

Department of Social and Decision Sciences
College of Humanities and Social Sciences
Pittsburgh, Pennsylvania 15213

To whom it may concern:

This is to certify that Elisabeth Madden has submitted an Honors Thesis entitled “Chilean Water Policy: Transaction Costs and the Importance of Geography” to the Social and Decision Sciences Department. This thesis has been judged acceptable for purposes of fulfilling the requirements to graduate with college honors.

Sincerely,

Dr. Silvia Borzutzky
Thesis Advisor

Dr. John Miller
Head, Department of Social and Decision Sciences

Dr. John Lehockzy
Dean, College of Humanities and Social Sciences

Chilean Water Policy

Transaction Costs and the Importance of Geography

Elisabeth Frances Madden

April 15, 2010

In 1981, the military government of Chile passed a new water code, based largely on the principles of neoliberal economics that had guided the policies of the government and the 1980 constitution. The idea behind the new water code was that if the government enabled a free market for water rights, water resources would eventually be allocated to their most valued use. This hypothesized efficiency, however, has failed to come to fruition in many parts of Chile, as evidenced by many empirical analyses conducted in different river basins. I argue that this failure was caused in large part by the transaction costs inherent in an unconstrained market, and also by the natural variance in geography and rainfall throughout Chile.

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Introduction

The motivation for this paper was sparked by a single article about a single Chilean town, which, according to the reporter who wrote it, was literally withering up due to a lack of water. The town of Quillagua, located in the north of the country in the Atacama Desert, had fallen victim to a combination of an ill-fated location (many residents cannot remember the last time rain fell in the town), pollution, and a permissive water rights policy which had allowed mining and agricultural interests to siphon away most of the water available to the town through the Loa river. The reporter interviewed many residents of the town, one of whom commented that “[the town] cannot resist any longer;” that the pull of private sector interests such as mining and agriculture buying up water rights was too strong, risking the loss of water needed for the town’s survival (Barrionuevo 2009). Reading this article sparked in me an interest to explore the origins and implications of a water rights policy which would enable that situation to occur.

Any analysis of Chilean policies is bound to take the student on a journey through land, people, and history. Chilean geography is as complex and varied as Chilean political history. Its borders contain just about every climatic extreme one could imagine: one of driest deserts on earth, some of the雨iest areas in Latin America, and even a claim to part of Antarctica. The country’s political history contains as many turns and transitions as a tour through its land. Chile’s presidential government system housed many different political philosophies and economic models during the 20th century, from a stint of socialism from 1970-1973 to the military coup and collapse of democratic government that followed, to the modern return to democracy brought by the Concertación coalition in 1989. The water policy has also had a complicated history.

However, it has remained fundamentally the same from 1981 to 2005, when it was reformed for the first time since being passed.

The Chilean water policy was drafted during the Pinochet regime and was essentially geared to create private markets for water use rights, which are separate from land rights and are treated as private property governed by civil law. There is little government oversight of water use rights once they are issued, and rights are issued on a first come first served basis, as long as there are not competing application for a single use right. The idea behind the water code was that if water rights were treated as tradable commodities that could be bought and sold, they would eventually be exchanged among users until they reached their most valued capacity, creating more efficiency and more profit for sellers. However, as many investigative reports of the late 1990s discovered, these trades simply were not occurring in many areas. The areas with the most trades were found to be those with certain characteristics, such as a heavy investment in water storage and transport capability. Those that did not experience trade seemed to be stagnant because transaction costs and barriers kept trade from being worthwhile. It is those transaction costs that motivate this paper.

In brief, this thesis will argue that the implicit goals of the Pinochet regime's water code, which were to create a system of market mechanisms to distribute and sell water rights has only partially accomplished its goals. While on the one hand the water code has allowed for the creation of an active water rights' market, on the other one it has failed to take into account the uniqueness of Chile's geography and access to water throughout the country. Most importantly, the government has failed to create adequate mechanisms for water storage and distribution that will allow for a better distribution of

water in those areas of the country that lack water resources, and that administrative changes could help to solve these problems. Essentially, what I will argue is that the very dogmatic application of market principles in the area of water distribution and rights assumed a perfect market without taking into account either human behavior or the peculiarities of Chile's geography.

The first section of the thesis will lay a foundation for an exploration into water policy by outlining Chilean geography and political history, with an emphasis on General Pinochet and neoliberalism in Chile. From there, the thesis will explore the history of water policy and the Water Code of 1981. The history portion of the thesis will end with a discussion of the water code debates of the 1990's. The 2005 reform will be analyzed in detail in the next section. The following section will outline the transaction costs that have kept the Chilean water markets from functioning in the manner the code assumed they would, and will conclude by explaining responses to these sorts of transaction costs in other countries with partially privatized systems such as Australia and the southwestern United States. The final section contains a set of policy recommendations guided by the finding of the preceding section.

Chilean Geography

The geography of Chile is arguably the most unique in the world- both in terms of the shape of the country and what is contained in its borders. Descriptions of the country's length range from 4,270 km to 4,300 km (Hudson 1994 and Bowman 1924). At its widest point, Chile spans 360 km, at its narrowest 90 km with an average width of 177km (Bello 1987 p.4). Travel down this “land of the interrupted path,” to quote J. David Bowen’s 1976 account of the terrain, reveals the Atacama Desert, the Andes mountain range, and a coastline full of fjords and inlets (p. 18). As Chile’s terrain is 80% mountainous in some form, the Andes have had a large influence on Chilean life (Hudson 1994). When Spanish explorers colonized Chile in 1535, they settled in what is now central Chile, and the Andes prevented them from moving any further east- the only options were to expand to the north or south (Hudson 1994 p. 64). Thus, the modern borders of Chile were born.

The Andes continue to impact Chilean life today. They are a relatively young mountain range, and Chile’s location above the meeting of the South American continental plate and the telluric Nazca plate, which is slowly moving east beneath the South American plate, makes them subject to earthquakes (Bowen 1976 p. 21). According to some historians, Spanish colonists debated about whether to abandon the earthquake-prone colony in the mid-1600’s. In the present day, Brian Loveman relates a common saying that “every president will have his earthquake” (2001, p. 9). Another result of the tectonic plates, the Andes mountain range, is a factor in Chile’s unconventional geographical mix. The Andes are almost ever present along the length of the country. Alongside them in the north lies the Atacama Desert, followed by the fertile

Central Valley and then by a blend of lakes, forests, fjords, glaciers, and islands in the Southern part of the country. As such, Chile's terrain lends itself to a five region breakdown¹: *el Norte Grande*, *el Norte Chico*, Central Chile, *el Sur de Chile*, and *Chile Austral*.

Starting from the top of the country, the first region is called *el Norte Grande*, which begins at the Peruvian border and ends at about 27 degrees south latitude (Hudson 1994 p. 69). Its most defining feature is the Atacama Desert, which George Bowman (1924) dubs the “driest climate in the world” (p.15). The Atacama, once described by Gabriela Mistral as “a sterility that has no use for man,” results from the Humboldt/Peru current, which runs through the Pacific just off the Chilean coast. When the winds, cooled by the current, reach land they suddenly become warm and retain all water until they reach the mountains and are cooled again (Bowen 1976 p. 86). The region is so dry, in fact, that there is just one river that runs all the way across it: the Loa. The edges of the desert contain a few scattered aquifers, which allowed trees to grow. These trees were mostly cut down and used as fuel for mining purposes, which had the unintended effect of making the climate even more arid (Hudson 1994, p. 70). Average temperatures at sea level are 20.5 degrees Celsius during the summer, and 14 degrees Celsius during the winter. As Isaiah Bowman of the American Geographical Society observed, “there is no such thing as normal desert rainfall:” in fact, in some places rainfall has never been recorded (Bowman 1924 p. 40). The far north houses a large section of the Andean plateau, where there is in fact a considerable amount of rainfall each year, but most of the rivers that form from the rainfall are lost to evaporation as they move downwards into the

¹ See Appendix 1 for a map of Chile's regions.

desert. Though the desert is the most salient aspect of the Norte Grande, its mineral wealth is also important to mention, since the largest copper mines are located in this region.

The next region is called *el Norte Chico*, and it extends from the river Copiapó to about 32 degrees south latitude. It is a semiarid region, which averages about 25 millimeters of rain during the winter months with trace amounts of rain for the rest of the year. In the summer, temperatures average 18.5 degrees Celsius and about 12 degrees Celsius in winter (Hudson 1994 p. 71). Here, the terrain transforms thanks to additional rainfall and rivers: This region contains more rivers than the *Norte Grande*, including the Aconcagua, one of Chile's principal rivers, and five other smaller rivers (Bello 1987 p. 119). The rivers are fed by the winter rains and from melting snow from the Andes- as such, their flow varies between seasons. The rivers carve deep transverse valleys that make excellent areas for raising cattle and growing fruit, though this land does not overwhelm the entire region. Like the *Norte Grande*, this region contains much mineral wealth: nitrate, gold, silver, copper, and iron mining provides a living for many inhabitants.

Moving down to about 32 degrees south latitude, Central Chile begins. This region houses the majority of the Chilean population- in fact, it is described as “the region that *is* Chile to most Chileans” by Bowen (1976, p. 19). A coastal mountain range frames the region on the Western side, and of course the Andes continue their course down the country on the Eastern side. Melting Andean snows augment the rivers in Central Chile, allowing water to be distributed throughout the region. The climate supports agriculture, being of the “temperate Mediterranean type,” with slight variations

in rainfall and temperature from city to city. For example, Santiago winter and summer average temperatures (19.5 and 7.5 degrees Celsius, respectively) are about two degrees Celsius higher than those of Concepción (17.6 and 9.3 degrees Celsius, respectively) (Hudson 1994, p. 71). While Santiago rainfall averages 69.7 millimeters per month in June and July, in Concepción the average is 253 millimeters per month (Hudson 1994, p. 71). The hospitable climate makes Central Chile a major point for agricultural production, and fishing provides another important source of income.

Moving past Central Chile, we reach El Sur de Chile, which extends from about 38 degrees south latitude and the river Bío Bío to about 43.4 degrees south latitude and the Island of Chiloé (Hudson 1994, p. 72). A huge departure from the Norte Grande and the Norte Chico, El Sur is one of the雨iest areas in the world-- for example, the city of Puerto Aisén averages an annual rainfall of 2,973.3 millimeters (Hudson 1994, p. 75). It is known as the Lake District of Chile because of the many lakes formed by the rivers as they descend to the south (Hudson 1994, p. 72). The region supports a burgeoning timber industry through natural hardwood forests and pine plantations. Tourists drawn by the beauty of the region create additional income. Aside from those industries, a 40% rural population depends on agricultural activity for income (Loveman 2001, p. 47).

The last region of Chile is called *Chile Austral*, which begins between 43 and 44 degrees south latitude and ends at Cape Horn. This is the point where the Andes range meets the Pacific Ocean, creating sharp elevations and thousands of small islands. Temperatures here are colder than in *El Sur*, about 11.1 degrees Celsius in the summer and 2.5 degrees Celsius in the winter. Rainfall is plentiful in the northern part of the region- Puerto Aisén, for example, receives about 2,973.3 millimeters of rain per year

(Hudson 1994, p. 75). The southern part of the region, on the other hand, receives much less- 438.5 mm per year in Punta Arenas, the southernmost sizable city in the world (Hudson 1994, p. 75).

A water resources motivated study of Chilean geography, of course, begs a resource-based comparison between all five regions². George Bowen (1976, p. 24) expresses the relation quite concisely:

In the Norte Grande there is no rain at all. In the Norte Chico it rains only in the winter. In the center, only the summers are rainless. In the South, it rains at any time, and by the time we arrive in the provinces of Valdivia, Osorno, and Llanquihue it seems to rain far too much.

Accordingly, demand for water in Chile has remained fairly constant over the past forty years, with the only significant changes projected in Central Chile and *El Sur de Chile*. In terms of percentage of total water demand, the *Norte Grande*'s demand was about 1.1% in 1970 and projected to be 1% in 2000 (Bello 1987, p. 21). The *Norte Chico* and *Chile Austral* were presumed to remain fairly constant as well, at 7.2 in 1970 and 7.7 in 2000 in the *Norte Chico* and 0.1 and 0.2 in *Chile Austral* (Bello 1987, p. 121). Chile Central, on the other hand, created 71.9% of demand in 1970 but was expected to drop to 52.5% in 2000 (Bello 1987, p. 121). Meanwhile, *el Sur de Chile* was projected to increase from 19.4% of demand to 39.5% of demand in 2000 (Bello 1987, p. 121). This seems odd, especially since Loveman (2001, p. 35) claims that Santiago's metropolitan area was the fastest growing region in all of Chile from 1970 to 1992. However, a look at population density within the regions shows that these figures are useful at least for a benchmark. According to Loveman (2001, p. 35), 50% of Chile's population lives within a 100-mile radius of Santiago. On the other hand, though, expanding the definition of

² See Appendix 2 for a graph of comparative rainfall between regions.

demand to domestic, industrial, and agricultural uses, the change may not seem so far-fetched.

A geographical study of Chile reveals the context for a study of water resources: a country with a huge variety of natural landscapes, climates, and precipitation that necessitates a perfectly tailored water system. The nature of this investigation is water policy, and accordingly, it will focus mainly on northern regions of Chile because of the pronounced water scarcity in the area. Of course, to bridge the gap between geography and water management, a study of political history, privatization, and utilities in Chile is necessary.

Early Political History of Chile

The political history of Chile provides a landscape just as varied as the geographical scope of the country. Though the cycles of political parties, leaders, and policies can become very tangled, one benchmark for these shifts is to examine the three Constitutions that were passed in 1833, 1925, and finally 1980. In 1833, the Chilean constitution concentrated power in the executive branch and empowered the landowning elite, aligning itself with the centralist and conservative political tradition. The constitution was geared to protect private property, a trend that Chile would later return to with the 1980 constitution. In 1879, the War of the Pacific spurred civil unrest as the war produced an economic development which created a large labor force, and also created inflation and upward redistribution of income through taxes. Working conditions were horrible, and represented “a little Chilean hell” for those who worked in the copper and nitrate mines (James O. Morris, quoted in Borzutzky 2002, pp. 5). The notion of a strong executive branch asserting influence over a weaker legislature ended abruptly with

the Civil War of 1891. Fighting within the government eventually gave way to a shift from a presidential system to a parliamentary system, with an assertive parliament exerting pressure over a weakened presidency (Oppenheim 2005, p. 10).

In the meantime, the growing work force began to hold greater sway in Chilean politics, forming different unions and organizations and generally pushing to be represented in Chilean politics. By the time Arturo Alessandri was elected president in 1920, the workers had been able to participate through the Radical and Social Workers' parties, however there was still a demand for more recognition of the newly emerged class. This, combined with the "boom-bust" cycles of the export-dependent Chilean economy (and the emergence of synthetic nitrates that lowered demand for Chile's nitrate supply), created a crisis that drove Alessandri to consider a new approach to governance (Oppenheim 2007, pp. 11). The Constitution of 1925 attempted to balance politics by strengthening the presidency expanding the right to vote. Presidents were granted a 6 year term and the power to issue decree laws and appoint key positions such as the controller-general (who essentially provided oversight to key legislative initiatives to ensure they were compatible with the Constitution), but added a limitation that the president could not be reelected. This aligned well with other reforms such as staggered elections.

The Constitution passed with support from the military, which ended up being a problem later on, as Alessandri felt that he had given up too much political independence in order to garner the support he needed to pass the new reforms. He was succeeded by a military dictator, General Carlos Ibáñez, whose two-year tenure in power was colored by the New York stock market crash of 1929 (Oppenheim 2005, p. 12). When elections were held again, President Alessandri was reelected, and set a basis for a long period of

democracy between the 1930s-1973. During this democratic period different political coalitions including center, right and left parties held power. While Chile's democracy expanded and remained stable, Chile's economy continued to be dependent and unequal (Oppenheim 2005, p. 12).

The next leader who attempted major economic policy reforms was Eduardo Frei. Frei operated within the framework of the 1925 Constitution, and his ambition was to create a “third way” that would reconcile capitalism and Marxism (Constable & Valenzuela 1991, pp. 23). Frei was a Christian Democrat, a reformist party, but he was also backed by conservatives and the US government; both funded Frei’s campaign because they wanted to avoid a leftist victory (Constable & Valenzuela 1991, 22). Once in office, Frei put forth a number of social initiatives such as opening higher education to the poor. What he is known best for, however, is the land reform he created through the Agrarian Reform Code of 1967. Under this act, the government was able to expropriate farmland from large farms in order to form peasant cooperatives. He also paved the way for the formation of peasant organizations which until then were prohibited by law (Borzutzky 2002, p. 84). These policies infuriated the conservatives who had supported Frei in the earlier election, and so they pulled their support for him in the next election. At the same time, he also alienated the peasants because the government did not deliver nearly as much land as it had promised. This paved the way for Salvador Allende to take office in 1970, as he used promises of delivering land as a support for his campaign (Oppenheim 2005, p. 36).

Following Alessandri’s attempts to include the working class in government came Salvador Allende, whose socialist policies later motivated Pinochet’s reactionary

reforms. We can see the Constitutions of 1925 and 1980 century as anchors, between which social and economic policy moved from a capitalist system attempting to bring the entire population into the political fold, but not into the economic fold to a period of socialism in which land and economic reforms pushed to create a new society but also alienated some citizens, to a military government concerned with bringing about individual economic freedom as the cornerstone of Chilean society.

Allende was elected in 1970, backed by a leftist coalition: his supporters ranged from the centrists to the radicals to the socialists. Once in office, Allende and his Unidad Popular (UP) coalition began the process of transforming government policy in order to redistribute income among the population. In order to do this, the administration planned to generate resources for the state to by nationalize industries such as copper. The administration also planned to use consumer goods as a base for economic development and use financial policy as a means to stimulate demand (Borzutzky 2002, pp. 125). The success of this plan depended on the asserted need to change the distribution of income within the society. Taken together, Allende's policies would create what was called the Chilean road to socialism. While Allende's policies were somewhat successful in increasing the gross national product and lowering unemployment³ and drew popular support, especially from the student and worker population, they were disturbing to the middle and upper income groups, many of whom took their assets abroad in fear that they would be taken away from them. In addition, the spending required to implement the new economic plan put the administration into deficit, and of course it did not help that the United States of America, unhappy with the election of a Socialist president, slashed

³ According to Borzutzky (2002, p. 126), unemployment decreased by 3.8% in 1970.

aid to Chile from \$260.4 million in 1967 to 3.8 million in 1973 (Constable & Valenzuela 1991, 26).

Eventually, tensions within the UP and within the different arms of the state (especially between the executive and the Congress) became overwhelming, especially as Allende did not have the strategic advantage of a majority in the Congress. Allende was forced to take measures such as appointing the four leaders of the armed forces to his cabinet in an attempt to ameliorate tensions (Constable & Valenzuela 1991, p. 28). However, the military was torn: on the one hand, their loyalty to the constitution told them they should respect the presidential mandate. On the other hand, the sight of growing food lines, angry civilians, and the chaos of an internal struggle within the elected government pushed the military towards action.

The Pinochet Regime

On September 11, 1973, a military coup took place wherein Salvador Allende died and a four man military junta, composed of General Augusto Pinochet, General Gustavo Leigh of the Air Force, Admiral José Toribio Merino of the Navy, and General César Mendoza of the Police, was established as the ruling body for Chile. What followed was a stain on the human rights record⁴ of Chile, in which UP supporters were interrogated, beaten, tortured and killed in Chilean stadiums and in the countryside (Constable & Valenzuela 1991, p. 32-35). Although these events are very important, they are beyond the scope of this policy-oriented research.

General Pinochet's long-term ambitions led him to draft a new constitution. Essentially, Pinochet wanted the military to play an even greater role in the government

⁴ Constable and Valenzuela (1991) describe the aftermath of the coup and its implications for human rights in Chile in Chapter 1 of *A Nation of Enemies: Chile Under Pinochet*.

and society, and allow that role to continue for a longer time than the previous constitution would allow. He also wanted to quell any stirrings in the political Left, and stifle any organization on their part. To help him draft the constitution, Pinochet turned to Jamie Guzmán, a very conservative constitutionalist and politician. The new constitution was partially a roadmap to enable the new administration to stay in power as long as possible, and on top of these more temporary measures it included new directives on power sharing within the government (Constable & Valenzuela 1991, p. 86).

While the constitution strengthened military power by establishing the National Security Council and strengthened the presidency by establishing an eight-year presidential term, it placed many limitations on individual rights. Whereas the National Security Council, made up of the heads of the branches of the armed forces, police, Senate, and Supreme Court, had the right to oversee civilian policy and the president had the right to suspend basic rights such as habeas corpus during a ‘state of emergency,’ individual rights were limited by provisions such as Article 8, which stated that propagating any doctrine that attacked “the family...or a concept of society or the state which is totalitarian or based on class struggle” was illegal (Oppenheim 2005, p. 118).

Overall, as Oppenheim describes, the 1980 Constitution was “a fundamentally undemocratic document whose purpose was to prolong Pinochet’s rule, institutionalize military oversight over civilian policy making, severely limit popular participation, and permanently exclude Marxist parties from participation in politics” (Oppenheim 2007, pp. 118). Ironically, despite the political provisions later passed in Pinochet’s Constitution, he and his advisors implemented an economic policy whose highest principle was individual freedom. It could be argued that this document allowed the

neoliberal economic model to permeate Chilean society in such a way that free markets gave way to a “social market economy” by the time, or even before, the Constitution was passed (Bauer 1998, p.16).

The Subsidiary State

Whereas Allende’s policies advocated a shift toward a more active role for the state, Pinochet introduced the subsidiary state model in Chile. In this model, the state only performs those essential functions that cannot be performed by the private sector. Pinochet, and many other government leaders as well as the judiciary, had been traumatized by “[Allende’s] experiment in socialism,” and were very receptive to a new economic model based around individual freedom and less state influence (Oppenheim 2007, pp. 125). The neoliberal economic model reached Chile by way of a group of University of Chicago-trained economists, later known as the Chicago Boys. The Chicago Boys argued that economic and social activities should be influenced mainly by private forces, creating a “structural revolution” in which the entire society would move based on individuals taking advantage of their freedom to act as they pleased, instead of the state directing most of the society as the previous governments had moved towards (Oppenheim 2007, p. 126).

The reforms Pinochet carried out and the philosophy of his government tend to seem contradictory because although the reforms in most cases promoted individual prerogatives in an economic sense, the authority of the regime built largely on repression of individual political expression. Pinochet governed with the idea of moral right: that his

government had a Divine approval⁵ of sorts to govern and carry out the policy changes that it created. The Pinochet regime had carved a very authoritative role for itself, both in terms of creating government policy and also in terms of suppressing individual rights. This structure allowed the state to more easily create and implement new policies, and it also made the idea of neoliberalism a very ironic introduction into Chilean society. Because the government held such a tight grip over policy and over the individuals in society, it was able to quickly introduce and extend an economic policy firmly rooted in the notion of absolute individual freedom. Even as the state extended its security, making itself felt in many aspects of individual life, in an economic sense it was decreasing its role in regulating the private sector and launching the seven modernizations: labor, social security, health care, education, local municipal control, the justice system, and agrarian system (Oppenheim 2007, p. 133).

By 1975, the Pinochet administration was ready to implement what is known as the “Shock Treatment” on the Chilean economy. The plan’s goal was to combat the rampant inflation that the Popular Unity’s economic policies had created through raising salaries and putting price ceilings on basic consumer goods⁶. To do this, the program deregulated the price of consumer goods and cut public spending. This stemmed the inflation somewhat, but also created unemployment. In addition, the government sold many previously state owned enterprises or returned them to their former owners, and it

⁵ Speaking on the coup, Pinochet commented that “Divine Providence, with her mysterious hand, gave the Armed Forces the order and fluidity to carry out the fast and prompt pacifying action.” (Borzutzky 2005, p. 5)

⁶ Oppenheim (2007, p. 84) describes the economic reforms of raising wages and lowering the price of basic consumer goods. According to Oppenheim, this strategy yielded positive economic consequences in the short term, but later caused inflation.

also drastically reduced tariffs. The Shock Treatment turned Chile into a free market monetarist economy (Oppenheim 2007, p. 111).

Socioeconomic Implications of Reform

After the privatizations had taken effect, the business community was, for the most part, eager to take advantage of the new freedoms and economic advantages it had been afforded by Pinochet's reforms. Interviews conducted by Constable and Valenzuela (1991) indicate that many business leaders saw the new policies as a challenge to all industries where "only the most efficient will survive," as the head of a prominent corporation predicted. At the same time, some businesses did not take advantage of their newfound freedom and were thus left behind by their more agile competitors. In 1976, a "massacre of industry" occurred as the global recession as well as the Shock Treatment combined to reduce national production significantly, and the end result was massive unemployment (Constable & Valenzuela 1991, p. 202).

In the period following the recession, the Chilean economy recovered and experienced an export boom; for example, fruit exports increased from \$30 million to \$136 million in the period between 1975 and 1980 (Constable & Valenzuela 207). At the same time, however, the country was increasing its imports, and the advent of credit cards not only increased the gap between the rich and the poor, but also created more individual buying power. The government had lowered tariffs on imported goods, so they were much cheaper than they had been in years past. This meant that many business owners were run out of business due to competition from imports, and by 1980 many felt bitterness and resentment towards the new economic stance of the government. The year 1982 brought another economic downturn, and finance minister Sergio de Castro, a rigid

advocate of pure neoliberal policy, was asked to resign. The man who eventually replaced him in 1985, Hernan Büchi, was more flexible in his application of neoliberal ideas, allowing some state supplementation to bolster the market economy (Borzutzky 2002, p. 190).

In terms of social classes and divisions, Pinochet's policies encouraged an even wider divide between the rich and the poor: poverty increased and wealth became concentrated in the top 10% of the population (Oppenheim 2001, p. 132). Not only this, but the rich were also more open about displaying their lifestyles and material possessions. The aforementioned seven modernizations also had a huge effect on the daily lives of Chileans. For example, the labor policy modifications resulted in a fragmentation of what had been large, powerful labor unions. It would seem that the shift to the neoliberal model, while welcomed by those who were most equipped to handle the pressures of a free market economy (i.e., agile business leaders and those with secure employment), had a devastating effect on much of the population.

Water Policy History

Of course, the nature of water policy was evolving and changing along with all of the political and policy changes described above. In the 1800s, Chile's water policy was very much modeled on the European tradition, which dictated that water was a public and collective resource. As such, the 1855 Civil Code defined water along a spectrum of usage rights, from public to individual use. According to the code, water completely contained on a single property (such as a lake or stream) was to be defined as a private right. All other water resources, however, were defined with public usage rights. Under this code, water resources fell under public administrative law.

The 1951 Water Code took the previous laws and added an element of state intervention and protection. While the definition of public and private rights remained intact, the 1951 Water Code established a new procedure for granting water rights. As soon as a water right was granted, the right became private property and it was governed by civil law, rather than public administrative law as the previous code had dictated. It also established a central agency to administer and sign over water rights, called the General Water Directorate (DGA). The right to use water was governed by a few basic rules under this code: first, the rights would only become official after actual use of the water had been documented. Second, water rights could not be used for a purpose other than that under which they were applied for under without a new application being filed. Lastly, the DGA had the right to revoke water rights if they were not used for a period of five years or more (Bauer 1998, p. 38).

The 1967 Water Code reflected the changes introduced by the Agrarian Reform Law of the earlier 1960s, which paved the way for government expropriation of farmland. Likewise, the 1967 Water Code aimed to facilitate land redistribution and increase the efficiency of water use (Bauer 1998, p. 39). To do this, the code declared water a completely public resource that the state could expropriate without compensation (Hearne & Donoso 2005, p. 57). It also gave the state the right to redistribute water according to the new “standards of rational and beneficial use” set out by experts who would establish the most efficient usage of water for each type of crop, and use planning criteria to allocate water for non-agricultural uses. It also retained the revocation feature, stating that water rights left unused for five or more year could be revoked by the government (Bauer 1998, p.

Water Policy Under Pinochet

By the time Pinochet's 1976 Constitutional Commission was established and tasked with, among other things, amending the water policy, many rich landowners had taken their assets abroad and left their land in order to avoid expropriation. In fear of having their property rights revoked, many Chileans were shy of investing in land titles, and one of the main goals for the new policies was to reverse this trend. Many of the members of the commission advocated a return to the 1951 Water Code as a way to do this. However, action was delayed until the Decree Law 2,603 of 1979 was passed. This law separated water rights from land usage rights for the first time (Bauer 1998, p. 42). It also tried to solve the problem of rights securities by legitimizing all water rights that were held at the time the law was written, and by declaring that the expired or cancelled water rights be auctioned. The law also attempted to frame water as a tradable commodity that could be transferred between sectors (agricultural to industrial use, for example), which the neoliberal economists asserted would make the water market more efficient (Bauer 1998, p. 43)

Eventually, the Water Code of 1981 took shape. This code is still the basis of water policy today, though it underwent a sizable reform in 2005, which will be discussed later. Although there had been talk of taxing water in order to cement its status as an economic good, they were blocked by the agricultural sector, the country's biggest water consumer (Bauer 1998, p. 45). It was also said that given the diverse geography of Chile, creating and enforcing a tax system for water would be far too difficult a task⁷. However, this did dampen the free market model that the neoliberals wanted to create: without

⁷ Bauer (1998, p. 45) outlines the factors that led to the water taxes being abandoned in the 1980 Constitution. Bauer states two main obstacles: first, the unwillingness of the farmers to begin to pay for a resource that had always been free, and second, the administrative roadblocks to establish an efficient tax system amidst the diverse geography of Chile.

taxes, there would be no price signals to stimulate transactions, and they would have to hope that the legal framework was permissive enough for a market to form by itself (Bauer 1998, p. 45). This whole process reflected a debate that has been active throughout modern water policy development: either to promote the legal security of water rights versus the promotion of free market for water rights. The key issue is which approach creates a better market. The outcome was a framework that was very permissive of free market transactions.

In practical terms, the Water Code established a freely tradable system of water rights that were fully separate from land use rights. Water rights would be granted free of charge by the General Water Directorate (Dirección General de Aguas, or DGA.) Despite this administrative power, the DGA had very limited control over the recipients of the permits it granted. If there is water physically available, the DGA is compelled to grant water use rights if an application is submitted. If more than one application is submitted for one water use right, the DGA must hold a public auction to determine the allocation of the rights. In addition, the code does not establish any sort of prioritization for the planned water use when granting water use rights, a departure from the 1967 Water Code (Ríos & Quiroz 1995, p. 319).

Once the water rights have been acquired, they fall under the jurisdiction of private civil law, rather than administrative law. Rights holders have tremendous freedom once rights have been acquired. There are no standards of use to which they are held, and they are able to change which use they put the water to at will, without going through any approval process. Further, the DGA has no right to cancel or revoke usage rights due to nonuse. The DGA does retain important administrative functions such as gathering data,

inspecting dams and canals, and preparing reports and studies on water use. In the case of a conflict over water use, the DGA does not have any authority: the issue must be settled via private negotiations (Ríos & Quiroz 1995, p. 319).

Empirical results of investigations of the economic implications of Pinochet's water policy revealed that the water transactions under the new code were the "exception rather than the rule" (Hearne and Easter 1995, p. 6). These empirical studies attribute this apparent inactivity of markets to a few structural, economic, and geographical complications. The most salient of these complications seemed to be that of personal economic decisions. The system established in the 1981 code depended on the assumption that water users would sell their unwanted or unused water rights, creating a natural redistribution to the users that valued the water rights the most. However, it quickly became apparent that owners were retaining their surplus rights rather than selling them (Bauer 1995, p. 6). Bauer suggests that self interest, especially for irrigation water rights, played a large role in this hesitancy to transfer water rights: in the case of water use for irrigation, it seemed to be more advisable to retain excess water in the interest of security in case of drought. It seems that the Chilean government also noticed these trends in the market, because in 1985, the government created subsidies for private investment in irrigation (Bauer 1995, p. 6). However, water policy remained fundamentally the same throughout Pinochet's administration. It was not until a new political coalition, the Concertación, won the presidency in 1989 that the water policy was called into question.

Transition to Concertación Leadership

The 1980 Constitution specified that a plebiscite was to be held in 1988 to determine whether the Pinochet regime would continue or whether elections would be held for a new leader. The center of left wing political parties (most notable the Christian Democrats and some factions of the Socialist party), united with the common goal of a collective ‘No’ to eight more years of Pinochet. While most of the active left-wing parties at the time desired free elections as soon as possible, they were forced to follow the timetable specified in the constitution and participate in the plebiscite first. Together, the Christian Democrats and groups within the socialist party (the Almeyda faction) organized a campaign, joined by almost all other left-wing parties, against Pinochet under the name *Concertación de Partidos por el No*. This campaign appealed to Chile’s democratic past by emphasizing the concepts of peace and social justice as the central tenets to their campaign. The coalition was strengthened by international funding that allowed an intensive media campaign (Borzutzky 2002, p. 196). The results of the plebiscite left ‘No’ votes at 55%, and ‘Yes’ votes at 43% (Loveman 2001, p. 303).

When the time came for elections, the Concertación put forth Patricio Aylwin as their candidate for president. Aylwin, a Christian Democrat, led a bloc of parties operating as the Concertación, which was able to negotiate electoral and constitutional reforms with the administration. Meanwhile, the Pinochet administration’s main objective in these negotiations was to find a way to preserve the authoritarian government structure and military influence in the government after the elections were over, while the Concertación desired more broad reforms of the constitution. The Pinochet regime accepted a few of these reforms, and ultimately the Concertación made gains such as a shorter presidential term and the incorporation of human rights treaties into Chilean law.

The Pinochet regime's major gains from the negotiations were to preserve the autonomy of the Central Bank from government influence, and the autonomy of the Armed Forces relative to civilian rule. The Armed Forces also retained their role as the “protectors” of the political system (Borzutzky 2002, p. 199).

While Aylwin eventually won the presidency, in the process defeating former Finance Minister Hernan Büchi, the parting actions of the Pinochet administration left him a tough path to reform. As Pinochet left office, he made sure to leave his own institutional legacy. While he framed his exit as though he was merely stepping aside to allow democracy to come to fruition in many of his speeches,⁸ he also pushed many decrees and organic laws that would “constrain the policy initiatives of the new government,” binding the new government to the philosophies of the previous one (Loveman 2001, p. 307).

Once Aylwin took office, his most salient objective was to advance the idea of democracy in Chile while at the same time maintaining the existing economic systems, and also addressing the social impact of the military government’s policies. As such, and because of the constraints placed on the new administration, none of the Concertación presidents broke with the economic policies of the past. While this resulted in economic growth, averaging 5.6% from 1990 to 2005, it was also clear that “the political conditions” that the Concertación presidents would have needed in order to reform economic policy were nonexistent at the time (Oppenheim 2007 p. 172).

By 1992, the Concertación turned its attention to the Water Code. Hernan Büchi, the former Finance Minister, had praised the water market the Code made possible as an

⁸ For a detailed description of Pinochet’s public reaction to the results of the plebiscite, see Loveman (2001), pages 303-307.

ideal “allocation mechanism” for water use rights, that by allowing individuals to trade in water rights, they would be sure to eventually arrive at their most valued use (Hearne & Donoso 2005, p. 58). However, the degree of individual freedom over water use became a point of concern for the Concertación (Bauer 2004, p. 55). The first reform package, mainly drafted by the DGA, proposed additional safeguards to the market, in part to prevent the unfavorable effects of water hoarding described above. The reform package advocated a return to the ‘use it or lose it’ rule, which would allow the DGA to terminate individual water use rights if they were not used for a period of five or more years (Bauer 2004, p. 56). It also called for a new approach to river basin management, with basin-wide organizations controlling water use in a single river basin (Bauer 2004, p. 56).

This new proposal met with opposition from private sector interest groups as well as right wing government parties. While the Concertación made many constitutional arguments in favor of this reform package, the ‘use it or lose it’ rule became the Achilles Heel of the reform. It drew heavy criticism first on a constitutional level, with opponents claiming it infringed on personal economic freedoms guaranteed in the constitution, and also on the basis that it would create an incentive for water rights holders to use their water rights inefficiently to avoid losing them (Bauer 2004, p. 58). By 1993, this approach was abandoned and a debate emerged between two different instruments, a yearly tax on water rights or a yearly fee for water rights not in use.

There seemed to be a hesitant consensus that the market needed some sort of price signal in order to function more effectively, but there was much debate over what sort of instrument (annual taxes versus nonuse fees) would be the best way to establish such a price signal. Carl J. Bauer (2004) outlines in great detail the arguments made for and

against each instrument, and the conclusion seems to be that both instruments would require the same detailed information to be implemented effectively (Bauer 2004, p. 58-60). However, an additional negative aspect of taxes was the possible constitutional issues surrounding the taxation of a private economic good. On the other hand, a negative aspect of nonuse fees was again the possibility of inefficient use by individuals trying to avoid fees. The positive side to an annual tax was that it would reinforce the legal security of water rights, as there would be a tangible body of proof to ownership outside of the document signing the rights over to the individual user. Nonuse fees, it was argued, may be easier to implement since they did not involve as many constitutional issues, and since they would affect a smaller amount of people, the political will needed to pass them might be less than for annual taxes (Bauer 2004, p. 58).

By July 1996, the Concertación was ready to introduce a new reform package, it was approaching reform from a ‘fine tuning’ sort of perspective. Accordingly, the reform did not suggest a completely new protocol, but it included a few key ways in which the existing procedures could be improved, including augmenting the power of the DGA. Under the new reform package, the DGA would ask for more specific information in water rights applications, and would also have the power to initiate a process of judicial review in cases of unused water rights. The proposal dropped the suggestion of new river basin organizations, which had been criticized in the first package for not being specific enough. In addition, the package suggested price signaling through the sorts of taxes and fees that were discussed above. Even though this package was politically softer than the first one, with less questioning of the status quo, the opposition refused to accept the bill.

Their opposition's main objection was the proposal of fees, which they deemed unconstitutional.

The proposal was eventually brought before the Constitutional Tribunal, which found that the proposed reforms did not violate the Constitution (Bauer 2005, p. 68).

After a lengthy debate, the reforms failed to pass into law. Questions of economic efficiency, constitutional issues, and private interests continue to stall progress for both sides, and the code has yet to undergo any major changes. Today, it seems that the need to reevaluate water policy has become even more pressing. For example, in the Norte Grande, specifically in the Atacama, government data indicates that while the regional authorities have issued permits totaling 16,000 cubic meters per second, the replenishment rate of water there is only 4,000 cubic meters per second (Derricot & Anderson 2009). Recently, Sergio Bitar, Chile's Minister of Public Works during the Bachelet administration, was quoted saying that "Chile requires a new water policy. We're seeing a rapid increase in the demand for water...and it's generating a shortage that we haven't seen before" (Derricot & Anderson 2009). Still, a substantive reform package has yet to be approved by the Congress.

Water Markets Research

Of course, before discussing the current state of water use in Chile, it is important to discuss the research that was the basis for reform in the first place. While significant amounts of research regarding water issues did not emerge until the late 1990's, there were a few studies done in the early and mid 1990's that became directive forces in the water policy debate in Chile. Bauer (2005) notes that many of these early studies portrayed the water markets and their functioning in a very positive light, overlooking or

failing to mention negative aspects of the policy. Others, however, brought to light the lack of transactions taking place in many markets that were supposed to have active trading; one such study was conducted by Hearne and Easter in 1995. Hearne chose four river valleys (the Maipo, Elqui, Limarí ,and Azapa) that were chosen based on “prior information which suggested that there was – or should be – active trading in the area” (Hearne & Easter, 1995, p. 14). The authors attempted to record all water transactions that had taken place from 1986 to 1993 in each river valley.

A comparison of the Limarí Valley to the other three valleys yielded interesting implications for water policy that have been supported by other scholars. Interestingly, they found that only one of the four river valleys, the Limarí, had what they deemed an active market because of its well developed water users organizations and canal infrastructure (Hearne & Easter 1995, p. x). Clarke, Kosec, and Wallsten (2004) delineate a number of reasons that privatization in utilities is more difficult to implement than in other sectors, which apply very well to the results of the river valley comparison in Hearne and Easter. They note that transaction costs and externalities are more pronounced in water markets, which require more investment by individuals. Indeed, many studies have noted that the infrastructure in many areas may not be conducive to trading and that trading may force individuals to incur extra costs. Hearne and Easter also note that water distribution systems were more heavily funded in the Limarí valley, which reduced the transaction costs otherwise inherent in water rights trade. Hearne and Donoso (2005) add to this economic explanation a cultural aspect: although legally separate, water and land remain culturally linked, which creates a reluctance to sell water rights. In addition, water is highly valued in irrigation, and farmers may be reluctant to

sell water that might be used later in irrigation. It seems that investment in infrastructure to reduce transaction costs in water markets may create the active trading that the Water Code was written to encourage, but that merely creating the legal space for trades does not mean that they will occur.

Interestingly, studies of water distribution have indicated that privatization of water supply and sewerage firms may have a positive effect on investment and welfare. In a 2003 working paper, Gabriel Bitrán and Eduardo Valenzuela compared public and private providers of water and sanitation services (in 1998, the government began to privatize the traditionally state-owned water services providers.) Because the government carried out the process slowly, the authors were able to compare data from publicly and privately owned services providers in a variety of regions. They found that after companies became private, they invested more in technology and capital (70% more in 2001 than in 1998, on average), and that companies that remained public invested almost 70% less money in those projects (Bitrán & Valenzuela, 2003, p. 2). Although this investment took place, the authors found that private companies still charged rates that were about 40% lower on average than public companies (Bitrán & Valenzuela, 2003, p. 2). The authors concluded from these and other data findings that firm-level privatization in the water sector seems to be a powerful mechanism to fill the funding gap between water rights and the infrastructure needed to distribute and sanitize the water itself. This is an interesting conclusion, as it is slightly counterintuitive to the individual trading findings that were discussed earlier.

2005 Water Code Reform

The first major reform of the Water Code was passed in 2005. This reform was motivated by the aforementioned issues of water speculation, as well as a need to keep water rights secure while also maintaining the legal initiative for active markets to emerge as prescribed by the Constitution. The 2005 reform established licensing fees for unused rights and a presidential discretionary power to eliminate certain water rights from economic competition in order to “protect the public interest” and included issues of environmental sustainability that had not been addressed in the 1981 Code (Williams & Carriger 2006),. The reform also recognized water users’ right to form unions and organizations that would be recognized as a legal entity, allowing groups of users with similar interests or in the same geographic region to be a more powerful voice in decisions that would impact their water use. The text of the reform preserves the original spirit of the first water code, including provisions to ensure the security of individual water rights. For example, regarding procedures to give up one’s water rights, the reform specifies that any surrender of water rights must be public, and be done in a way that is “not to the detriment of others” (Article 1, Paragraph 1). At the same time, the reform establishes new rights for both the president and the DGA to ensure higher water quality and stricter environmental standards.

The environmental aspect of the reform is important to keep in mind because it was completely new to Chilean water policy. Title X of the reform is dedicated to ecological preservation, and it specifies that the DGA will in the future be responsible for the “preservation of nature and the protection of the environment” largely by establishing a *caudal ecológico mínimo*, or a minimum rate of flow in a given water source. In

addition, the DGA is directed to establish quality standards for both superficial and subterranean water sources (Artículo 129 bis 3).

Another new measure of control over water rights was that of nonuse fees (or *patentes*.) These fees are levied once the right is found to be unused, and the reform creates a system of escalating fees. The first fee is determined by a preset equation that varies from region to region. For the next time bracket, from six to ten years of nonuse, the annual fee paid for the first five years will be doubled. From ten years onward, the original fee will be quadrupled. Exceptions to these fees are water rights below a certain flow threshold, 10 liters per second between the north of the country and Santiago and below 50 liters per second in the rest of the country (Artículo 129 bis 5). The DGA is to publish a list of the water rights subject to these fees every January, and the fees are to be paid in March of each year (Artículo 19 bis 7). In the case of a non-payment, the DGA must contact the rights-holder with an official letter requesting payment. The holder then has until the first or the fifteenth of that month to pay for the right. If that term passes, then the DGA must advertise the right for auction in the newspaper of the province the right is contained in.

Transaction Costs in the Water Market

In the previous sections, the water code was introduced, its purpose outlined, and its reform summarized, this section looks at the factors that may impede its implementation as a free market allocation system for efficient water use. In the space between the written policy and actual transactions between water rights owners and potential buyers arise issues such as storage capability, water rights security, and contract negotiations. Many insightful publications have framed this problem in the context of

transaction costs theory, and indeed I will use this approach to problems within the system in this section. As an introduction to the next section, I would like to establish a basic understanding of transaction cost theory as it applies to a water rights market. In economic theory, transaction costs are defined as any sort of additional cost associated with an exchange of goods.

Robert Hearne puts forth a basic definition of the possible obstructions to trades in Chapter 9 of the book *Markets for Water: Potential and Performance* (1998). He outlines three main sources of transaction costs, saying that they stem from building infrastructure (storage and transfer capabilities, for example), search costs for willing sellers and buyers, and the costs associated with the security of rights (p. 142). So, within markets, issues can arise in three spheres: the physical investment in water, information about the market, and uncertainty related to the stability of water flows or the legal security of rights. Bonnie Colby also adds that policies can induce transaction costs, by creating frameworks related to transferability of rights, return flow obligations, and the timing of transfers (Easter, Rosegrant, and Dinar 1998 p. 95). This means that by imposing more regulation on markets, certain policies may have the effect of increasing user costs to the point that trades are no longer attractive.

Clearly, the Chilean government has historically attempted limit these policy induced transaction costs, whether deliberately or otherwise, by restricting government interference in the market system. Chilean water policy is modeled on the idea that an unrestricted market for water rights will result in the most efficient allocation system. Currently, the Dirección General de Aguas holds power over water rights in the following ways: to give priority to certain users in case of drought (Article 66), to declare high risk

sectors to be “areas de restricción,” implying a prioritization of rights (Article 65), and to strip owners of rights if they remain unused for a period of five years (2005 reform). The power the DGA holds over markets, however, is the ability to issue rights, to set flow limitations, to curtail rights that have not been used for five years, and to auction rights with competing applications. The most direct power that the government is allotted over the market is the aforementioned presidential discretionary power to exclude certain rights from trade (Williams & Carriger 2006).

Unfortunately, this encouragement of nonintervention also extends in the other direction, allowing transaction costs in the market to a certain extent. For example, the text of the water code notes that:

El proyecto, construcción y financiamiento de las modificaciones que fuere necesario realizar en cauces naturales o artificiales, con motivo de la construcción de obras públicas, urbanizaciones, edificaciones y otras obras en general, serán de responsabilidad y de cargo de quienes las ordenen (Codigo de Aguas 1981, Article 5(41))

This roughly translates to the idea that if people need to build modifications in waterways, the responsibility for the costs should fall on the people themselves (and implicitly, not on the government.) On the one hand, the Chilean government has subsidized projects such as dams and reservoirs in the past (Carl J. Bauer, personal communication, February 24 2010). While the government does not actively seek to encourage trade, it has shown interest in encouraging water rights security as well as expanded irrigation capability (Robert Hearne, personal communication, February 22, 2010). On the other hand, it is difficult to conceive of users having enough motivation to build this sort of infrastructure by themselves, especially if it is only for one trade. While

large users such as power companies, for example, are able to shoulder the costs of infrastructure if necessary, other users may not be willing or able to do so (Carl J. Bauer, personal communication, February 24 2010).

Another transaction cost that the government may have inadvertently created is that of information sharing. Historically, records on registration and trades have been kept by local real estate agencies. This does seem efficient at first, as record keeping is more easily done from the bottom up. However, this system could clearly become a problem in cases where water is bought from one region, and transported to another for use, or even in cases where it becomes necessary to evaluate water-trading activity. This issue will be discussed in more detail in the Policy Recommendations section.

During the 1990s, many research studies were conducted into the activity of water markets in various regions throughout the country. As this research unfolded, so did the debates that eventually led to the water reform of 2005, though not all of the results were not addressed in the 2005 reform. It is important to remember that, as Bauer noted in 2003, the studies and published reports on the success of the water code underwent a great deal of evolution: while at first, most reports were overwhelmingly positive and declared the market system a success, they gave way to more balanced and more empirically based research studies conducted in the mid to late half of the decade (p. 5). These studies collectively suggested that trade was not common in many parts of Chile, and moreover that there were large discrepancies between different regions in terms of trade activity. This in turn suggested that the efficiency maximization that had been expected as a result of market reallocation might not have come to fruition in those years either (Bauer 2003 p. 6).

Hearne and Easter (1995) explored markets in four river valleys and noted differences in the amount of trading occurring as well as possible explanations for these discrepancies. They found that of the four valleys, only one, the Limarí experienced frequent water trading (p. ix). However, efficiency increases occurred when permanent rights were transferred to higher-valued uses no matter where the trades occurred (p. x). The authors attribute the active trading in the Limarí valley to “modern infrastructure and well-developed WUAs” (Hearne & Easter 1995, p. 32). The valley’s canal system was able to help users who wanted to trade physically transfer water, and the water user’s associations were able to provide additional services to enable the community to engage in trade (Hearne & Easter 1995, p. 39).

Carl Bauer outlines several important studies that are “available only in Spanish and are largely unknown outside of Chile,” that nonetheless contain similar observations as Hearne and Easter’s 1995 study (Bauer 2004, p. 83). Salient trends in this research were the transaction costs stemming from a lack of infrastructure, as well as insufficient information and recordkeeping (Bauer 2004, p. 85). Additionally, water rights security as a limitation to trade emerged, although the rest of this paper will focus more on issues of information and infrastructure.

Water User’s Associations

The previous section mentioned Water User’s Associations as an important aspect of communication and infrastructure maintenance in irrigation in many river basins. Since Water User Associations will be mentioned again in the Policy Recommendations section, it is important to establish a working understanding of their structure and current level of interaction with the Chilean government. Indeed, the Chilean government has

effectively “devolved the management of irrigation facilities to water user groups and their umbrella organizations,” creating opportunities for users to share costs and work together to encourage market activity (Berger et al. 2007, p. 130). In the recent past, the Chilean government subsidized the construction of canals and reservoirs in many river basins; however, Bauer identifies the question of how to make these investments attractive without government funding as an emerging issue (Bauer 2004, p. 117). This creates a problem in terms of incentives: while storage and transfer capabilities are necessary to facilitate trade, a single user will likely be unable to invest in creating these structures for a one time transaction. An exception to this observation would be large power companies, which are able to put forth large amounts of investment in order to get to the water rights they need (Bauer Interview.)

There are three types of water user associations in Chile: *Comunidades de Agua*, which monitor water activity at the lowest level between users, *Asociaciones de Canalistas*, which maintain the canals, and *Juntas de Vigilancia*, which oversee the diversion of water from rivers and streams to canals (Berger et al. 2007, p. 132). These groups are linked administratively to the DGA, as the Dirección de Obras Hidráulicas, which is responsible for infrastructure maintenance. These water user associations are typically used by irrigators, and they provide an important basis for future policy reforms, as will be discussed in the policy recommendations section of the paper (Berger et al. 2007, p. 130).

Comparative Water Policies

This section of the paper will compare the Chilean system of water resources management with that of two other countries, Australia and the United States. These two

countries were chosen not only because they also utilize markets as a resource allocation system to some degree, but also because they have similar patterns of water uncertainty in at least some parts of the country. It is interesting to compare the Chilean system to two countries with very different political histories, geographic locations, and sizes because it creates a wide range of historic responses to similar problems, especially those of hoarding and speculation. Observations from these comparisons will later be used to guide the policy recommendations section at the end of the paper.

Comparison 1: The Australian System

Australia provides a valuable example because water policy makers in both countries face issues of drought, creating a policymaking environment characterized by uncertainty as to water flows from year to year. Australia's largest water basin, the Murray-Darling Basin, spans four states as well as the Capital Territory of Canberra, and is managed by representatives and ministers from all of those states and the federal government. Actions taken by this governing body thus span a large landmass and affect many people. The Chilean system has already been in practice for more than a decade when a 1994 reform introduced tradable water rights, but there are still many valuable lessons to be learned from the Australian experience and approach to water rights. This is partially because most states had tradable water rights in some form many years prior to the 1994 reform, and also because once the 1994 reform was introduced, federal and state governments faced issues similar to those Chile has encountered.

The motivation to introduce tradable water rights in Australia on a national level stemmed from a few different factors. First of all, drought became a major consideration

after 1970, when a trend towards declining rainfall became noticeable (Quiggen 2007 p. 5). Although in terms of water per capita, Australia has “abundant” resources, variability is as much a problem for Australia as it is for Chile, both in terms of time and in terms of regional water disparities (OECD 2009 p. 398). In fact, Australia faces a “spatial inconsistency between water availability and water demand” that relates quite well to Chile’s geographical distribution of water (Saleth & Dinar 1999 p. 22). For Australia, then, it seems that the key motivator for water reform was to smooth consumption levels—both over time and space.

Despite any differences in motivation or historical context, however, it is clear that both countries have faced similar issues due to markets for water. This provided the impetus to create reform that would address the “economic, environmental, and social implications” of poorly allocated water resources (COAG 1994 Paragraph 1). Thus, the reform would proceed, through economic channels, to revise the distribution of water to reflect principles of cost recovery as well as environmental concerns. In this way, the motivation to a market based distribution mechanism is markedly different from that which inspired the Chilean system. While markets were the veritable foundation for the Chilean system, for Australia they were introduced as a way to target specific problems within the established policy, which had until that point been administered by the federal and state government.

The 1994 Water Reform Framework endorsed a market for water that would, partially through pricing mechanisms, “achieve an efficient and sustainable water industry” (COAG 1994 Paragraph 2). The 1994 document addresses many of the issues that have already been mentioned in relation to Chilean water policy. As it was argued in

the previous section on transaction costs, a key aspect of any water market system is that rights be secure: otherwise, trading may not occur. The 1994 document specifies that water right be separate from land and that States issue formal allocation permits to water users, but also that, for environmental concerns, the State reserve the legal right to review user activity five years after an allocation is made. Rights security became a pivotal issue in later years, as the appropriate level of rights security was debated. The Organization for Economic Cooperation and Development notes the tension between the need to keep intervention costs low in case of environmental concern and the desire to encourage trading by lowering the potential costs associated with relatively weak rights (OECD 2009, p. 404).

The government noted that because the changes were to be so sweepingly broad, that an implementation period of five to seven years would be necessary (Communiqué 1994). This period proved to be full of challenges for the government at the federal and state level, as OECD describes. Because the reform was to be implemented by the states, and because differences in rainfall between states are so pronounced, it was difficult to coordinate implementation between states. This recalls the problem of inter-region disparities in Chile as markets were much more active in certain regions than others, although these problems were caused by a different set of issues.

Introducing market mechanisms created a novel set of issues for the Australian government, but for readers of this thesis, the problems will seem very familiar. The first problem that emerged was hoarding since the tradable rights were a valuable resource, “landowners rushed to capture [rights ownership] before controls were established in this capability” (Quiggin 2007 p. 9). In this way, the immediate effect of Australia’s transition

to a market mechanism was that many rights were claimed, without a specific usage intention. This also resulted in many more rights being issued than may have been advisable given year-to-year flow variability.

While Chile eventually chose to address this problem with agency oversight for unused rights (the ‘use it or lose it’ provision of the 2005 reform), the Murray-Darling Ministerial Council chose to address it on a broader level in southeastern Australia by instating a temporary cap on all water rights in 1995 to be set at usage levels for the year 1993-1994 (Murray-Darling Ministerial Council 2008). Another emerging problem is that of interstate and inter-locale (urban to rural or vice versa) trading. Quiggin (2007) notes that because each state has created rights in its own legislation, that rights do not necessarily transfer between states cleanly and may require “some form of ‘tagging’” before they can be transferred before users in different states can trade, which is currently being addressed by agreements between states (p. 11). Chile has avoided this sort of problem by establishing water rights under a single national agency, the DGA, though of course centralized management of water resources in such a diverse country brings its own set of issues.

Australia’s water system yields several important insights into the management of water markets in general. First of all, the idea of a cap on water rights is a very interesting one, as it is an avenue that has not yet been a large part of Chilean policy. One thing that the Chilean system emphasized continuously in the past is the security of water rights, and an important component of rights security is accessibility. It is important that the water rights issued not exceed the availability of water, and a cap may prove a valuable stopgap if important policy changes are made in the future. Practical implications such as

measuring consumption are also extremely important considerations in evaluating the effects of different policies. In fact, the 1995 cap was implemented as a result of an intensive evaluation of water use in the Murray-Darling Basin (MDC 2008). In Chile, empirical scrutiny of the water markets did not gather momentum until the mid-1990s, but it was those very results that helped to shape the reform debates that occurred throughout the decade. Clearly, stepping away from the goals and motivations of a policy in order to evaluate its results is a step that should be taken often to ensure the quality of the policy implementation.

Another pertinent idea is that of full cost recovery addressed by the market system. As McKay (2005) notes, using a price based mechanism to control allocation would “account for infrastructure costs and the variable costs and would also include a component to capture opportunity costs, environmental costs, and society costs” (p. 48). This philosophy recalls the earlier discussion of transaction costs, the idea that trading may not come to full fruition without the proper infrastructure, which may not exist or be too expensive for users to establish. Therefore, this idea may be a valuable one, as it views the market as not only a means to efficient allocation, but also as a tool for the promotion of other important national agendas. Although manipulation of price to capture facets of water other than scarcity is a fairly novel idea in Chilean water policy, Chile’s aforementioned environmental goals make this idea worth examining.

While Australia’s implementation of a water rights market is very different in terms of motivation and historical context from Chile’s, the countries’ similarities in terms of problems associated with water resources make this comparison very valuable. Furthermore, the fact that Australia implemented a water market as an add-on to an

established system yields important lessons in terms of implementation and evaluation that Chile could learn much from. Lastly, Australia's interesting techniques for cost management are very unique, and knowledge of them is a valuable asset for any Chilean policymaker attempting to fine-tune the market system.

Comparison 2: The Southwest United States

Most of the southwestern states of the US use the appropriative system to allocate water rights, making them a useful point of comparison to the Chilean system. While both systems entail tradable water rights, the system in the United States exercises more control over individual rights than the Chilean system, creating interesting implications for the appropriate amount of government or administrative guidance over water rights once they are issued.

Water rights in the United States generally fall under either the riparian system (in the East) or the appropriative system (in the West.) Under the riparian system, water rights are issued mainly based on property rights: thus, any property owner along a waterway would be entitled to “unimpaired use of the waterway, regardless of the location of his property...and regardless of the time at which the property is acquired” (Burness & Quirk 1979 p. 25). This system also entails severe restrictions on diversions in the interest of preserving the idea that a riparian right holder cannot impair other riparians from using the water. On the other hand, the appropriative doctrine implies that rights are established through use, in terms of time, continuous use, and beneficial use. Technically, an appropriative right is defined by Hutchins (1977, p. 226) as

an exclusive right to divert from a public water supply a specific quantity of water-provided it is available there in excess of the requirements of all existing vested rights-

and to apply such water to a specific beneficial use or uses in preference to all appropriative rights of later priority.

This means that appropriative rights are defined in specific amounts of withdrawal, and that they are further subject to restriction based on the use they are put to, and moreover, whether users who established their rights first have been able to fulfill those rights. In terms of federal-state relations, “state water laws cannot be self-contained units” because Congress must approve any projects involving the state building dams, dikes, or other such structures in “navigable waters” (Hutchins 1). Nonetheless, states remain quasi-sovereign governing bodies who have the power to determine which bodies of water are subject to appropriative rights, as well as who has the right appropriate water. Still, many of the Western states share similar regulations, and most of the differences seem to stem from the regulation of groundwater, as some states will not allow appropriation of groundwater that is not part of a stream.

As previously stated, the appropriative system entails many more forms of control over water rights than the Chilean market system. While rights are transferable, there are many instances in which a water user might have to forfeit his right to water. The most well-known, and possibly the most referenced of these is forfeiture, or the “use it or lose it” doctrine, which states that rights that are not put to a good and beneficial use for five continuous years will be lost. This aspect of the system was referenced widely in much of the literature covering the Chilean system in the early 1990s, and this idea was also reflected in the 2005 reform. Outside of forfeiture, there are a few other conditions that could cause a user to lose his water right. The first of those is “using water in a manner that creates egregious water loss” (Ruml 2005, p. 171). A second is through

abandonment, which requires establishment of “intent to abandon and...an actual relinquishment or surrender of the water right” (Ruml 2005, p. 172). A last way is through a failure to satisfy the historical use requirement, which essentially means that users are limited in changing how they use their water rights by the use to which the right has historically been put. These restrictions have been refined since the system began in the 1850s, and in recent years, economists have begun to examine the rights system from the same transaction costs perspective⁹ that has characterized exploration into the Chilean system.

In 2005, C. Carter Ruml applied the Coase Theorem to the appropriative system as a whole, using evidence from different states to argue “the system at large is not at Coase Equilibrium, but that Equilibrium does prevail inside the water institutions” (Ruml p. 170). Because of the nature of the transfer process, there are quite a few possible blocks to transactions, which Ruml outlines in the paper. First of all, he points out that during water shortages, “the burden of shortage falls completely on junior appropriators,” and because of this, there is a group of users that would benefit if they “could demonstrate that more senior appropriators were no longer entitled to their diversions” (Ruml 2005, p. 174-175). In addition, the transfer process itself creates some difficulties in terms of transaction costs. The usual procedure for transferring water rights in the Western states is somewhat lengthy: an application must first be made to the state water administration, which are then published in newspapers (Ruml 2005 p. 176). At that point, any opponents of the transfer can make their views known, and if the

⁹ See Bonnie G. Colby’s 1990 article in the American Journal of Agricultural Economics for an example of this sort of analysis in a Western USA context.

administration or court deems it appropriate, the parties to the transfer may need to revise their proposed use for the water right.

Ruml asserts that several areas in the transfer process can create transaction costs for the parties involved. Perhaps the most compelling is his analysis of the cost the transfer process adds to the value of the water right being transferred. Because of the extra costs associated administrative and dispute resolution, up to \$300 per acre-foot could be added to a \$1500 per acre-foot purchase (Ruml 2005, p. 178). Because value would be distributed over a lower volume of water in smaller purchases, the author argues, this added cost would defer small scale transfers from occurring, possibly creating an efficiency problem. In addition, time is a possible obstacle for transfers based on the sorts of protests that might occur. There is also the possibility that potential traders may not engage in transfers because of the perceived costs associated with the process, a problem of self-screening (Ruml 2005, p. 177).

Another paper examining transaction costs focused on water transfers in California, specifically a transfer between the Owens Valley and Los Angeles, which became “a pivotal episode in the political economy of western water allocation” due to its contentious nature and the nature of the two parties (agricultural users transferring to urban users) (Libecap 2004, 1). This is a historically important transfer because it was the first of its kind in the American West (Libecap 2004, p. 2). Essentially, this was a shift of water rights from agricultural uses in the Owens Valley, to urban uses in the city of Los Angeles. Because the two parties involved (individual farmers and a city board) had such different interests and approaches to valuing water that many bargaining disputes occurred. Because water was attached to farmland, the city was compelled to purchase

large amount of farm land in order to create an aqueduct through which to withdraw water (Libecap 2004, 9).

The arrangement created massive transaction costs due to issues associated with negotiations and measurement. For example, in valuing the land to be transferred, the Water Board of the city wanted to use the agricultural value of the land, whereas the landowners wanted to value it based on Los Angeles land and water values, because they perceived the key motivation for the city to be the water itself. Further, the board wanted to make sure that excess water, which may not have held much value for agricultural purposes, was valued according to its benefit to the city (Libecap 2004, p. 10).

Eventually, the landowners called for binding arbitration to establish price (Libecap 2004, p.12). These actions eventually led to losses for the town of Owens Valley, whose Reparations Committee demanded the city Water Board to pay compensation for damages caused by economic deterioration (Lipecap 2004, p. 10). Overall, the exchange was rife with transaction costs, and tension between the parties ensured that there would be no quick solution to the problems the transfer had caused.

The experience of the Western United States demonstrates the problems that water markets can encounter if they are regulated with a more heavy hand than is used in Chile. Whereas both systems operate on an implicit idea that efficient use will eventually emerge through tradable water rights, the United States takes proactive steps to ensure that water rights will not fall into disuse or abuse, and Chile favors safeguarding the liberties of individual rights holders. We can see that both philosophies can result in a loss of efficiency, and interestingly, the transaction cost issues arise frequently in both systems. In the US, however, these transaction costs seem to be more associated with the

legality and processing of the transfer itself: users, especially those who wish to convert a water right to a novel use, have much less freedom to do so than Chilean users. At the same time however, Chilean users may never reach the point of transfer without appropriate structures, such as dams or aqueducts, in place.

In a sense, the two policies mirror each other in that there are gaps or possible flaws on opposite sides of a market transaction. In Chile, users may hesitate to even enter an agreement in the first place because proper infrastructure is not in place, whereas in the Western United States, users may be discouraged by the extra cost added by legal and administrative fees. This has a few implications for future reform in Chile. First of all, that perhaps striking a balance between the two systems could result in lower transaction costs for all users. In addition, the US experience, especially the Owens Valley-Los Angeles transfer case study, can also yield some important lessons in terms of inter-sectoral transfers, something that has proven a problem in all of the water allocation systems that have been examined in this paper.

Policy Recommendations

This paper has focused mainly on the ideological foundations of Chilean policy and the problems with the market system that have arisen due to transaction costs and the variability of water in a given year. The implications of these problems, discussed in detail in the previous sections, are that users are deterred from trade due to additional costs inherent in completing a trade, or by the risk of lower water flow from year to year. The following recommendations can be organized in two groups: the first three examine ideological conflicts inherent in water policy reform and discuss options for the new

Piñera administration; the other two are of a practical nature and are geared to improve efficiency in the system.

Recalculating Social Benefits

A key conflict in the Chilean market has is that of disproportionate incentives and benefits associated with conflicting uses of water. Bennett (2005) suggests that in Australia and in water markets in general, it is important to equalize the marginal social benefits of water use if water is conceived of as a public good (p. 10). He notes that, ideally, policymakers would want to be able to establish trade offs between different uses of water: environmental conservation versus in-home consumption for example.

In Chile, this sort of competition has emerged in ways that are sometimes quite shocking: examples such as that of the town Quillagua mentioned in the introduction of this paper illustrate the loss of welfare that can occur when benefits and costs are not appropriately assessed in water allocation. Because water is defined in the constitution as a national resource for beneficial use, it is important that the government take steps to weigh the costs and benefits of different uses of water, even though the market system does not allow the government to allocate water explicitly.

Furthermore, this sort of knowledge could help direct future policy efforts, especially in the case of externalities associated with active trading. In fact, as active trading begins to emerge in more regions, it will be especially important to consider the fact that the Water Code does not currently include any provisions for how to control or mitigate externalities caused by water transfers (Bauer 2003, p. 7) In addition, it may be important to be able to evaluate the risks of the previous 2005 reform. For example, Hadjigeorgalis (2006) points out that what has previously been termed as speculation in

this paper served as an important insurance policy for small farmers, and that restrictions on unused water may have the unintended effect of taking away an important risk-sharing capability among farmers (p. 24). Exploring this tradeoff may prove to have important implications for the future direction of water security, whether in a regulation or a user-oriented context.

Even if the government does not use this information to reallocate water, it can be used to guide price signaling, a practice that is highly recommended in markets for scarce resources. Additionally, if research is done to establish these tradeoffs, it can be used to guide a Proportionality system as discussed below.

Rethinking Water as a Resource: Legislative Options

With the new Piñera administration due to take power before this paper is completed, it is important to discuss the ideological conflict that continues to characterize much of the discussion of water policy in Chile. Before the recent elections, Michelle Bachelet introduced a Constitutional reform bill to Congress to address water scarcity. This reform recognizes water scarcity as a threat to national security, which implies that the government would have the right to restrict private water rights holders' use of water in case of a crisis (Estrada 2010). The reaction to this bill exemplifies an essential conflict behind much of the disagreement over water reform in Chile. While the Bachelet administration held that this reform was important to the sustainability of water as a resource, many associations such as the National Society of Agriculture, which represents large landowners mostly in the Central Valley immediately voiced worries that the bill would allow the government to expropriate water without compensation (Estrada 2010). In addition, the new Piñera administration, because it represents certain conservative

interests, has little incentive to continue this reform in the coming years. This illustrates a crucial issue: that the constitution was written with secure, tradable water rights in mind, yet the government remains divided as to how extensive this security should be, especially when considering water as a sustainable resource, over an economic one.

This inherent political conflict is one that reaches far beyond water policy, and it may be years before different political parties can come to an agreement in terms of how much further the current policies can be amended without restraining the market unfavorably. However, one strategy that might be employed to address water's status as a scarce resource is a shift in allocation to a Proportionality System. This policy would issue rights as shares of water, rather than explicit quantities (Easter, Rosegrant, and Dinar 1998, p. 23). Hearne (1995) notes that this definition of rights as shares is what has generally occurred in practice, however the Code itself recommends that rights be issued by a "volume of flow per unit of time" (p. 6). If this practice was to be officially adopted in the law, variations in water availability could become a risk that is shared by all users (Easter, Rosegrant, and Dinar 1998, p. 23). This would require additional resources to either forecast or measure the amount of water for a given time period; however, the added benefit or risk sharing, especially in regions with highly variable flow from year to year, make this system worthy of consideration.

Rethinking Water as a Resource: Market Options

Ereney Hadjigeogalis puts forth some very interesting ideas for market risk-sharing instruments in a 2006 paper presented at the Western Economics Forum, and I summarize them here as interesting directions that markets might take in the future. As was previously stated, spot markets, or temporary trades for water, are highly utilized but

not necessarily efficient ways for users to deal with water scarcity from year to year.

Options to make these temporary water needs more efficiently met involve purchasing water rights in advance, in anticipation of drought. The benefit here is that users can avoid price hikes in years that they need water, and also assure themselves of the stability of their future water endeavors.

The first approach of this nature is that of a water bank (p. 25). This would entail a locally managed water pool, through which users could buy price-controlled shares of water in times of need. In the past, this approach has been implemented mostly by state and local governments (p. 25). However, this seems to be something that could be implemented by Water User Associations, given that the WUA is managed by directors who do not have a particular stake in certain users being given priority to water reserves. The cost of purchasing these rights could be an opt-in system, where willing users contribute funds to purchase reserve water and then enjoy the privilege of withdrawing it at will without being accused of speculation; or it could be a cost absorbed by higher user fees for all members and the resulting water distributed back equally in times of drought.

A second approach is that of “water derivatives” (p. 25). In this case, users would be able to contract obligatory fixed-price purchases of water years into the future in anticipation of need, or they could purchase an option to buy a water right at a specified time and then pass on that purchase if they do not need additional water then the time comes (p. 26). These water purchases were coordinated by the established water banks in practice, in an experimental program in the mid-1990s (p. 26). The program was rendered unnecessary due to “abundant rainfall” in the year it was implemented, but sellers were able to retain a total of over \$100,000 due to the options paid by the buyers (p. 26). Since

the Chilean market is far less restricted than the United States markets, and faces the same uncertainties in terms of rainfall variation, these market mechanisms are a worthy point of consideration in the coming years, especially because they do not entail major framework changes but rather a refinement of the market system already in place.

Centralized Record Keeping

Centralized record keeping for water trades would be a tremendously helpful addition to the national water policy. Currently, records of transactions are kept on a local basis by real estate agencies. This makes national coordination difficult because the records, while improved from the early 1990s, are not fully available in one location. While data from the past few years is available on the DGA's website, it is not completely comprehensive, and as Bauer (2004) suggests, some rights may go unregistered as smaller volume users may prefer to keep away from formal procedures to register rights (pp. 95). In addition, temporary trades in which users buy excess water rights from other users for a short amount of time; often go unrecorded (Hearne & Easter 1995, p. 2). As Hadjigeorgalis (2007) and others have noted, these temporary trades serve an important purpose as stopgap in drought years, especially for small famers (p.1). At the same time, though, these "spot market" transactions are likely to be very costly, and also to create loss for farmers if they are unable to afford the high cost of additional water when demand is high (Hadjigeorgalis 2006, p. 25). Record keeping of these sorts of rights and transactions could yield valuable insight into the markets and actual usage of water in ways that have previously been accessible only through fieldwork.

The benefits of a central, comprehensive database for trades are numerous. First of all, they would encourage and assist in future empirical analyses of the markets. It

seems that most studies of transactions in the past ten years have focused on a limited amount of regions, but with a centralized system would come the ability to conduct comparative studies on a national level. Additionally, a centralized system would enable policymakers to evaluate active withdrawal. Lastly, in the past, the DGA noted that it has had trouble performing its monitoring function because of a lack of information, especially in terms of water use conflicts (Ríos Brehm & Quiroz 2000, p. 22).

Bennett (2005) suggests that a comprehensive registry system could be broken down into two parts: the titling, or rights registry function, and also the resource management function, which would record actual trades (p. 86). In this way, rights holdings and rights trades could conceivably be administered separately. While this may seem counterintuitive, it could in fact have two significant benefits. First of all, it would put less of a strain on government funding (if the trades register were to be implemented by the government), because the agency would only be keeping track of transactions, leaving registration and maintenance of water rights to local agencies. Secondly, this separation of the accounting function would provide a useful crosscheck for the local water registries, and periodic comparisons of the two could ensure that accurate information is being recorded. Because the proper functioning of markets is a priority for the government, it is sensible for the national government and the DGA to keep these transaction records, while rights registers, which are of more local concern, could be kept at the local level.

Water User Associations Coordination

Well-organized water user organizations were found to be beneficial in encouraging active markets in many cases. While two of the three types of water users'

associations have legal status in that they can take out loans once they are formed, only one type is monitored directly by the DGA (Rios & Quiroz 1997, p. 4). In 2009, Nancy McCarthy and Timothy Essam found that, in irrigation associations, economic heterogeneity in groups of water users led to less participation by and communication between, those users in collective maintenance of irrigation structures. A formalized structure for these associations that would encourage participation by offering legitimized security and incentives for users to participate could balance the mix of different users in a given basin.

User organizations are an effective means to share costs for necessary infrastructure and maintenance of the water supply. If the Chilean government were to assist these groups of users by linking association leadership with established governmental water authorities, as McCarthy and Essam suggest, they could encourage full participation by all users (2009, p. 32). Government oversight could look to well-managed water user associations as a model to train local leadership and facilitate more cohesive relations within groups. In turn, this group cooperation could help to resolve some issues of transaction costs: a cohesive users group could share costs for infrastructure, not only for the use the water will be put to (i.e. irrigation), but also for reservoirs and other trade-enabling features. In addition, formal water users associations would facilitate information sharing among users in case of scarcity or water contamination.

Conclusion

This thesis set out to explore the political, economic, and geographic background of the current Chilean water policy, with the end goal of evaluating the success of the

policy, comparing it with other systems, and contributing recommendations for the future. I conclude that due to issues arising from information sharing, geographic variability, and market transaction costs, that the water policy has been only a partial success.

This thesis yields several important points to consider in the assessment of Chilean water policy. The first is the geographical extremes included in the country's borders: the top of the country houses one of the driest deserts on earth, whereas the south of the country experiences substantial rainfall.¹⁰ Exploration into Chile's political history brought up important events that affect public reaction to new water policy proposals, including the Agrarian Reform Law of 1967, which was traumatic to many farmers and an impetus to minimize government control over private resources; the Constitution of 1980, in relation to the 1981 Water Code and 2005 Reform was discussed.

The work of many prominent scholars was synthesized in the thesis, with several important findings. The thesis emphasized transaction costs in the market system as an essential and long lasting problem for the policy. However, while the function of the market has been a source of debate and change in the past, many contemporary issues are beginning to drive the call for policy reform. One that is emphasized in this thesis is the notion of water as a resource: while this paper does support tradable water rights as a policy, it also notes the fact that defining water as solely a market good and overlooking its role as an essential human resource is a very limited perspective.

¹⁰ Please see Appendix 2 for a more detailed depiction of annual rainfall in each region.

Lastly, comparisons of the Chilean system to the Australian and Southwest United States systems yielded important insights into crafting water policy. Market based applications of total cost recovery in Australia echo an idea of a functioning market independent from government intervention. In addition, the intensive evaluation of market functions in Australia's Murray-Darling basin is a reminder of the importance of thorough evaluation of the effects of the water policy before policy changes are implemented. The experience in the Southwest United States provides a valuable counterexample of a market based policy supplemented with heavy government regulation of user rights. Transfers in the US water markets have historically been impeded by the lengthy legal processes involved in buying and selling water, and this shows that the Chilean government will have to create a balance between government checks and market based solutions to problems in the system. Lastly, case studies of intersectoral transfers in the United States (specifically the Owens Valley-Los Angeles transfer) show the importance of a central, government sanctioned system of water rights pricing and valuation that can translate between different uses of water.

All of these insights guided the final section of policy recommendations, which are geared first towards addressing the essential conflicts that seem to guide policy debate, and then towards improving efficiency in the market system already in place. In conclusion, there seem to be two sets of problems occurring in the Chilean system. The first is that of ideology and politics. Markets for water create two classes of stakeholders: those directly affected by the transfer of scarce water resources, and those who want to acquire water resources for commercial and agricultural uses. Reforms geared toward emerging environmental problems will certainly put these two interests in conflict, and

will probably become an obstacle to future policy changes, especially with a new, conservative, administration now in power in Chile. The second is a set of practical problems. Communication between users and the government is impeded by a lack of cohesive water user associations in many areas, and so too does data gathering lack on a central basis. It seems that local management and incentives for users to cooperate are lacking in many areas, creating inefficiency that results on high transaction costs for users attempting to buy and sell water. The recommendations attempt to address the ideological and practical issues discussed in the previous paragraph by encouraging political discourse to resolve lingering issues, as well as market based solutions to the market problems.

In its current form, the Chilean water policy has achieved some significant triumphs. In places where the policy has worked, it has worked extremely well: active trading has occurred, water user's organizations have facilitated communication and cost sharing, and infrastructure has become well-developed. The 2005 reform's addition of a 'use it or lose it' policy was also an important step to guide the markets away from the speculation problems that characterized the early years of the policy. Lastly, the concept of a market for water rights implies a certain degree of flexibility and quick response times that is important for allocation of a scarce resource like water, even if the market has not fully lived up to that potential in many cases.

A few areas of concern still remain for the policy, however. The first involves information sharing, both among users and among government agencies. Although some data on water transactions is currently available on the DGA website, most record keeping is currently conducted by local real estate agencies, and it is unclear how

accurate or complete the national data is. In addition, disparities between different water user's associations imply that not all users are able to share information, and that there may not be adequate networks to disseminate pertinent information on scarcity in a timely manner. Because the 2005 reform includes provisions for limited withdrawals during droughts, it is extremely important to create a network to enforce these limitations efficiently and equally in every drought-affected area. Furthermore, the current notion of water as an economic good should include a more explicit prescription for price signaling in case of water scarcity, and also for the effect scarcity should have on current water use rights. Lastly, the government should make efforts to educate the population as to the policy and possible effects that large intersectoral water transfers could have on civilian life.

Data and empirical research have historically contributed to debate and policy change in Chile, and any future investigations would do well to include empirical analysis of market activity. Another area that merits further investigation is the relationship and communication between the different levels of administration. A theme that emerged in every water resources management system mentioned in this paper is that of water price mechanisms to reflect water scarcity. Although the ability of markets to reflect scarcity in water pricing has long been hailed as an advantage, it seems that there is still disagreement across many countries as to how to put this idea into practice.

Another emerging aspect of water policy research is that of modeling demand and user relations: Berger et al. (2007) recently published an article on applying a multi-agent framework to water use in the Maule river basin in Chile. This model was able to predict the "impacts of technical change as well as informal rental markets on household income

and water use efficiency" (Berger et al. 2007, p. 130). This sort of practical impact modeling scheme could prove invaluable to future policy reform, since water is a dynamic and sometimes inconsistent resource.

Lastly, this thesis has focused mainly on water market issues that affect agriculture and other major industrial interests in Chile. This is both because agriculture constitutes 84-89% approximately of water withdrawals in the country, and also because much of the research into market efficiency issues centers on agricultural water use (EarthTrends 2003, p. 1 and Saleth & Dinar 2000, p. 180, respectively). However, in the future market issues may trend toward not only efficiency in individual sectors, but also to the interaction between different sectors as they compete for limited water resources. This has implications not only for industry and competition, but also for the environment and domestic water consumption. As markets become more active and fine-tuned, policymakers must be able to understand the possible impacts of active trading.

Overall, I conclude that the Chilean government has implemented a water policy that has excelled in certain situations, and fallen flat in others, meriting a set of policy recommendations targeted towards both efficiency and ideological resolution. The market system has proven itself to be capable of active trading, and in places where active trading has not occurred, the obstacles are clear. It also seems that in many cases, legitimate proposals to improve the market system have been blocked by political argument rather than proven shortfalls. Therefore, I would recommend the government to commit to improving the function of the markets as a top priority, as well as attempting to create market based solutions for problems such as speculation and environmental issues.

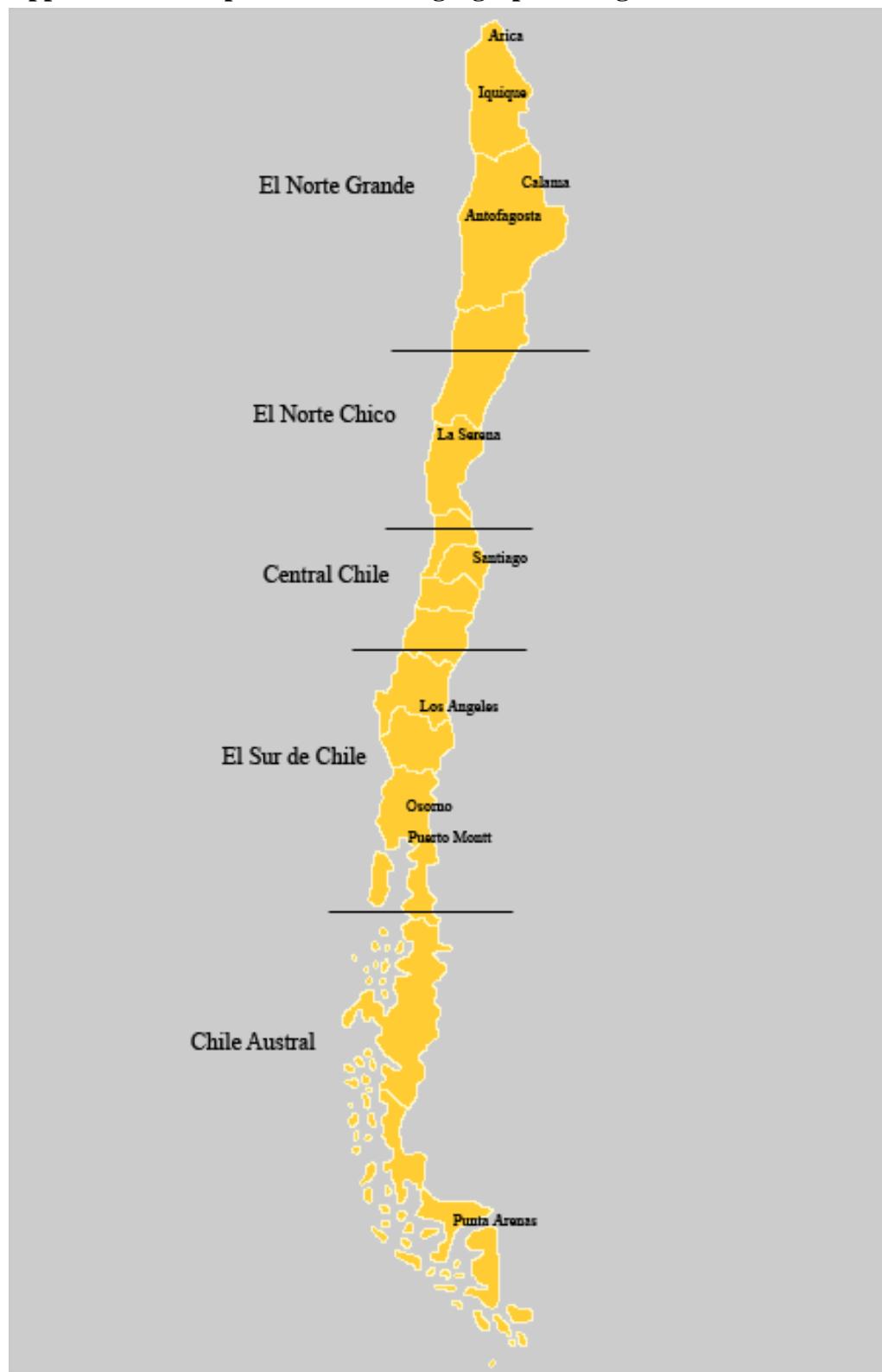
A Note on the Appendices

The following appendices are meant to give the reader of this thesis a visual representation of many of the concepts discussed throughout the paper. I have included a brief explanation of the relevance and production of each figure below.

- Appendix 1 displays the boundaries of each geographical region discussed in section 1 of the paper. It was produced in Adobe Photoshop by layering text and lines atop an existing map.
- Appendix 2 shows the average annual rainfall for numerous Chilean towns in different regions. The regional breakdown of the list of towns is displayed in both the table and the graph. This graph illustrates the distribution of rainfall throughout the country. It was created by entering a dataset from the DGA into Excel, and using Excel to create a bar graph.
- Appendix 3 illustrates average annual rainfall by month in a single city, Santiago. This figure should give the reader an indication of typical distribution of rainfall throughout an average year in a city where rainfall is plentiful.
- Appendix 4* shows the number of permanent water rights transactions that were completed in each geographical region in 2009. For a more detailed explanation of the significance of this figure, please see the appendix.
- Appendix 5* shows the amount of permanent water rights transactions completed by municipality in 2009. This figure was an important intermediate step in producing the figure shown in Appendix 4.
- Appendix 6* shows the number of permanent water rights transactions completed in each month in 2009, with the exception of October-December due to insufficient data.

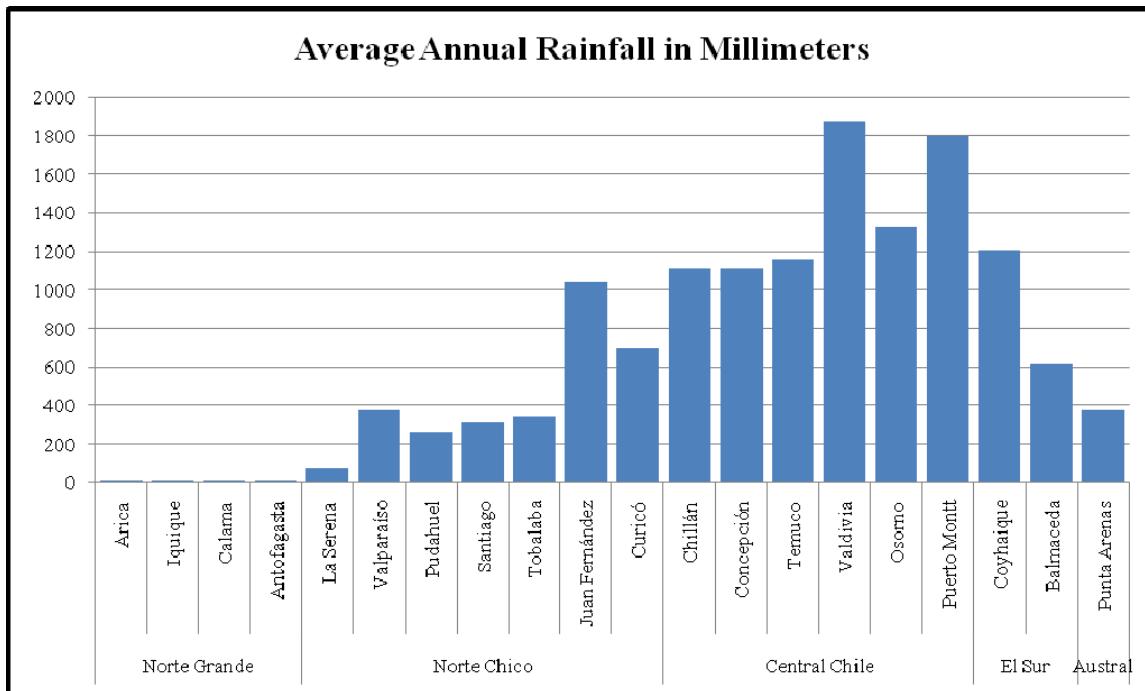
* The figures shown in Appendices 4-6 were produced using a data file downloaded directly from the DGA website. However, it is possible that the data is not all-inclusive, due to discrepancies in abbreviations found in the data file. However, it can be interpreted as a representation of the volume of transactions that likely occurred in the year 2009.

Appendix 1: A map of Chile and its geographical regions.



Source: Adapted from Trek Earth Maps, http://www.trekearth.com/images/maps/Chile_map.png

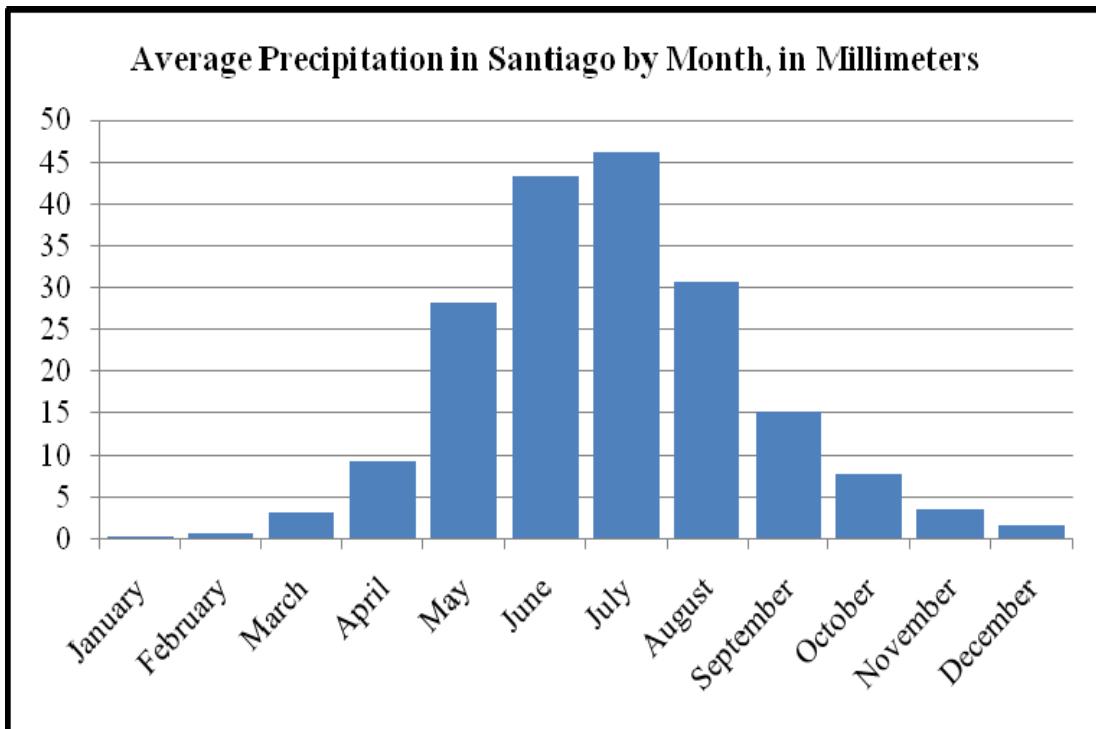
Appendix 2: A sampling of annual rainfall for various Chilean towns.



Region	City	Annual Rainfall (mm)
Norte Grande	Arica	0.5
	Iquique	0.6
	Calama	5.7
	Antofagasta	1.7
Norte Chico	La Serena	78.5
	Valparaíso	372.5
	Pudahuel	261.6
	Santiago	312.5
	Tosalaba	347.2
	Juan Fernández	1041.5
	Curicó	701.9
Central Chile	Chillán	1107
	Concepción	1110.1
	Temuco	1157.4
	Valdivia	1871
	Osorno	1331.8
	Puerto Montt	1802.5
El Sur	Coyhaique	1205.9
	Balmaceda	611.6
Chile Austral	Punta Arenas	375.7

Data Source: Created using data from the Dirección Meteorológica de Chile,
<http://www.meteochile.cl/precipitacion.html>

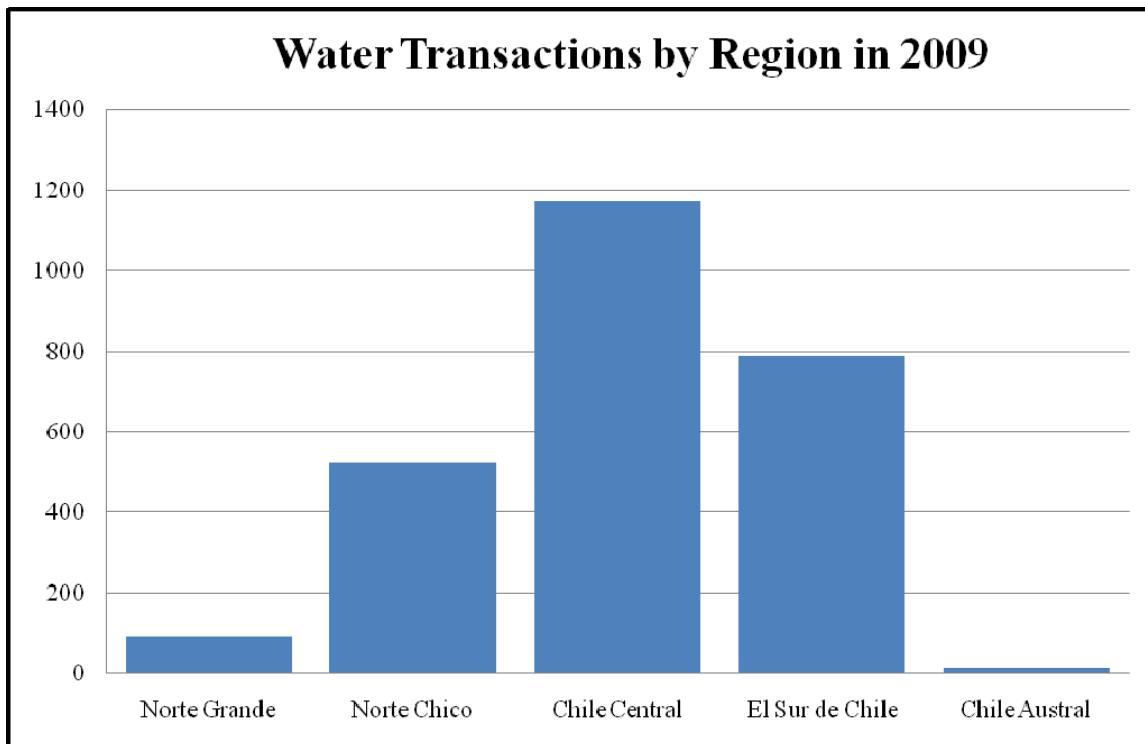
Appendix 3: Variation in rainfall throughout an average year in Santiago.



Month	Precipitation
January	0.3
February	0.7
March	3.1
April	9.3
May	28.1
June	43.2
July	46.2
August	30.6
September	15
October	7.7
November	3.5
December	1.6

Data Source: Created using data from MSN Weather,
http://weather.uk.msn.com/monthly_averages.aspx?wealocations=wc:CIXX0020

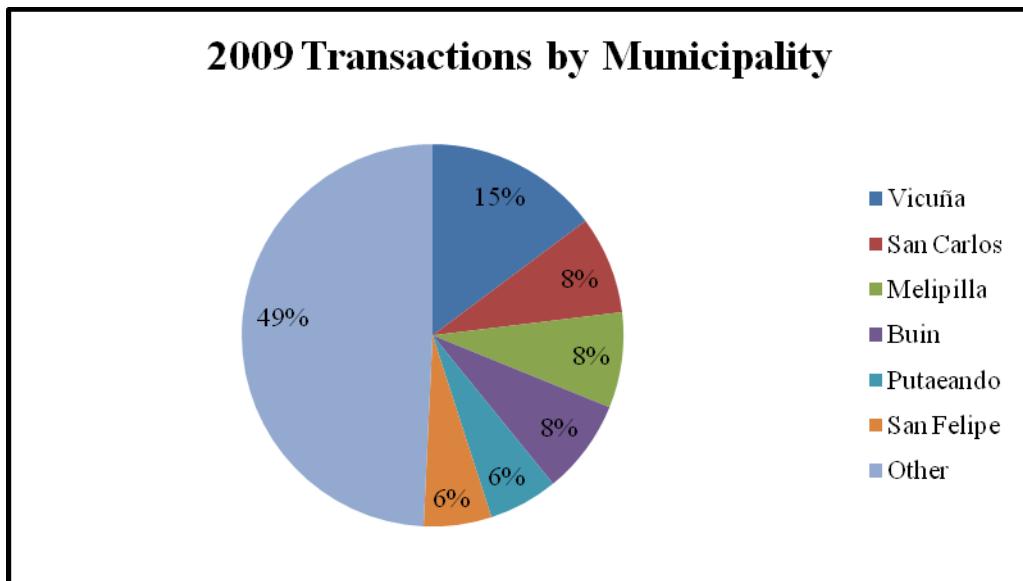
Appendix 4: Permanent water rights transactions by region in 2009.



Region	Transactions	% of Total
Norte Grande	94	4%
Norte Chico	523	20%
Chile Central	1171	45%
El Sur de Chile	787	30%
Chile Austral	13	1%
Total	2588	

Source: Created using data from the Direccion General de Aguas.
<http://www.dga.cl/index.php?option=content&task=category§ionid=26&id=242&itemid=368>

Appendix 5: Permanent water rights transactions by municipality in 2009.

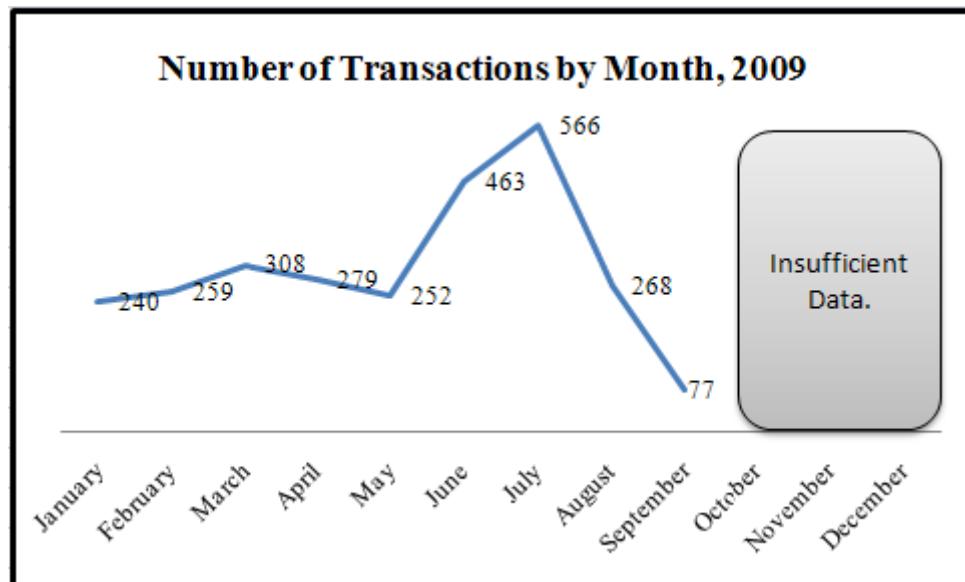


Municipality	Percentage	Number
Vicuña	14.79%	388
San Carlos	8.27%	217
Melipilla	8.08%	212
Buin	8.00%	210
Putaeando	5.87%	154
San Felipe	5.75%	151
Other*	49.24%	1292
	Total	2624

*Note: 'Other' includes all municipalities with less than 5% of total transactions for 2009. These municipalities are as follows: La Calera (4.46%), Los Angeles (4.34%), San Bernardo (3.93%), Vallenar (3.89%), San Fernando (3.62%), Los Andes (3.16%), Chillan (3.09%), Casablanca (3.05%), San Vicente (2.55%), Arica (2.48%), Bulnes (1.94%), Santa Barbara (1.91%), La Ligua (1.49), Pozo (1.33%), Limache (1.18%), Peralillo (1.14%), Cabrero (0.99%), Calama (0.88%), San Antonio (0.65%), Copiapo (0.61%), Peumo (0.61%), Coyhaique (0.38%), Lautaro (0.30%), Osorno (0.23%), Pozo Almonte (0.23%), Puerto Montt (0.19%), Villarrica (0.15%), Chile Chico (0.11%), Mulchen (0.11%), Coronel (0.04%), Puerto Alto (0.04%), Quilpué (0.04%), Valparaíso (0.04%), and Vina del Mar (0.04%).

Source: Created using data from the Dirección General de Aguas
<http://www.dga.cl/index.php?option=content&task=category§ionid=26&id=242&itemid=368>

Appendix 6: Permanent water rights transactions by month in 2009.



January	240
February	259
March	308
April	279
May	252
June	463
July	566
August	268
September	77
October	Insufficient data.
November	Insufficient data.
December	Insufficient data.

Source: Created using data from the Direccion General de Aguas
<http://www.dga.cl/index.php?option=content&task=category§ionid=26&id=242&itemid=368>

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