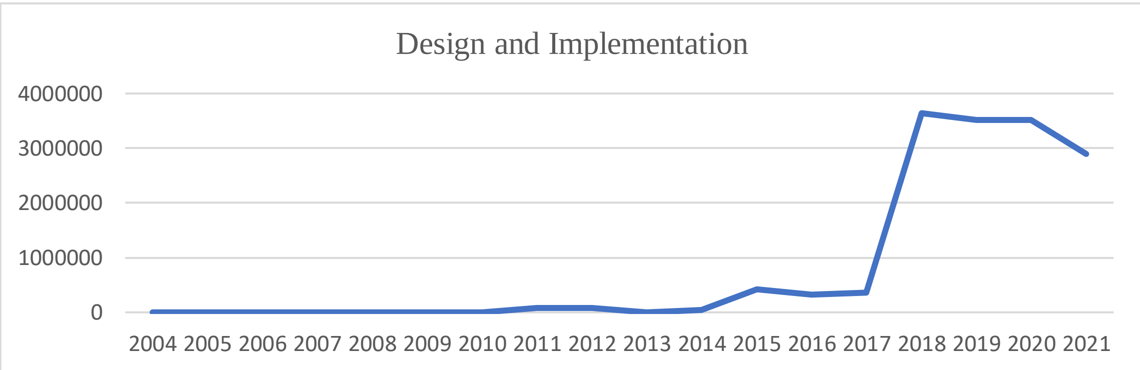
Source: own elaboration

A2; Time Series Adaptation or Replacement



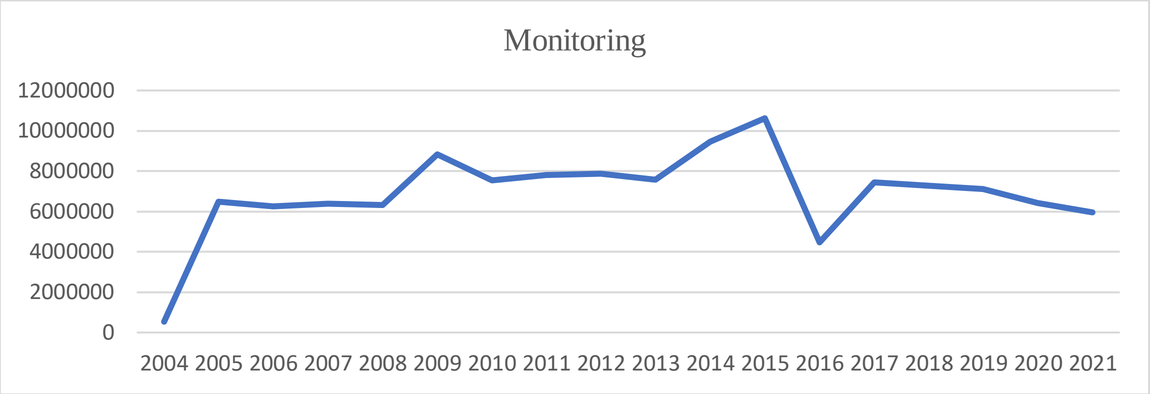
Source: own elaboration

A3; Series Design and Implementation



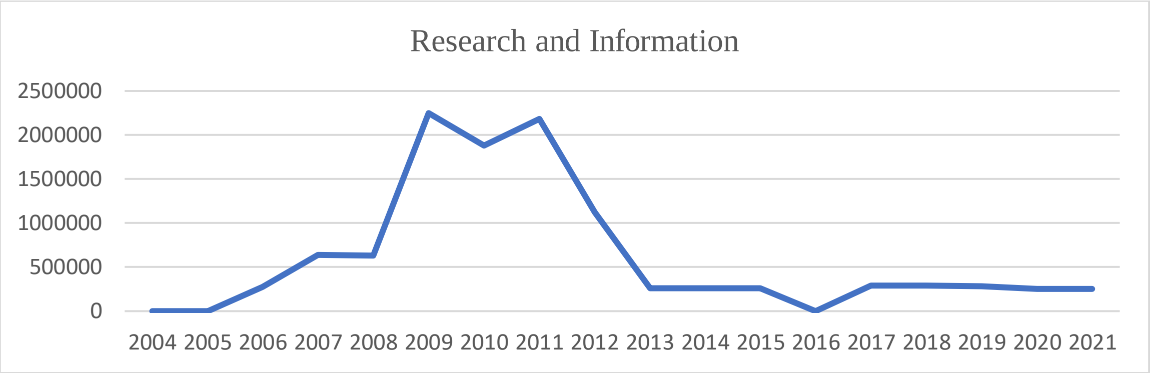
Source: own elaboration

A4; Time Series Monitoring



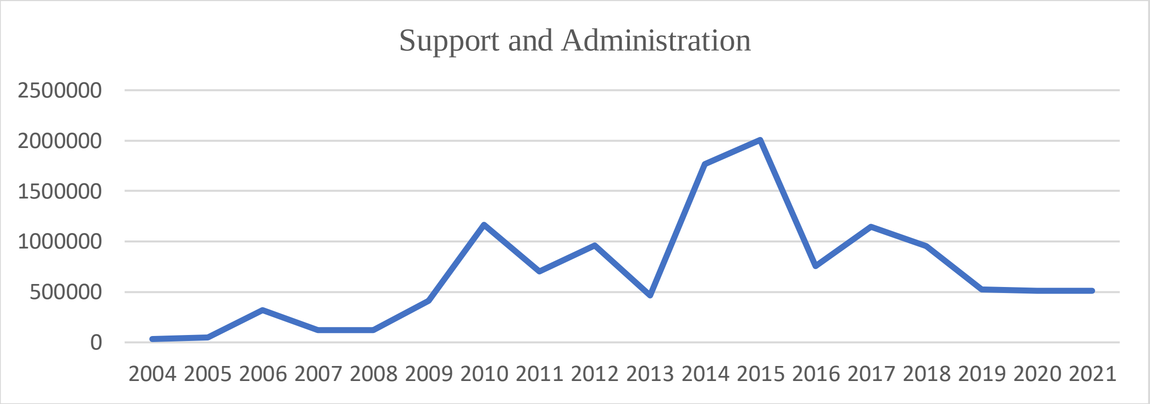
Source: own elaboration

A5; Time Series Research and Information



Source: own elaboration

A6; Time Series Support and Administration



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