

Institutional Inertia: Persistent Inefficient Institutions in Spain

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Abstract

There is ample evidence that suboptimal institutions persist over time. However, the mechanisms that cause this persistence are not well understood. I explore a particular historical episode and provide a mechanism that explains institutional persistence. The irrigation community in Mula, Spain switched in 1966, after over 700 years, from a market institution (auctions) to a non-market institution (fixed quotas with a ban on trading) as a way to allocate water from the Mula river. This change happened in the absence of either political or technological change. The new institution was more efficient than the old one but it required an egalitarian distribution of property rights. Hence, a transition into a more efficient institution was delayed due to a holdup problem. I show how a financial public policy focused on helping exporters, together with a temporary increase in payoffs which increased collateral, solved the holdup problem and led to a change into a more efficient institution.

“There is nothing more difficult to arrange, more doubtful of success, and more dangerous to carry through, than to initiate a new order of things”

Niccolò Machiavelli, *The Prince*

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1 Introduction

In recent years we have seen a growing literature on institutional persistence. This is not a new topic (North, 1990; Alston et al, 1996) but it was not until recently that a comprehensive set of empirical papers on the topic emerged. These empirical papers focus on particular historical episodes and regions of the world, including India (Jha, 2012), South America (Dell, 2010) and Europe (Guiso et al, 2008; Voigtländer and Voth, 2012) among others. These papers concisely assess institutional persistence and present robust empirical results but lack a formal mechanism that explains the persistence.

Further, this literature is usually agnostic about the causes of institutional persistence. Traditional explanations for institutional persistence require technological or political change to spark institutional change. This paper provides an alternative mechanism, called *Institutional Inertia*, that explains institutional change in the absence of technological or political changes. Institutional persistence usually occurs because the agent cannot commit *ex-ante* to compensate the principal and therefore the latter blocks the institutional change. Institutional inertia happens when the new institution requires the agent to own the property rights but she cannot commit to pay the principal after the change. In addition to providing an explicit mechanism for institutional inertia, this paper also advances the notion of a transitional institution, i.e., an institution that is temporary and whose sole purpose is to instrument the change from the old institution to the new one.

I test the institutional inertia framework in a particular historical episode: an irrigation community in Mula, Spain. Christians from from the kingdoms of Castile and Aragon, but also from France and Italy, settled the towns and cities of the Kingdom of Murcia after defeating its Muslim rulers in the 13th century. Notice that the nature of the *Reconquista* means that the peasants in Spain were free to change residence and that all cities have democratic elections, usually twice a year, where the head of each household that qualified as neighbour (*vecino*) could vote.

Most towns adopted a non-market mechanism (quotas) to allocate water. Only the cities of Mula and Lorca adopted an auction mechanism. Although contemporaries thought these auctions inefficient, and observed neighbors in most surrounding towns allocate water by fixed quota, it was not until 1961 in Lorca and 1966 in Mula that these cities implemented quotas. Hence, an inefficient institution persisted for over 700 years.

The timing of an institutional change is as follows: (i) the principal chooses the institution; (ii) the agent makes a monetary transfer to the principal. In a world with perfect information, no bargaining costs and perfect commitment –one in which the Coase Theorem (Coase, 1937) holds– the new institution is put in place. The lack of institutional change results from a misalignment of incentives between the principal and the agent.

One way to solve this problem is for the agent and the principal to join forces. This will happen, for example, when the agent gains decision rights, either property rights or political power. When the agent has decision rights, the principal/agent distinction disappears and hence, the institution is efficient.

Acemoglu and Robinson (2008) detail this approach.

Another explanation focuses on technological change that affects principal/agent payoffs. In particular, if the losses of the agent under the old institution are sufficiently large, the mechanism preventing the agent from adopting her preferred institution collapses. Thus, the benefits of the change offset the transaction costs associated with it. Notice that, for this argument to hold, the agent must have some commitment power and receive gains big enough that she is willing to pay the transaction costs, for example by lobbying. The New Institutional Economics (NIE) literature (see Menard and Shirley, 2005) takes this approach.

This paper takes a third approach, overlooked in the literature, which requires an increase in the commitment ability of the agent. The agent under this new institution should compensate the principal and, since efficiency has increased, the agent's payment to the principal is lower than the agent's gains. If the agent can credibly commit to compensate the principal, then the institutional change will occur. If the agent cannot commit to this payment, then an inefficient institution persists over time. This can happen even if it is common knowledge that the institution is, indeed, inefficient.

This condition for institutional transition –a change in ownership with the promise of a future payment– structurally resembles a debt contract. There is a transitional period –after the principal decides but before the agent pays off the debt– with different rules and incentives than those of either the old or new institution. The transitional institution, here the debt contract, is required only to change from the old to the new institution. In other words, both institutional inertia and a transitional institution only occur when the new institution is more efficient and requires the agent to own the property rights. The institutional inertia model presented here is asymmetric because the inertia may occur when the optimal institution has an ownership restriction, but not otherwise. In the hypothetical case in which the optimal institution does not have an ownership restriction, e.g., a market, the change would happen immediately.

In Mula, the old market institution of auctions did not require any restriction on the distribution of water property rights. The new non-market institution of quotas, however, required a particular distribution of property rights. Donna and Espín-Sánchez (2014) showed that, in the present setting, quotas were more efficient than auctions. If the agent (farmer) was poor, she faced a holdup problem when she tried to buy the property rights from the principal (original owner or Waterlord). Since she could not pay in cash, she would promise to pay in the future, i.e., take on debt. In the presence of uncertainty, however, a debt contract may solicit a sub-optimal level of effort. Thus, the farmer would not be able to make the promised payment with certainty. The Waterlord would refuse such a contract. If the farmer owned the property rights, as was the case in other towns throughout the region, she would exert the first-best level of effort and would thus have been able to pay the debt.

1.1 Literature Review

The theory proposed here is consistent with the comments and findings of both contemporary (Díaz Casou, 1889; Brunhes, 1902) and current historians who have examined traditional irrigation organizations in Murcia and Mediterranean Spain (Passa, 1844; Glick, 1967; Gil Olcina, 1994).

While most scholars rely on a Hobbesian Leviathan, Elinor Ostrom (1990, 2005) has extensively

studied the benefits of self-governing institutions like the one I am studying here.¹ The model presented here fits within Ostrom's framework, but concerns the choice between two self-governed institutions (auctions and quotas) rather than the choice of whether or not to self-govern. Mula farmers allocated water through one self-governing mechanism or the other without the intervention of a third party. Moreover, farmers under each regime established their own courts and appointed their own judges.

Acemoglu and Robinson (2008) argued for the importance of commitment when dealing with institutional change. However, the mechanism proposed here requires a different type of commitment and differs from theirs in two important aspects. First, they focus on the commitment ability of the principal (*elite*). In their model, the principal uses democracy as a commitment device to avoid expropriating agents (*citizens*) in the future. To the contrary, I focus on the commitment ability of the agent (*farmer*). Agents use collateral or upfront payment as a commitment device to prevent shirking and to facilitate payback. Second, no transitional institution exists in their model. Thus, commitment ability is relevant only for the new institution (*democracy*). In this paper, commitment plays no role in the old institution nor in the new one. Instead, commitment is important for the transitional institution. Without a credible commitment from the agent (*farmer*), the principal will never agree to change from the old institution to the transitional institution.

In a study of medieval trade, Greif (2006) proposed an institutional change model based on commitment ability and unintended consequences from previous institutional arrangements. Although this paper's approach is different, both approaches share the argument that a change in payoffs or in the available set of players' actions does not prompt the emergence of a new institution. Instead, the agent's commitment ability and the principal's beliefs about whether or not the agent will honor their contract determine the change.

Gelderblom (2013) proposed a model of institutional change based on competition between political entities. After a change in the environment, different cities experiment with different institutions with more successful formulas as models. In this case, institutional change is triggered by changes in payoffs. According to this theory, the absence of competition between neighbors could explain the absence of institutional change in the presence of technological change. However, this mechanism cannot explain the lack of change in the Mula setting because institutional change did not occur despite the centuries-long use of the more efficient institution in many neighboring towns.

This paper also aims to contribute to the literature in empirical studies on institutional persistence. Some of the papers in this literature relate to culture and violence. Jha (2012) showed the relationship between Indian cities which were trading ports during the Middle Ages and Muslim-Hindu violence in 1850-1950. He found cities that were Medieval trading ports were less likely to experience violent riots. Voigtländer and Voth (2012) found that German cities that experienced *pogroms* during the Middle Ages showed greater antisemitic behavior during the 1930s.

Focusing on economic outcomes, Guiso et al (2008) found Italian cities which experienced self-governance (*free cities*) in the Middle Ages have more "civil capital" today. In particular, citizens from

¹The Hobbesian *legal centralism* theory has been criticized by Ellickson (1991) among others. Moreover, there are situations in which people are not constrained by formal legal institutions (Posner, 2000), but by some commonly agreed social norms.

northern *free* cities display a higher level of trust than citizens from southern cities. Nunn and Wantchekon (2011) studied the effect of the slave trade on current levels of trust within Africa.

Melissa Dell (2010) demonstrated how Peruvian towns under a forced mining system (*mita*) during the Spanish Empire have greater poverty rates than otherwise similar towns today. Banerjee and Iyer (2005) looked at British colonial land institutions and found a correlation between the type of original colonial institutions and economic outcomes today. Dell and Banerjee and Iyer attribute differences in outputs to differences in inputs, such as land regimes and provision of public goods, but they do not explicitly model how the original institutions affected the inputs (*policy*).

1.2 Institutional Diversity

Traditional explanations for institutional diversity between Mula and Lorca and the rest of the towns in the region have mainly focused on geographical differences.² In this sub-section I explore some of these explanations. I highlight whether or not arguments in each case are consistent with the data. Any explanation for the institutional diversity in the region has to explain three main facts: (i) why did Mula and Lorca had auctions initially?; (ii) why did the institutions in Mula and Lorca remain different than those in surrounding towns for centuries?; (iii) why did Mula and Lorca change from auctions to quotas during the 1960s? The goal of this section is to see whether the current explanations are consistent with these three facts.

1.2.1 The “Dryness” Hypothesis

According to this hypothesis, towns with auctions were very dry, much more so than the rest of the region (Musso y Fontes, 1847; Lemeunier and Pérez Picazo, 1984). Anderson and Maass (1978) claimed, in line with the spirit of the NIE, that auctions were always more efficient than quotas but were more costly to manage. Hence, auctions were only used when water was very scarce and valuable with respect to the costs of running an auction.

Other studies, more in line with Acemoglu and Robinson (2008), mostly by historians such as González Castaño (1992), have claimed that auctions –or private property rights of water– were just another means by which the local elite could exert their power over the peasantry. By controlling the water, the local *elite* could control the *non-elites*. Auctions were then an effective way to exert power only in places where water was very scarce.

The problem with this line of argumentation is its reliance on an incorrect fact. Mula and Lorca were not drier than the towns that had quotas. Moreover, the co-existence of quotas and auctions characterizes all provinces of Mediterranean Spain, from the humid region of Gerona on the border with France to the deserts of Almería and Murcia in the South (López Ortiz and Melgarejo Moreno, 2005).

The argument for relative dryness takes two flavors: either towns with auctions are drier in the sense that they have lower average rain (or the same average but greater variance); or they are drier in the

²The citizens of Mula and Lorca obtain their water from the Mula and Guadalentin rivers, respectively. Both rivers are tributaries of the Segura river. However, there are towns that obtain their water from the same rivers or from other tributaries that have never had auctions.

sense that the ratio between available water and irrigable land is lower. We can see in Table 1 that Mula and Lorca are neither especially dry, nor especially humid, with respect to other towns in Murcia.

Table 1 displays a comprehensive sample of towns in the region with irrigation communities (see Figure 1). The most reliable data source for Mula and Lorca comes from their dams and, as we can see, they are around the median. If the argument were correct we would expect towns like Ulea, Fortuna or Alguazas, all of which have quotas, to run auctions. Garrido (2011) has already presented this critique effectively. He points out that there is no correlation between weather or geography and private property rights of water between regions in Spain.

The second flavor of the relative dryness argument springs from the observation that towns with quotas have a larger amount of water available for irrigation per hectare than do towns with auctions. However, the causality is most likely reversed. When landowners had property rights to water, as in the quota system, there was less of an incentive to expand the irrigable land, which meant that more water was available per irrigable acre, as Ruiz Funés (1916) suggested.³ Moreover, as Garrido (2011) shows, the biggest increase in irrigable land that took place in all towns happened several centuries after the initial institution was put in place. The choice to have an auction or not cannot be a function of scarcity.

Between the 15th and the 19th century, irrigable land tripled both in towns which held auctions –Alicante and Lorca– and in Murcia where quotas were in use (Chacón Jiménez et al, 1979). This pattern suggests that the increase in irrigable land was due to improvement in irrigation technology. Hence, there is no evidence to support the claim that Mula and Lorca were intrinsically different than other towns around them during the 13th century. From the above arguments, one can feel confident that the dryness hypothesis is not true. Even if this hypothesis were true, it could only explain the the initial choice of auctions and the persistence of difference. However, it cannot explain the institutional change in the 1960s unless it assumes that the weather dramatically changed in Mula and Lorca in the 1960s. It did not.

1.2.2 The “conquest” hypothesis

During the reign of the King Wolf, Ibn Hud (1228-1238), the Kingdom of Murcia enjoyed some measure of prosperity and stability. When Ibn Hud was murdered in 1238, his kingdom was dismantled. That same year, Jaime I, King of Aragon conquered Valencia and prepared to march south. Rulers in Castile were also advancing to the south, expanding territory at the expense of the now fragile Kingdom of Murcia. By 1242, Castile had conquered most of the Kingdom of Murcia. Ahmed, the son of Ibn Hud, traveled to Alcaraz (Toledo) to meet then-prince Alfonso. They agreed that what remained of the kingdom would become a protectorate of Castile.

The Muslim governors of the cities of Mula and Lorca rejected this agreement. In April 1244, Alfonso was in Murcia with his army ready to attack Mula, the nearest of the rebel cities. After Mula was conquered, the army moved to Lorca, which surrendered by the end of June. The governance of Mula

³If the owners of the water and the owners of the land are the same people, they will restrict the size of irrigable land in order to maximize the average or total output. If the owners of the water are not the owners of the land, they will increase the amount of irrigable land beyond the point that maximizes total output, in order to maximize revenue. They will increase the amount of the irrigable land until the point at which marginal output equals average output.

and Lorca was given over to the Order of Santiago, while Murcia was given, in part, to the descendents of Ibn Hud according to the terms of the Alcaraz Treaty. However, the rulers of Castile had absolute authority over the cities of Mula and Lorca, since those were conquered by force. Rodríguez Llopis (1998) pointed out that the institutional configuration in place in each town in Murcia by the end of the Middle Ages was the outcome of the tensions between the Crown, the Castilian aristocracy, the regional nobility and the local elites during the 13th century.⁴

Water rights were the ideal financial asset for any investor who did not want to reside in the city or work the land. Water rights paid a flow of dividends every year, needed little monitoring and, more importantly, produced a flow payoff negatively correlated with the weather cycle: returns are high during a drought and low during rainy years. Unlike with land rights, the moral hazard problems associated with water rights are minor compared because the good is homogeneous and can be easily transferred to another agent. Hence, absentee lords and convents seem like the ideal candidates to hold these property rights if the farmers cannot afford to buy them. The original owners of water rights were the Knights of the Order of Santiago and the Order of the Temple, both of which had participated in the sieges of Mula and Lorca, with the Maestre taking the lion's share (Rodríguez Llopis, 1998). During the modern age, and until the end of the institutions, the biggest shareholders in each town were the Nuns Convent—which received its shares as donations from members of the nobility in the years after the *Reconquista*—in Lorca and the *Marquis of Los Vélez* in Mula.⁵

This hypothesis is useful in that it can reconcile institutional diversity and homogeneous geography and weather. However, it is incomplete and does not provide an answer for institutional persistence or the institutional switch in the 1960s. The model presented in section 3 combines with this theory to fully explain (i), (ii) and (iii).

2 Background and Data

In this section, I discuss the history of Mula and its particular characteristics before, during and after the institutional transition. Geographical, historical and social conditions at the time the Christians conquered the Kingdom of Murcia had an important impact on the way institutions were initially set up. According to the model presented in section 3 this switching, or experimenting, was possible only in those towns where farmers were not expropriated during the *Reconquista*, where the initial distribution of water property rights was egalitarian.

⁴This initial shock in institutions is similar to that in Chaney (2008).

⁵As during much of the Spanish *Reconquista*, Christian populations were brought to the area with the goal of establishing a Christian base. Hence, the new Christian settlers in Mula started *tabula rasa* and created new institutions. Mula and Lorca were also frontier cities between a Christian kingdom and a Muslim kingdom, which, until the conquest of Granada in 1492, were in a constant state of war. Moreover, since the rule of these two cities was given to the ecclesiastical orders, it is not surprising that the institutions there differed from those in other towns.

2.1 Institutions

After the separation of water and land ownership, the owners of water property rights (Waterlords) were different persons than the land-owners (farmers) and a well functioning cartel was established. The Waterlords themselves began to run the auctions. In the 19th century, this cartel was formalized, legalized and named *Heredamiento de Aguas*. The land-owners were small proprietors, with family-size plots, who created their own association, *Sindicato de Regantes*. The aim of this association was, on the one hand, self-regulate and settle disputes that arose between neighbors and, on the other hand, to keep the balance of power in the market for water.

Tandas (Quotas)

Contemporaries considered quotas the fairest institution. Water ownership was tied to land ownership. Every plot of land was assigned some amount of irrigation time during each *tanda*, a period of three weeks. The amount of irrigation time allocated to each farmer depended on the size of the plots she owned. A tree takes several years to be fully productive, but can die in a given year without sufficient water. Other crops like tomatoes, which take a farmer three months to grow and harvest, incur no losses, beyond the cost of seeds, during a drought. Hence, a farmer with a secure supply of water plants trees and receives a higher expected return. This system had the advantage that every farmer periodically got some “fair” amount of water, a desirable feature during a drought. Because of the *insurance* property of this institution, farmers had the security needed to carry out risky investment such as planting trees.

Subastas (auctions)

The units sold in the auction refer to the right to use the water flowing through the river at a specific date and a specific time, within a window of three hours. The property rights of water and land were independent: some individuals were the Waterlords and some were the land-owners. In Mula, water property rights were well established and were divided into 832 shares. The functioning of the cartel was similar to a modern corporation: votes were proportional to shares and shares were tradable.⁶ The cartel paid dividends once a year.

2.2 Environment

Southeastern Spain is the most arid region of Europe. It is located to the east of a mountain chain, the Prebaetic System, which includes the Mulhacen, the second highest mountain in Europe. The rainfall frequency distribution is skewed: most years are dryer than the average. Summers are dry and rain occurs mostly during Fall and Spring. Despite the fact that the region is dry, rivers flowing down the Prebaetic System provide the region with the water needed for irrigation.

I refer here to the traditional production system, present in the southeast of Spain from 13th century until the last third of the 20th century. As reported by Anderson and Maass (1978), in each of the

⁶The cartel did not have limited liability, however.

two systems for allocating water, the production structure is based on small family-size units. More than 90% of the parcels are smaller than one hectare. The environment here makes the moral hazard problem between the landowner and the tenant so important as to render a larger scale of land exploitation unprofitable.⁷ Since the land is owned individually but the water irrigation system –the river, the dam and the channels– is managed jointly, farmers must create an institution to manage the common resource.⁸

The optimal mechanism in this environment is to *sell* the firm to the agent. Calatayud and Garrido (2011) show that this was indeed the case in eastern Spain. They further show that all contracts in this type of environment require either that the farmer owns the land or that the farmer has a long-term contract with the Landowner providing for compensation of all the improvements. Such a long-term contract is roughly equivalent to the farmer owning the land. Finally, since plots are adjacent in a small area, externalities with respect to the choice of crops might be present. For example, trees could prevent severe damage to the soil during a flooding, but only if one's neighbors also have trees.

2.3 Transition

If a new economic institution could substantially improve Pareto efficiency, in the absence of transaction costs one would expect the new institution to be put in place. If those with the power to decide are worse off under the new institution, the winners could compensate them to prevent them from blocking the change. However, one problem that can arise is lack of commitment. The Waterlords could sell their rights to the farmers. Farmers would then make undistorted decisions and, thus, increase output. However, in Mula, farmers were penniless and could only buy water rights with a promise of future payment.

One option would be to use land as collateral. On one hand, this would imply that farmers should carry a lot of risk, since they can lose “everything” during a drought. On the other hand, it would be hard for the Waterlord either to take over the land or to sell it to someone else since most farmers would likely be in the same financial situation.

Farmers might also be reluctant to collateralize their land because of the characteristics of agricultural debt. As shown by the model in section 3, a debt contract also creates inefficiencies in production due to the risk that the farmer bears, even if they are risk neutral. In the likely case that the farmer is risk averse, the inefficiency will be even greater. In the stochastic world of agriculture where weather fluctuates and crop production is differentially sensitive to effort, a debt contract implies that the farmer will get little or none of the output produced in some states of the world. If this is very likely, the farmer would optimally choose to exert an inefficiently low level of effort. Hence, commitment problems can

⁷The same argument appears in Hoffman (1996) and Rosenthal (1990).

⁸However, in neighboring non-irrigated areas the structure was radically different. Powerful landowners hired seasonal workers to work in large estates and paid them wages just above their survival needs. These large estates were used to grow cereals and were not irrigated. The goods produced in the *huertas* (irrigated orchards) were also different than those produced in the large estates. *Huertas* produced mainly vegetables and fruits. They were also the main producers of white mulberry leaves during the silk boom in the 16th and 19th centuries. However, large estates produced mostly grain and fodder. *Huertas* produced goods heterogeneous in quality, while large estates produced homogeneous goods that yielded low profit per acre. The former products (citrus, peaches, etc) are very sensitive to weather conditions and require constant and close attention.

delay or make impossible an institutional transition. In such a situation, the only way to achieve full efficiency would be to *give* the water rights to the farmers, i.e., *give* the firm to the agent.

Not surprisingly, this was the proposition of the newly elected national government in 1931 when a new dam was built (see Figure 3). The government made an offer to the Waterlords of 4.2 M *pesetas* for all the water rights of the Mula river. After the purchase, the government would give water rights to the farmers in proportion to the size of their land holdings, and water property rights would be tied to land property rights. Hence, the commitment problem would be solved and the more efficient institution would be adopted.

The Waterlords took the offer very seriously. They printed a small book with the details of the offer, the opinion of the president and other members of the council and the main conclusions reached during meetings prior to a vote of the general assembly. The opinion of the water owners split into three groups. The group of small owners (1 or 2 shares) was in favor of the sale, at any price. Since these owners were also farmers reliant on a small number of water shares, they would have benefited greatly from the change. Not only would they have received money from their shares, they would have also been awarded more water rights than they had before. The group of middle owners (3 or 4 shares) was also in favor. Many of them were farmers, and would have received roughly the same amount of water rights as under the auction system, but they would have been paid for the water they owned. The group of big owners (5 or more shares) was in favor of the offer only if the price offered was sufficiently high and the payment was made in cash. The offer of 4.2 M *pesetas* was considered a “fair” price according to most of the big owners and the offer was accepted by the Waterlords during their general assembly.

However, the sale was never completed. The Waterlords demanded payment in cash, but the government—the newly established 2nd Republic of Spain—could not afford to pay in cash. The government was unable to make a credible promise of future payment. The concerns of the Waterlords were justified: three months after the delayed payment was rejected, the government defaulted on its national debt. Had the Waterlords accepted the offer from the government, they would not have been repaid. Soon after, the civil war broke out and the prospects for change looked dimmer than ever.

By the 1950s and 1960s, though, Spain was in the midst of an economic boom. The government’s foreign policy began to change. Borders were opened and trade agreements drafted with the EU and the US. This situation produced an unprecedented boost in the Spanish economy: the *Spanish Miracle*. This boost was especially important for the farmers in Mediterranean Spain. Exports of fresh and dried fruit grew exponentially.⁹ For the first time in their history, the farmers of Mula could produce enough output to create a surplus that could be saved. Improvements in the financial sector and a state policy directed towards increasing local savings and providing easy access to credit for small business created the perfect environment for savings (see sub-section 4.4). By 1966, the combination of a policy of easy lending with the savings accumulated by the farmers in Mula over the previous decade was enough to provide a credible promise of future payments.

After several centuries of continuous operation, the auction mechanism came to an end in 1966. The farmers’ union (*Sindicato de Regantes*) reached an agreement with the cartel (*Heredamiento de Aguas*)

⁹See Morilla Critz, Olmstead and Rhode (1999).

and the auction was replaced by a system of fixed quotas. Both parties agreed that the *Sindicato* would pay a fixed price for each *cuarta* of the water flowing through the river. The price would be revised every six months. The *Sindicato* then allocated the water among the farmers using quotas.

The key to the transition was the credit line a savings bank extended the *Sindicato*.¹⁰ In 1966, the *Sindicato* signed an agreement with the bank for a credit line that could be used only for buying water property rights. Hence, in 1966 the *Sindicato* began buying each of the shares from the original owners. During the transition process from 1966-1981, farmers had to pay an extra fee, proportional to their land area, in order to repay the loan. By 1981, the association owned all the shares and formally changed the legal status of the water. Since then, the water of the Mula River has been tied to the land, in the pattern of other towns in Murcia. Farmers now only have to pay the operational costs of the system in proportion to their land area. They are now owners of both land and water.

2.4 Data

Although the process of allocating water in the region has varied slightly over the years, the basic structure has remained essentially unchanged in each town since the 13th century. Land in Murcia is divided into *regadío* (irrigated land) and *secano* (dry land). Irrigation is only permitted in the former. *Regadío* lands are fertile and close to the river, facilitating an efficient use of the region's scarce water. A channel system allows water from the river to reach all *regadío* lands. Since it is forbidden to irrigate lands categorized as *secano*, only the farmers that own a piece of *regadío* land in Murcia are allowed to buy water.

Agricultural Census and Economic data I use data from different sources for the analysis. Most of the economic data comes from INE (*Instituto Nacional de Estadística*). The data includes prices of agricultural products. Production quantities and area cultivated are available by product at a national and at regional level. I also collect financial data about deposits in public savings banks (*Cajas de Ahorros*) and rural loans provided by the government. I use the price index computed by Ballesteros and Reher (1993) because it covers the whole period considered here (1803-1991). The Ballesteros and Reher index tracks the more volatile Sardá (1998) index of the 19th century.

I augment the data with individual characteristics of the farmers' land, which I obtain from the 1954/55 agricultural census. This census was conducted by the Spanish government to enumerate all cultivating soil, producing crops and agricultural assets available in the country. Here, farmers are potential bidders and their names are matched with the names in the auction data. Individual characteristics of the farmers' land include land type and location, area, number of trees, production and the price at which the product was sold in the census year. Figure 4 shows a sample card for one farmer from the census data. It can be seen in Table 2 that *Land Extension*, *Number of Trees* and *Kg sold* vary considerably across farmers.

¹⁰Information obtained via personal interview with the current president of the *Sindicato*, who is both a farmer and the son of the president of the *Sindicato* in 1966.

Auction Data Auction data is from the historical archive of Mula.¹¹ Figure 5 shows the oldest auction sheet in the sample, corresponding to May 8th, 1803. The sample for this study includes more than 150 years of auction data spanning from 1803 until August 1st, 1966 when the allocation system was modified from auctions to quotas. Every week, 40 units were sold. Each unit corresponded to three hours of irrigation. No auction was run in the Dam was dry.

Water Ownership data I collected available water shares ownership records from the historical archive of Mula for 1912-1966. Each record book contains the name of each owner and the number of shares (*cuartas*) she owned. The total number of shares is 832.

Rainfall data The auctions data is complemented with daily rainfall data for Mula (1933-1992) from the *Agencia Estatal de Meteorología*, AEMET (Spanish National Meteorological Agency). Rainfall in Murcia occurs mainly in spring and autumn. Products grown in the region most require water between April and August. During this cultivation period, when the quality of citrus fruits is more sensitive to water deficits, more frequent irrigation is advisable. Although annual average rainfall is 320 *mm*, most years are dryer than this average: the rainfall frequency distribution is skewed. Torrential rains are uncommon; when they do occur precipitation is high.

3 Model

For simplicity we consider the problem that a single farmer faces against a single Waterlord. Each farmer could buy water rights from many Waterlords. Competition between Waterlords to sell the water rights to a given individual farmer means that the Waterlord will sell the water rights as soon as his expected payoff from the sale is greater than his reservation value.

The production function in this economy depends on the state of nature s , the water rights required for irrigation θ and the unobserved effort exerted by the farmer e , i.e., $f(s, \theta, e)$. s is a random variable that is realized after the agent has put in effort. The problem for each farmer is analogous, up to the amount of property rights that the farmer needs θ . Hence we can get rid of θ to simplify the notation, i.e. $f(s, \theta, e) \equiv f(s, e)$. The production function $f(s, e)$ is strictly increasing and concave in each argument.

The problem that the Waterlord is faces, when deciding whether to sell water rights to a given farmer, will be identical for each farmer. Thus, we can focus on solving the problem of the Waterlord with just one farmer. The Waterlord will act as the principal and will offer a contract B to the farmer. The contract should be based on observables.

The contract B chosen by the Waterlord is a standard debt contract, i.e., the farmer has to pay a fixed amount B . If the farmer does not pay B , the Waterlord incurs a bankruptcy cost $C > 0$ and takes over all the output. This standard debt contract is optimal in the present setting: it maximizes the set of parameters under which the sale will occur.¹²

¹¹From the section *Heredamiento de Aguas*, boxes No.: HA 167, HA 168, HA 169 and HA 170.

¹²See Townsend (1979) and Gale and Hellwig (1985) for results on the optimality of the standard debt contract.

The game has three stages. In the first stage, the Waterlord offers a contract B to the farmer, i.e., the Waterlord decides whether to sell the water rights to the farmer and the amount to be paid B . In the second stage, the farmer decides how much effort to expend, based on the contract, i.e., $e \equiv e(B)$. In the third stage, after the uncertainty is realized, the farmer pays the Waterlord the debt B or, in case he cannot pay, the Waterlord gets the collateral of the farmer and all the harvest.

The farmer has some wealth D that she can use as a down-payment. Let I be the value that the Waterlord assigns to the ownership of water rights which is equal to the market value of the water under the auction system. I assume that $D < I$, otherwise the farmer could use his collateral to buy the water property rights and the transition to a more efficient institution is trivial.

The Waterlord asks the farmer for a payment B after the output is realized. The Waterlord incurs a risk because the farmer may not be able to pay the full amount B . Thus, in equilibrium we have $B \geq I$. The Waterlord will sell the water rights as soon as she gets a profit from doing so. This means that the selling price for the Waterlord equals I .

Throughout the paper I refer to observable or contractible as the same concept. I will not consider situations in which some variables are observable but not contractible. Hence, I assume a *complete contracts* setting. If contracts were incomplete, the change will be even less likely. If effort was observable, the analysis would be simpler. The Waterlord will ask the farmer to exert the first-best level of effort. This situation, however, is unlikely to happen in the real world.¹³

3.1 Example

Here I present an example in order to explain the implications of the model. Let $f(s, e) = 20\sqrt{s \cdot e}$. Here s is the amount of precipitation in the farmer's plot. The value of s is 1 or 25 with equal probability. In this economy, if the farmer owns the water rights, she will exert the first-best (FB) level of effort, i.e., $e^{FB} = 900$, get an expected output of $E_s[f(s, e^{FB})] = 1800$ and obtain an expected surplus of $TW(e^{FB}) = 900$. The value of owning water for the Waterlord is lower than it is for the farmer. This example reflects the idea that quotas are more efficient than auctions as shown by Donna and Espin-Sanchez (2014). Let $I = 800 < 900 = TW(e^{FB})$.

The first thing to notice is that the farmer will go bankrupt if $s = 1$ whenever $B > 600$. That is, if the debt is too high to be paid in full in the low productivity state, then the farmer will default. When $B \leq 600$ the farmer will never default and will always be the residual claimant of the output. Hence she will put the FB level of effort. If $B > 600$ then the farmer will be the residual claimant of the output only when $s = 5$, hence she will put in the second-best (SB) level of effort at most. If $B > 1250$ the farmer's expected utility is negative. Even though she is the residual claimant of the output when $s = 5$, the output that she receives in this case is not enough to offset the effort cost. Hence, the effort of the farmer as a function of the contract offered is:

¹³See Stiglitz (1974) for a discussion about unobservables and optimal contracts in agricultural production.

$$e(B) = \begin{cases} e^{FB} = 900 & \text{if } B \leq 600 \\ e^{SB} = 625 & \text{if } 600 < B \leq 1250 - 2D \\ 0 & \text{if } B > 1250 - 2D \end{cases} \quad (1)$$

Notice that the farmer's best response is independent of her own ability to make a down-payment D . However, it is important because it determines the contract that the Waterlord is able to offer to the farmer.

When the down-payment is zero, i.e., $D = 0$, the farmer does not have any money to spend as a down-payment. However, the Waterlord needs at least 800 in expectation, i.e., $B \geq 800$, and thus the farmer exerts at most the SB effort. Under this contract, the farmer does not get any output if $s = 1$. With this result, equation 2 becomes:

$$W_0(e, B) \equiv \frac{1}{2} [\min \{B, 500 - C\} + \min \{B, 2500\}] \leq 800 \quad (2)$$

The minimum value of B that satisfies this equation is $B = 1100 + C$. Hence, equation 8 has no solution when $D = 0$ and $C > 150$.

In other words, if the Waterlord offers a contract with $B > 1250 - 2D$ the farmer will not exert any effort and the Waterlord will get nothing. If the Waterlord offers a contract with $B < 1100 + C - 2D$ he will get less than he is getting while keeping the water rights and running the auction. Hence, when bankruptcy costs are $C > 150$, the Waterlord will not sell the water rights to the farmer under any future payment B .

When the down-payment D is positive, a sufficient condition for an institutional change is:

$$C \leq 150 \quad (3)$$

A sufficient condition for a change to happen is that bankruptcy costs are low compared to the down-payment. Hence, there is a threshold in the bankruptcy costs that triggers the institutional change.

Equation 3 is a sufficient condition for institutional change, but not a necessary condition. Equation 3 indicates the threshold for an institutional change where the farmer will exert SB level of effort. However, an institutional change can happen when the farmer exerts the FB level of effort.

As noted above, the farmer will be the residual claimant in all states, and thus will never default. Moreover, when $D \geq 200$ the Waterlord will offer a contract with $B \leq 600$ and the farmer will exert the first-best level of effort. Notice that, since the farmer will never default in equilibrium, the bankruptcy costs are irrelevant. A sufficient condition for an institutional change is:

$$D \geq 200 \quad (4)$$

Figure 2 shows all the possible outcomes depending on the parameters of the model. There are three cases:¹⁴

¹⁴When $D > 200$ and $C < 150$ an inefficient institutional change could happen. However, such a contract will give the principal the same expected payoff as the efficient contract but will give the agent a lower output. Competition on the

- I. $C > 150$ and $D < 200$. No institutional change is possible.
- II. $C \leq 150$ and $D < 200$. Inefficient Institutional change happens (SB).
- III. $D \geq 200$. Efficient Institutional change happens (FB).

The shape of the indifference equations are specific to the functional form in the example but the qualitative results are valid under more general specifications.

3.2 General Case

I now compute the solution of the game in the general case. The expected payoff of the Waterlord is an increasing function of the level of effort exerted by the farmer. Hence, the farmer is implicitly choosing the expected transfer. The Waterlord sells the farmer the water rights θ and asks for a fixed amount B to be paid after production occurs. The problem of the farmer is then:

$$\tilde{V}(B) = \underset{e}{\text{Max}} V(e, B) \equiv \underset{e}{\text{Max}} \{E_s [\max \{f(s, e) - B, 0\}] - D - e\} \quad (5)$$

where the expectation is taken over r . The farmer has to pay B and D to the Waterlord and keep the rest of the output. If the farmer cannot pay B , i.e., if $f(s, e) < B$, then the Waterlord will take the output and the down-payment, after paying the bankruptcy costs, and the farmer will get nothing.

Incentive Compatibility requires that the Waterlord should not be worse off selling his water rights:

$$W(e, B) \equiv E_s [\min \{B, f(s, e) - C\}] + D \geq I \quad (6)$$

In equilibrium the Waterlord will be indifferent, hence equation 6 holds with equality. $W(e, B)$ is the Waterlord's payoff if he sells the water rights to the farmer under contract B and the farmer effort is e .

Notice that, for a fixed level of effort e , this is a zero-sum game, i.e., the Waterlord gets what the farmer does not, except for the bankruptcy costs. With positive bankruptcy costs this is a negative-sum game because the bankruptcy costs are incurred in equilibrium with positive probability.

The first-best (FB) level of effort of this game is equal to the level of effort that a farmer would exert if she owned water property rights equal to θ , i.e., $e^{FB} = \underset{e}{\text{argmax}} TW(e)$. If the farmer is the owner of the water she never enters into bankruptcy and does not have to pay the bankruptcy costs:

$$\tilde{V}(B) + W(e, B) \equiv TW(e) = E_s [f(s, e)] - e \quad (7)$$

Notice that the level of effort that the farmer will exert under a debt contract is not greater than the FB level, i.e. $e(B) \equiv \underset{e}{\text{argmax}} V(e, B) \leq e^{FB}$.

The farmer will put in the FB effort if she always has a large enough down-payment to cover the loan, i.e., $f(s, e(B)) \geq B$ for all s . In this case, the problem of the farmer is identical to the FB. Moreover, since there is no risk, the Waterlord will ask for the minimal acceptable amount in the loan, i.e., $B + D = I$. However, if the farmer does not have enough collateral, she may not be able to pay

banking side will prevent the inefficient institutional change in this case.

back the loan with certainty. In this case the Waterlord may ask for a payment greater than the value he assigns to the water rights to compensate for the risk.

We can solve the game by backward induction. We can write equation 6 as a function of B only:

$$\widetilde{W}(B) \equiv E_s [\min \{B, f(s, e(B)) - C\}] + D = I \quad (8)$$

We are interested in the lowest value of B that satisfies this equation. Equation 8 will have no solution when the value that the Waterlord assigns to the water rights is too big compared to the collateral, i.e., I is too big compared to D , when the reduction in output associated with the reduction in effort due to the holdup is big, i.e., $f_e(s, e)$ is big, and when the bankruptcy costs are high, i.e. C is high.

The long persistence of this inefficient institution can be explained by the high-powered incentives present in the economy. As explained in sub-section 2.2, growing fruit trees is an effort-intensive activity. After paying for their living conditions, farmers did not have any money left over to save. Thus, they did not accumulate considerable savings to use as collateral until the 1960s, as shown in sub-section 4.3. Finally, bankruptcy cost here is a proxy for the quality of the institutions. It measures the costs that the lender faces if the farmer defaults on the loan. The improvements in financial institutions and the preferred treatment of rural loans explained in sub-section 4.4 imply lower bankruptcy costs.

Let \underline{D} be the minimum amount of down-payment such that equation 8 has a solution. Under any level of down-payment D greater than \underline{D} a transition will occur. However, the effort exerted by the agent will always be suboptimal as long as $D < I$.¹⁵

3.3 Institutional Inertia

The model presented above shows that, even in a world with perfect contracting and perfect observability, a mutually beneficial arrangement will not be attained if there are commitment issues. These issues could be generated by limited liability. In other words, the punishment that the Waterlord can use against the farmer in case of default is limited. This problem vanishes if the farmer has enough wealth that she can use as collateral.

Institutional Inertia, then, is a situation in which a more efficient distribution of property rights cannot emerge due to lack of commitment from the potential winners, in this case the farmers. Efficiency, when farmers have homogeneous productivity, requires the distribution of property rights to be egalitarian.¹⁶ If the new distribution cannot be attained due to contractual problems, it will not emerge. Moreover, since auctions can be run under any distribution of property rights, the inverse transition (from *quotas* to *auctions*) could always been achieved without delay. The Institutional Inertia is asymmetric.

¹⁵The result that down payments can be used to improve efficiency in the allocation of resources is not new in the finance literature (Stiglitz and Weiss, 1981).

¹⁶When farmers are heterogeneous in productivity, efficiency requires the expected marginal productivity to be equal among all farmers. Hence, more productive farmers will have greater quotas. In the years following the *Reconquista*, this was indeed the case in Murcia. There were up to seven different categories of land quality that were assigned different levels of water per land unit. The farmers also had to pay their share of maintenance cost proportional to water received, not to land owned.

This practice disappeared from all towns during the 19th century, which suggests that changes in technology during that century made all the land of similar quality.

Imagine a situation with several towns. Initially, in each town, both the allocations of property rights and the original institution (*quotas* or *auctions*) is established arbitrarily. Quotas require the allocation of property rights to be egalitarian. Farmers start with no wealth but can save some money over time. If *auctions* were more efficient than *quotas*, then the towns in which the original institution was *quotas* will immediately change to *auctions*.¹⁷ In this case there is no Institutional Inertia. However, if quotas are more efficient than auctions, as shown by Donna and Espín-Sánchez (2014), towns with auctions will not switch to quotas until farmers have saved enough to use as collateral.

There are several factors affecting the likelihood of a transition to a new institution:

- A change in $f(\cdot)$ can be interpreted as a change in output prices or a change in technology. However, the effect of a change in the production function on the likelihood of the institutional change is ambiguous. We can see in Figure 7 that, although prices were rising during the 1950s, by 1966 they were in a clear decline. Sub-section 4.1 discusses whether a technological change could have affected the transition.
- A more equal distribution of property rights implies that many farmers already own water property rights. Hence, the transition is more likely to happen. Fewer farmers face a holdup and there are more farmers who are members of the water cartel and would thus vote in favor of the change. Sub-section 4.2 discusses whether the distribution of property rights had an impact on the transition.
- The greater the savings of the farmer, the greater the amount available for collateral. With a larger down payment the probability that a transition happens is higher. We can see in Figure 9 that the deposits grew more than threefold during the 1950s and 1960s. Figure 10 is a back of the envelope calculation of the proportion (of the total value) that an average farmer could pay as a down payment. It was not until the 1960s that the average farmer could pay more than 10% as a down payment for the water property rights.¹⁸ I discuss in sub-section 4.3 the effect that the increase in savings had on the transition.
- In the analysis presented above, there is an implicit assumption that lenders earn zero profits in expectation. Greater bankruptcy costs and lender profits means that the transition is less likely. A more developed financial system and cheaper access to credit thus imply that the transition is more likely (see sub-section 4.4).

4 Empirical Evidence

In this section, I address the empirical predictions made by the model. I show that institutional change cannot be attributed to changes in technology by looking at data from the auction, as well as other micro

¹⁷Indeed, there is evidence of institutional experimentation during the years immediately following the Christian invasion. The towns of Totana and Librilla –located down the Guadalentin river from Lorca– switched back and forth between quotas and auctions before the 15th century (see Rodríguez Llopis, 1998).

¹⁸Saving banks in Spain typically require a down payment equal to 10-15% of the principal for a mortgage.

indicators: the distribution of water ownership, price of water and prices of the output. I show that, with the data available, we cannot predict a structural change in 1966.

The structure of power or ownership within the organization shows no particular trend during the years preceding the change. If the change happened due to an increase in the inefficiency gap, i.e. the difference in output under both institutions, we would observe a decrease in the concentration of water ownership over time. However, as we can see in Figure 8, the structure is very stable during the decades preceding the change. Hence, either all farmers were identical and the situation for all of them changed in exactly the same way during the summer of 1966, or there were some externalities associated with the chosen institution or the transition implementation.

This evidence suggests a collective action solution, which is consistent with the idea that the risk of selling water rights is lower if it is mutualized across farmers than if done individually. The evidence is also consistent with some externalities produced by the crops chosen by the farmers. As explained above, the new institution would increase the number of trees farmers planted. Trees would then reduce the damage cause by flooding –by reducing erosion– while at the same time alleviating the incidence of severe droughts –by maintaining humidity through reduced transpiration.

A financial revolution occurred in Spain in the late 1950s and the early 1960s. A more efficient credit market is not a necessary nor sufficient condition for an institutional change but it expands the set of parameters under which the change can occur. The increase in savings during the previous decade, and especially since 1957, had no precedent in the history of Spain (see Figure 9). According to the model, a sufficiently high amount of savings for use as collateral is a necessary condition for a change in institution to occur. The specific amount depends on the other parameters of the model.

4.1 Changes in Technology or Payoffs

In the absence of a commitment problem, but the presence of transaction costs, NIE (North, 1973; Libecap, 1978) predicts that a new institution, with a more precise definition of property rights, will emerge when the price of the underlying asset is sufficiently high.¹⁹ In the Mula water rights case, the transition went from an institution with better defined property rights (auction) to an institution with more diffuse property rights (quota). Quotas imply a reduction in property rights on at least two dimensions. Trading of water rights is forbidden, hence ownership is not transferable. Selling water is also forbidden, hence water usage is restricted.

If the technology improves or the demand for the output increases, the total surplus will increase under both institutions. In other words, both the value of the water for the farmers under the quota and the value of the water for the Waterlords under the auction would increase. Thus, the sign of the change of the inefficiency gap after an increase in the demand of the output is ambiguous and depends on the shape of the production function.

As we can see in Figure 7, real output prices declined beginning in 1961. Prices increased in the early 1950s, peaked in 1961, and then decreased. Prices first increased, probably due to the increase in

¹⁹Or when the inefficiency gap becomes big enough. The inefficiency gap is the difference in total surplus under the new (more efficient) institution minus the total surplus under the old (less efficient) institution.

international demand, and then slowly decreased. The shock was transitory, not permanent. While this analysis implies that the long run value of the water did not change, farmers' profits in the short run were high enough to provide the collateral needed to change the institution.

Figure 6 also shows that the real price of water, equivalent to the marginal productivity of water, did not change much during the period considered here. More surprisingly, there is no clear price trend during the 19th century although there might be a slow upward trend at the beginning of the 20th century. In 1923, the construction of a new dam was announced. The dam was finished by 1930. The dam construction explains why prices peaked in 1930 and then dropped in 1931. Farmers, anticipating the increase in supply, increased their demand for water beginning in 1923. They planted more trees to increase their production capacity. The closer to the 1930 shift in supply, the greater the incentive to increase capacity, thus the peak. When the dam opened in 1931, the supply increased and, hence, the price plummeted. Price volatility during the 1930s and 1940s was due to the Spanish civil war (1936-1939), WWII and the post-war period together with the autarky of the dictatorship (1939-1950s). Prices rose dramatically beginning in 1952 under the Spanish government's new foreign policy of openness and export promotion. As with output prices, the rise in input prices also proved temporary. Over time, supply increased to adapt to the new international demand. By 1962, prices were already similar to historical standards and continued to fall throughout the 1960s. Although the demand shock was temporary, farmers in Mula used the opportunity to accumulate savings and capital for the first time in history.

4.2 Ownership Distribution

One puzzling issue arises here. Why did each farmer not simply buy water rights and solve her own problem? According to the intuition and the model, buyers should not have waited until everyone had sufficient collateral. Richer farmers could afford to buy some water rights earlier than poorer farmers. Hence, the transition should have been gradual rather than sudden. However, as Figure 8 shows, this is not what happened. The proportion of owners with just one water rights share—, an amount insufficient to irrigate the average plot in a universe of 832 shares and about 500 farmers— was constant across time at about 30%. Moreover, the data excludes some farmers who owned no water at all. The distribution of shares remained unchanged by number owned over time.

Several facts could help explain this puzzle. First, wealthier farmers can retain some cash and eliminate their liquidity issues without having to buy water rights. Second, some of the gains from quotas come from internalizing externalities. In addition to the externalities mentioned above, there might also be organizational improvements. Since farmers and water owners are now the same people, conflicts about improving channels and rules of rationing during extreme drought will be easier to solve. Moreover, and related to the third point, a sudden transition is easier because the lender—whether a Waterlord or a financial institution— can use the law of large numbers and eliminate the idiosyncratic risk associated with each farmer. By pooling all the claims into a single claim, the lender must still bear the aggregate risk, but not the idiosyncratic risk. This means that the risk premium the lender requires is lower. This pooling solution also eliminates the adverse-selection problem by mutualizing debt amongst all farmers. Hence, when externalities and idiosyncratic risk are important, the set of parameters in which the transition

happens suddenly outweighs the set of parameters in which the transition happens slowly. Under these conditions we expect a rapid transition.

Third, and most important, farmers began collectively asking for the loan through the labor union *Sindicato de Regantes*. The purpose of a bank is to identify good investments and monitor the agent to ensure loan repayment. In this case, the *Sindicato* has better monitoring technology than either the Waterlords or a potential financial intermediary. The farmers, as members of this organization, are jointly responsible for the loan. Hence, the *Sindicato* can encourage each farmer to pay their share of the loan. Further, it can also prevent farmers from cheating by using both monetary and social sanctions. These facts do not explain why the change took place in 1966 and no earlier, but they do help us understand why the change was sudden rather than gradual.

4.3 Savings and Living Conditions

In Figure 9 we see that the evolution of real deposits followed an erratic path during the 19th century. Real deposits grew slowly until peaking during the crisis of 1898 and then declined until the 20th century inter-war period. During Primo de Rivera's dictatorship (1927-1930) deposits seemed to recover until the civil war (1936-1939). Deposits did not grow during or after the war, or during the autarky (1940s). Not until the 1950s did deposits grow again, this time more sharply and steadily. However, one should be cautious here. The data shows the evolution of the average deposit, not the individual deposits of the farmers in Mula. I am implicitly assuming that the evolution of the farmers' deposits follows the evolution of the average deposit. This is a reasonable assumption since these farmers fall within the target audience of depositors at public savings banks.

The graph makes clear that, however erratic and dependent on the macro-environment deposits were, the uniform growth beginning in the 1950s was unprecedented. Living conditions, in addition to the savings of the lower and middle classes, improved during the 1950s and reached a new standard by 1960. This growth was important for Murcia, where both measures initially lagged the national average before catching up by 1957 and then surpassing it. The growth of living conditions and savings and the peak of real deposits in 1966 are all consistent with the model. In order to solve the commitment problems, farmers had to put up enough collateral to demonstrate a credible payback commitment.

The government offered to buy Mula water rights for 4.2 M *pesetas* in 1931. If we knew how many farmers shared the water we could know how much each farmer had to pay. According to the census data, 452 farmers cultivated Mula land in 1954. Between 1954 and 1966, 537 farmers bought water according to the auction data. This is an upper bound because some farmers could have sold their plot to another farmer or to their child; thus two different names would appear for the same plot's water. Figure 10 shows the percentage of water value a farmer covered with her savings each year. The percentage increased from less than 5% to about 15% in 1966 and continued on an upward climb. Although 15% seems like a small proportion, it is meaningfully greater than 3-4% for farmers. Also, this measure is a lower bound for the collateral required.²⁰

²⁰The farmers could have also asked for loans from their relatives and friends. Before the increase in living conditions that began in the 1950s, the living conditions in the town were not far from subsistence, which makes an informal lending

By 1966 the average farmer had 12,000 *pesetas* deposited in a savings bank in Murcia (Figure 9).²¹ The price of one unit of water could reach more than 4,000 *pesetas* during a drought (Table 2). However, the average price of one unit during a drought would be around 2,000 *pesetas* per unit (see Donna and Espín-Sánchez, 2014). The average farmer with trees needs to irrigate several times every year and more frequently during a drought.²² A back-of-the-envelope calculation suggests that the average farmer would expend 8,000-10,000 *pesetas* buying water in a dry year. Hence, the average farmer in 1966 would be able to buy water for her plot during a drought. However, many of farmers with below-average savings would not be able to do so.²³ These farmers might have enough savings to obtain a long-term loan to purchase water property rights –arguably at government subsidized rates– but would be unable to buy the water needed for a single dry year using out-of-pocket cash. In other words, farmers were solvent, but still illiquid, in 1966.

4.4 The Financial Revolution 1957-1962

The last empirical prediction of the model is that more efficient financial markets would help to solve the commitment problem that the Waterlords and the farmers faced. Francisco Comín (2005, 2007) explained the role of the government and its agencies in promoting economic development during the 1950s and 1960s. The government's goals were to increase exports, expand the industrial sector, modernize agriculture and provide cheap credit to small businesses and households. The main instrument used for these purposes were the *Cajas de Ahorros* (Public Savings Banks). Crucially, the Public Savings Banks only functioned as financial institutions, rather than charities, when the Ministry of Finance replaced the Ministry of Labor as regulator in 1957 Comín (2007).

In 1962, the Bank of Spain was nationalized and new banking regulations were passed in Spain. This new legislation changed the role that Savings Banks played in the financial sector and increased the importance of the ICCA, a national agency which coordinated macro-decisions of the local Saving Banks. The new law also fostered banking specialization, alongside long and medium term stability.

The economic growth that followed Spain's openness to international trade, mostly with western Europe and the US, together with easier access to credit and a more efficient financial sector, reinforced each other in a virtuous circle. Economic growth in the 1960s enabled the Savings Banks to expand their

market unlikely. However, potential lenders would be in the same situation as the farmers were, needing cash right before the harvest months. Even if they were not short of cash, the neighbors might be reluctant to lend money to another farmer who would then try to outbid them during the next auction. Lastly, the most obvious source of credit would have been the Waterlords who could allow the farmers to delay payment for water until after the harvest. However, the evidence points in another direction. Not only did the Waterlords not like to delay the payments, but they also kept a special book with the names of debtors to the *Heredamiento*. Debtors were not allowed to bid in the auction. The historical record is replete with cases in which the Waterlords had trouble collecting their money (mostly from fines) from small farmers. It is little wonder that the Waterlords wanted to be tough in this aspect. The evidence also suggests that land could not be used as collateral as it was hard to take over in case of unpaid debts (see Ruiz Funés, 1916).

²¹It is also worth noticing that, in an economy with double-digit inflation, and one in which the daily wage of an unskilled worker was 50-100 *pesetas*, holding 12,000 *pesetas* in cash to bid in the auction during the following year meant high losses in forgone earnings.

²²During a drought only farmers with trees will irrigate, given their higher value for the water. In humid years, farmers with water intensive non-tree crops such as potatoes or tomatoes will also buy the cheaper water to irrigate their crops.

²³There is no disaggregated data for individual deposits.

operations due to growing deposits. Further, these banks diversified deposits through new regulations set forth in the Development Plans in 1964.

Figure 11 shows how both the quantity and the size of rural loans began to increase at an exponential rate in 1951. However, the change in the institution did not occur in 1951, nor at any time during the 1950s. The rise in prices from extra profits was temporary, and hence, the system's long-run inefficiency was unaltered. However, every year of high prices provided some extra profits, which farmers decided to save. By 1966, although prices had been falling for several years and had reached normal levels, farmers had accumulated enough savings to use as collateral for the purchase of water rights. Further, these farmers were able to secure a loan from a Public Savings Bank, a loan a private bank would have denied.

5 Discussion

The inertia produced by the lack of commitment is asymmetric: a system can move from quotas to auctions at any time but requires a specific distribution of property rights to switch from auctions to quotas. This feature of the institutional inertia model is not intrinsic to auctions. Rather, the model's construction requires one of the institutions to operate under a specific distribution of property rights. In this section I show how the model is applicable to other situations in which land or labor is the scarce resource. Thus, the holdup problem also concerns these other production factors.

Land Reform While water ownership is not an important issue in some places, the Mula case is very similar to episodes of land redistribution all over the world, especially in Latin America –20th century Mexico– and Eastern Europe –19th century Russia. In these cases, there was consensus that land would be more productive in farmers' hands but landlords remained unwilling to turn over the land for free. The typical solution to this problem has been a government intervention, whether through guaranteed loans, expropriation without compensation, or something in between.

In the context of the model proposed here, each solution would have different effects. If farmers had to pay back all or most of the value of the land, the holdup problem implies they would not put in enough effort, would not produce enough output and would end up defaulting. This was the case after the Russian abolition of serfdom, as documented by Nafziger (2014). The only way to prevent such a default was to give the land to the farmers for free, or to sell it at a highly subsidized rate. Thus, either landowners' would receive nothing for their land, or would be compensated from taxes on the non-agricultural sectors of the economy. Neither option was politically viable in Russia, nor in many other places. It is interesting that in this case the former serfs obtained property rights to their labor for free –their former masters were deprived of that labor without compensation– but were denied property rights to the land they cultivated.

Indenture Galenson (1984) discussed the case of indenture contracts in America.²⁴ Indenture was introduced in the 17th century primarily because workers did not have enough money to pay for their

²⁴See Gupta and Swamy (2014) on the introduction of indenture in India.

trip to America. The main consequences of indenture were workers' lack of effort and poaching by other employers. The intuition is the same as in the water rights case presented here. The employer (principal) needed to hire laborers to work on a plantation. The worker (agent) would have liked to travel to the plantation but did not have enough money. In a world with perfect contracting, or one in which the worker had sufficient funds to pay for the trip, the worker would cover the cost of her own trip and, once on the plantation, agree to the first-best contract. However, the worker could not commit *ex-ante* to not run away from the employer, renege on her debt for the trip's cost, or find a higher wage with another employer. Hence, the employer proposed indenture, a second-best contract. This contract did not necessarily elicit effort from the worker. Subject to high personal costs associated with lack of freedom and physical punishment, the worker only wanted to finish her term and negotiate a better contract.

Slavery and Manumission Fenoaltea (1984), citing Moes (1960), argued that "slavery would disappear not because it was unprofitable, but because it was even more profitable to allow the slave to buy himself back," that is, if the slave had the money. Following the same line of argument as in the indenture case above, slavery existed not because it was optimal but because the slave could not initially buy his freedom since he could not commit to pay the value of his work to the master in the future. Fenoaltea noted the Roman custom of manumission, in which the slave purchased himself from his master after a long period of good service. Again, had the slave had the money to buy his freedom, he would have done so as soon as possible. The only explanation for the delay in manumission is the slave's inability to commit to pay. The slave would "outbid anyone else because he had a sentimental attachment to his person" (Moes, 1960).

6 Conclusions

The main contribution of this paper is to explain a puzzling transition that happened in irrigation communities in Spain in the 1960s, when some towns which had allocated water from the river through auctions switched to quotas. This transition is puzzling for two reasons. First, the transition happened in the absence of political instability or important technological changes. Second, unlike most institutional changes over the last two centuries, the allocation mechanism changed from a market institution (auctions) to a non-market institution (quotas).

In order to explain the first puzzle, I suggest that the transition was not motivated by a change in decision power over water rights, or by a change in payoffs. Rather, what changed was farmers' ability to credibly commit to pay the value of their water rights to property owners. Following a temporary boom in agricultural exports from the region, and a public policy focused on easing small exporters' access to credit, farmers were able to accumulate savings for the first time in centuries. They used the savings as upfront payment (collateral) to buy the water rights from the Waterlords. The transition from auctions to quotas was delayed for centuries because, had farmers purchased the water rights, they would have been unable to pay for them.

Table 1: Rain in several towns in the region

Town	Sample Period	Average	Standard Deviation
Ulea	1961-1966	150	201
Lorca, C. H. S.	1933-2007	212	276
Fortuna	1952-2010	228	286
Alguazas	1933-1981	234	300
Murcia, C. H. S.	1933-2007	236	297
Jumilla	1912-1930	242	259
Lorca, Castle	1948-1978	243	360
Librilla, C.H.S.	1934-2010	260	350
Yecla	1935-2010	261	289
Mula, De La Cierva Dam	1933-2010	262	362
Lorca, Valdeinfierno Dam	1933-2010	268	338
Totana	1913-2010	269	344
Mula, Diputación	1954-1977	271	311
Mula, C. H. S.	1953-1978	274	343
Murcia, Institute	1863-1955	275	344
Blanca	1945-2008	278	331
Ricote	1944-2010	290	353
Pliego	1954-2010	306	394
Moratalla	1933-2010	308	356
Lorca, Casa Iglesias	1916-1978	406	589

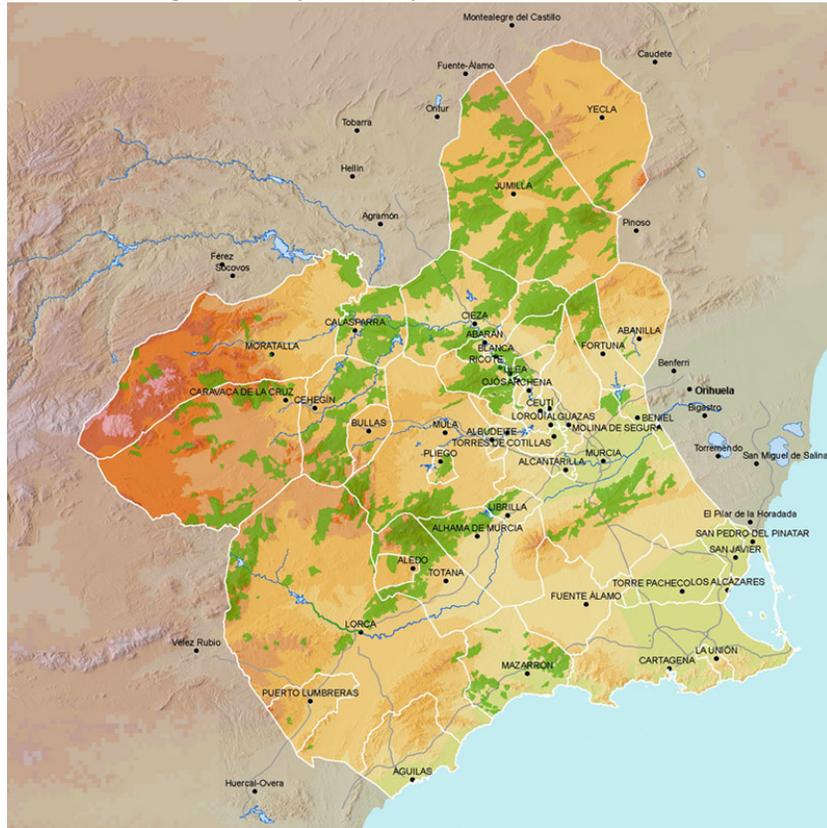
Source: Own elaboration with data from the AEMET. Sorted by average rainfall. Monthly rainfall data measured in millimeters (*mm*). C. H. S. refer to measures by the *Confederación Hidrográfica del Segura*, a public regulatory agency. Towns in bold letters (Mula and Lorca) had auctions while all the other towns had quotas.

Table 2: Summary Statistics of Selected Variables

Variable	Mean	SD	Min	Max	Obs
Rain (<i>mm</i>)	8.53	46.33	.00	980.00	3,834
Price (<i>pesetas</i>)	271.61	374	.05	4,830	13,872
Land Extension (<i>ha</i>)	5.54	32.24	.25	900	819
Output Price (<i>pesetas/kg</i>)	15.07	222.52	.02	5,700	964
Kg sold	5,569.70	10,003.76	0	110,000	1,000
#Trees	161.49	493.45	1	12,300	946

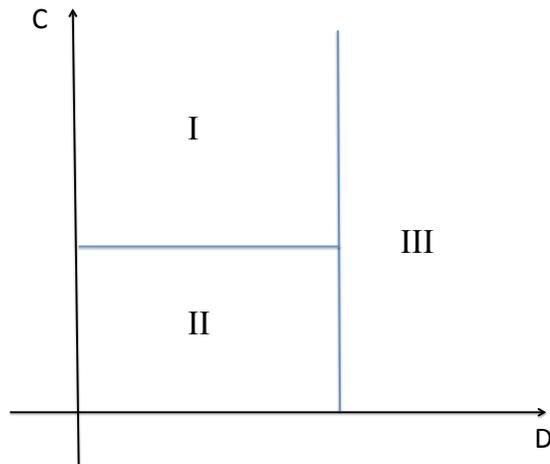
Source: Own elaboration from the data from the Municipal Archive in Mula, section *Heredamiento de Aguas*.

Figure 1: Physical Map of Murcia and Towns.



Source: <http://www.murcianatural.carm.es/>

Figure 2: Possible Equilibria



Possible Equilibria: I) No Institutional Change; II) Inefficient Institutional Change; III) Efficient Institutional Change.

Figure 3: Offer made by the government for the full ownership of the water, pp 10-11

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Cuadro de precios de los diferentes cuartos de agua

	VALOR		Preferencia	Valor sin Preferencia		TOTAL GENERAL	
	Puntos	C.		Puntos	C.	Puntos	C.
De las cuatro							
Hilas de arriba	7	19,023	14	2,800	21,823	152,761	
Treses " "	2	14,267	12	1,800	16,067	32,134	50
Doses " "	13	9,511	50	1,000	10,511	136,649	50
Unos " "	4				4,755	19,023	
Doses de abajo	10	9,511	50	14	400	9,911	50
Unos " "	76				4,755	361,437	
De las cinco							
Hilas de arriba	27	19,023	14	2,800	21,823	589,221	
Treses " "	5	14,267	25	1,800	16,067	80,336	25
Doses " "	55	9,511	50	1,000	10,511	578,132	50
Unos " "	23				4,755	109,382	25
Hilas de abajo	1	19,023	8	1,600	20,623	20,623	
Doses " "	35	9,511	50	4	400	9,911	50
Unos " "	310				4,755	1,474,282	50
De las Seis.- 1^o D^a María							
Hilas de arriba	2	15,736	12	2,333	18,069	36,138	88
Treses " "	1	11,802	09	12	1,400	13,302	08
Doses " "	2	7,868	06	10	833	8,701	39
Unos " "	1					3,934	03
Doses de abajo	10	7,868	06	4	333	8,201	39
Unos " "	4					3,934	03
Unos " "	8					3,934	03
						4,200,000	03

Figure 4: Sample of individual data obtained from the Agricultural Census

DIPUTACION PROVINCIAL DE MURCIA

DECLARACION NUM. 268

ARBITRIO SOBRE RIQUEZA PROVINCIAL

Declaración que presenta D. Bernabé de Cristóbal Segura Sánchez como Propietario (1), con domicilio en Murcia, XXXX Calle y XXXX número, de los productos sujetos al Arbitrio, obtenidos durante el 1^o, 2^o y 3^o trimestres del año actual, en la finca denominada XXXX del término municipal de Murcia.

Especie	Pago o parcel	Cantidad	Núm. de labores	Cosecha	Superficie arriada	Nombre del propietario	Precio de venta por arca		Distribución		Observaciones
							Puntos	C.	Puntos	C.	
S.	Cogiten	1000	800	Almendro	4.125	Hernandez	2.50	17.165			
P.	Palma	7	300	Naranja		Leandro Gállego López	2.50	7.000			
P.	Trucoestillo	8	240	id		id id id	id	10.000			
P.	Carrasquilla	2	75	Naranja		Juan González Fernández	id	4.000			
P.	Alboreja	10	40	D ^a H ^o m	10.000	José Yulo Martínez	2.50	27.000			
P.	Carrasquilla	22	40	Malocoton	400	Constantino Herrera	4.00	1.600			
P.	id	3	80	Naranja	8.000	Fern XXX	2.50	16.000			
S.	Cogiten y Rincón	1007	7100	Trigo	13.272	Servicio Nacional	3.50	52.000			

Total

10 % amortización empotrada

Tributo total

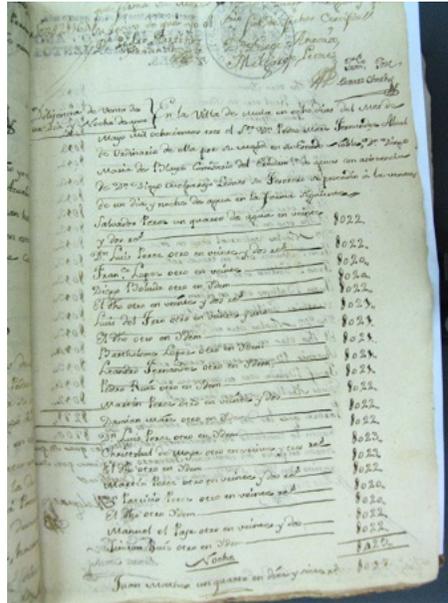
Suma

Murcia, 5 de Diciembre de 1954

Fdo. Bernabé de Cristóbal Segura Sánchez

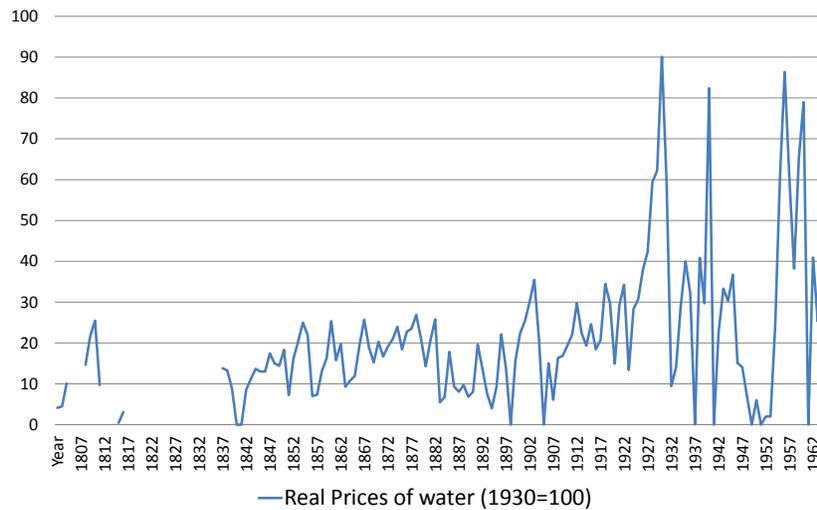
(1) Tachase el que no sea.
(2) P=Propietario, M=Marido, S=Señor.

Figure 5: Sample of Auction Sheet



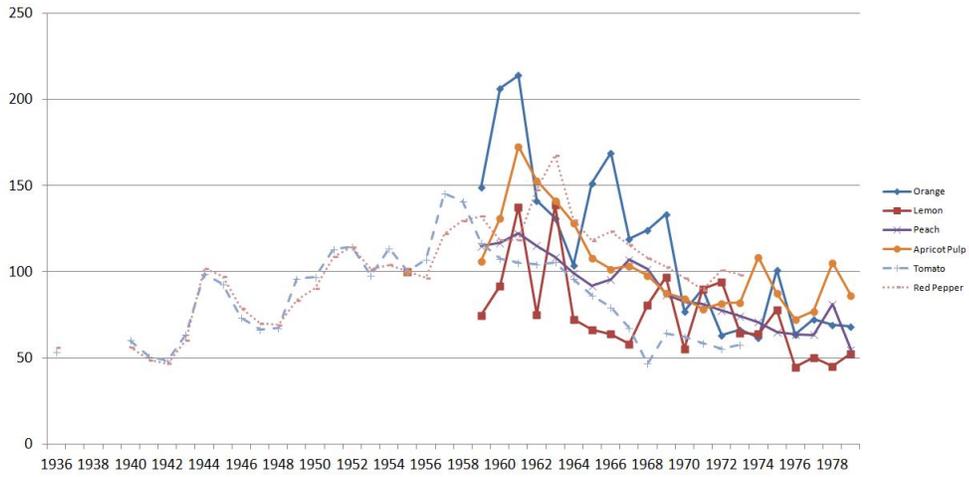
"In the city of Mula the 8th of May of 1803, D. Pedro Martínez Fernández, Mayor of the city, [...], D. Diego María de Blaya, Commissioner of the *Heredamiento de Aguas*, D. Diego Melgarejo Leones, Treasurer, the sale of one day and one night of water began, with the following result."

Figure 6: Real Prices of water (1803-1966), *Pesetas* (1930=100)



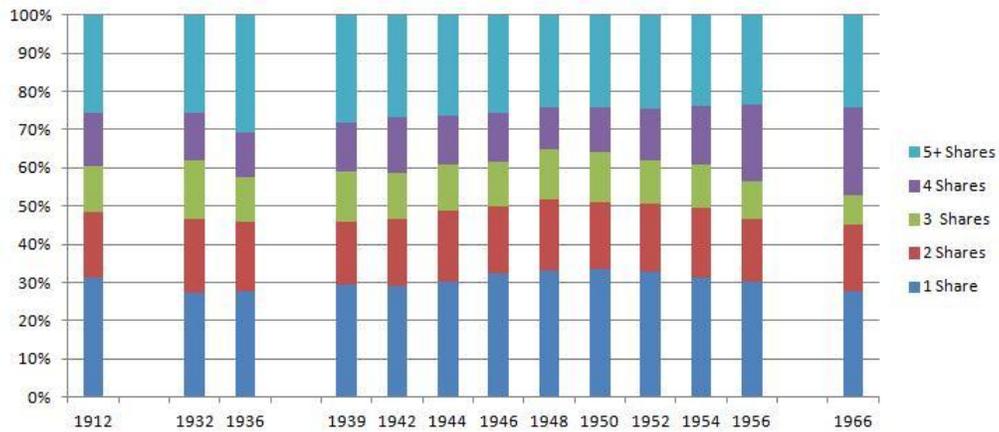
Source: Own elaboration from the data from the Municipal Archive in Mula, section *Heredamiento de Aguas*. Some years are missing. I use the price index series proposed by Sardá (1998).

Figure 7: Real Prices of Agricultural Products, *Pesetas/kg* (1955=100)



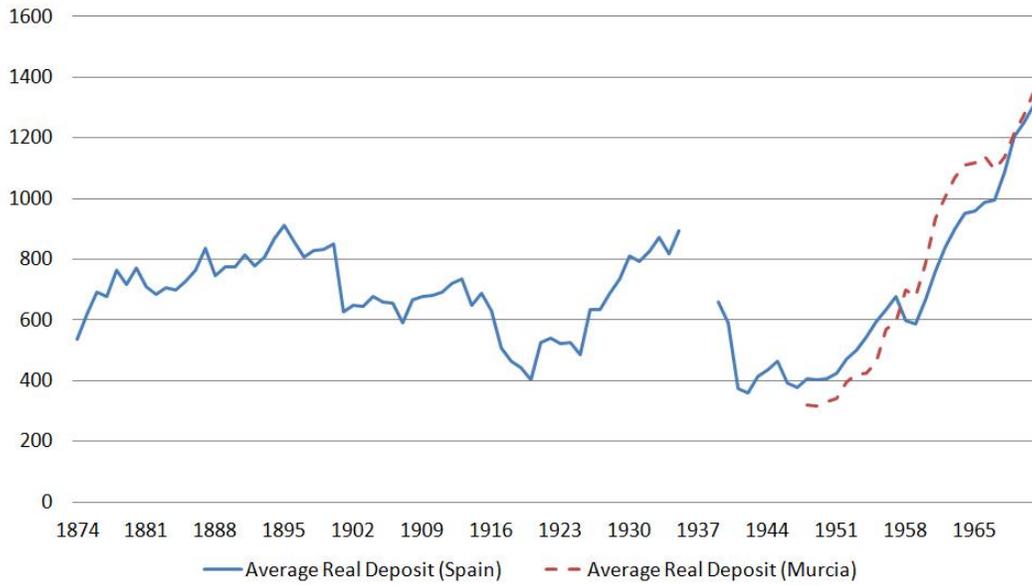
Source: Own elaboration with data from INE (Fondo documental del Instituto Nacional de Estadística). Price Index for the most common agricultural products harvested in Mula (Base 1955).

Figure 8: Composition of water owners by holdings during the 20th century



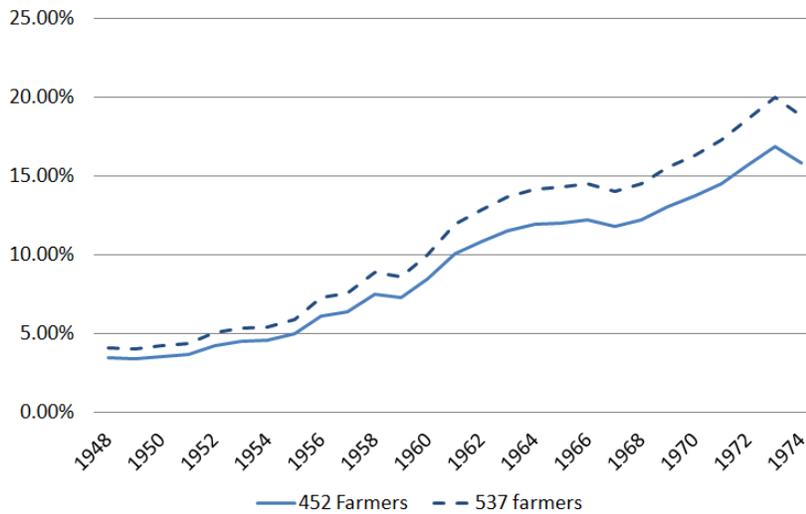
Source: Own elaboration from the data from the Municipal Archive in Mula, *Heredamiento de Aguas*. Some years are missing.

Figure 9: Average Real Deposits in Rural Banks in Murcia and Spain



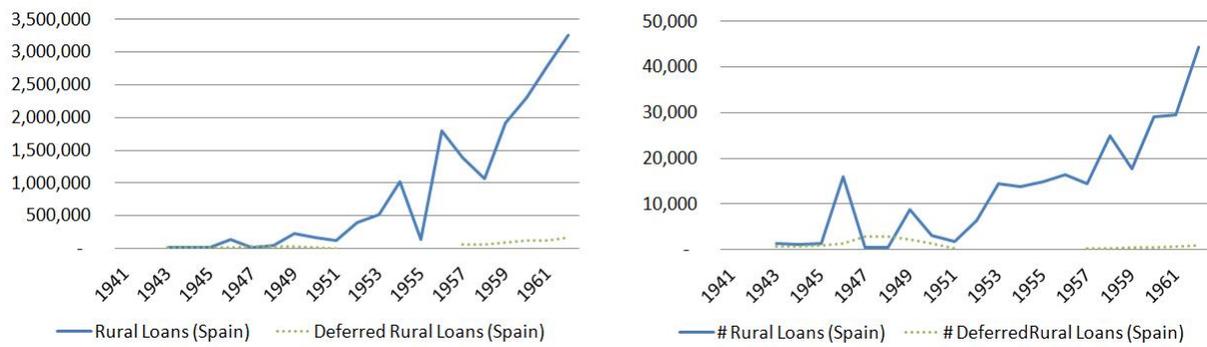
Source: Own elaboration with data from INE (Fondo documental del Instituto Nacional de Estadística). Average value of deposits in *pesetas* (Base 1930).

Figure 10: Percentage of the value of water that could be cover with collateral



Source: Own elaboration.

Figure 11: Evolution of Rural Loans and Deferred Rural Loans in Spain



Source: Own elaboration with data from INE (Fondo documental del Instituto Nacional de Estadística). Data for Deferred Rural Loans for the years 1952-1956 is missing. The left graph shows the nominal volume of loans in 1,000 pesetas for Spain.

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